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The changeover from the NEDC to the WLTP and its impact on the effectiveness and the post-2020 update of the CO_2 emission standards

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Summary

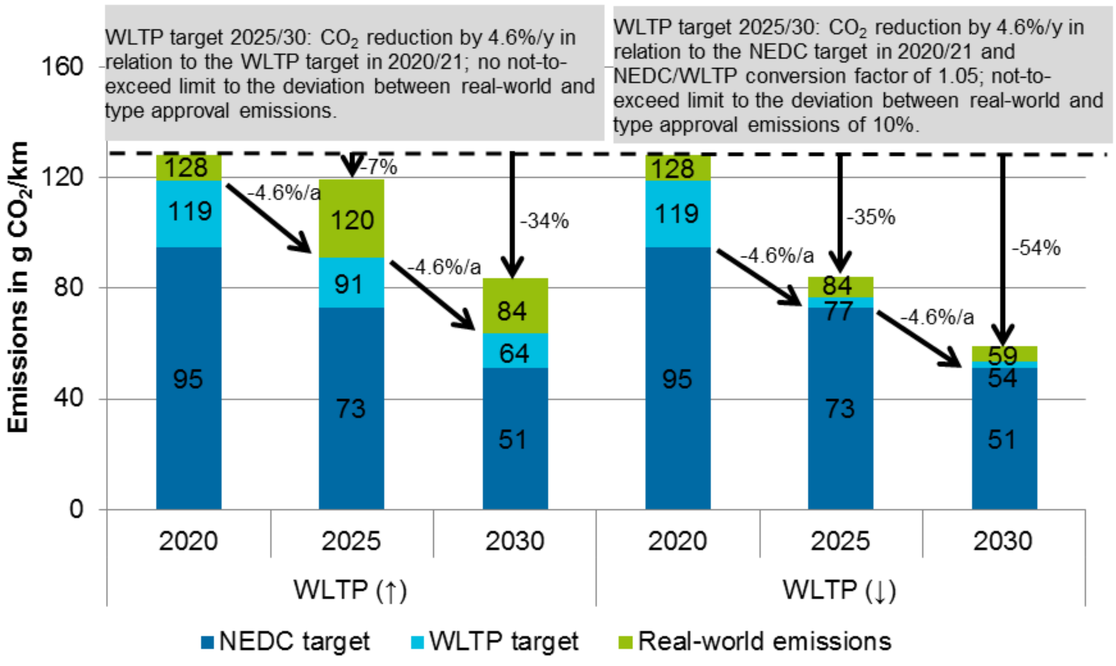
The CO_2 emission regulation based on the New European Driving Cycle (NEDC) has successfully decreased emissions in chassis dynamometer measurements during type approval procedures. However, CO_2 emissions in operation on the road have only decreased to a minor degree. In consequence, CO_2 emission standards will gradually be transferred from the NEDC to the Worldwide Harmonised Light Duty Test Procedure (WLTP) from September 2017 until 2021. The new procedure is expected to deliver a better representation of real-world emissions and to effectively reduce real-world emissions to the required level in the future. The changeover leads to a number of recommendations for action for the post-2020 regulation:

- The procedure for converting the NEDC target value into the WLTP target value for 2021 presents a major incentive to achieve a high ratio between WLTP and NEDC equivalent emission values in 2020 and, thus, to meet the “95 g”-target with rather low effectiveness in terms of real world emission reduction. In order to decrease this incentive, a 2025 target should be formulated as an absolute value. If the 2025 target is defined in terms of a percentage reduction over the WLTP-based target values for 2021, as recommended by VDA and ACEA, the regulation’s low effectiveness until 2020 will be transferred to the post-2020 period.
- Similarly, if the post-2020 WLTP target values are derived from existing proposals of NEDC target values (e.g. the European Parliament's suggested target corridor), the factors used for converting NEDC target values into WLTP target values in 2020 should not be applied. These conversion factors serve to define a new target value through which the efforts made by the manufacturers do not change compared to the existing NEDC regulation. With a procedure of this kind the low effectiveness of the current CO_2 regulation would be transferred into the post-2020 regulation. In Mock et al. (2014), the ICCT proposes a value of 1.05–1.07 as an appropriate conversion factor for changing the NEDC target value to a WLTP one.
- The changeover to WLTP will lead - if at all - to minor reductions of real-world emissions in 2020. However, while a gap between type approval measurements and real-world emissions will remain, WLTP does reflect real-world emissions more accurately than the current NEDC procedure. In order to make the regulation more effective and to exploit the potential of real-world emission reduction, it should be linked to suitable RDE and in-use testing procedures, as well as a not-to-exceed limit for deviations between type approval measurements and real-world emissions.

Figure 0-1 illustrates the possible impacts of two different approaches for updating the CO_2 target value after 2020. Both scenarios are based on the European Parliament's suggested target corridor of 68–78 g CO_2/km (NEDC) in 2025. In the scenario WLTP (↑), the 2025 target value is defined in relation to the 2020/21 target value according to the proposition of the European Parliament (approx. 5% p. a.). The scenario does not stipulate a not-to-exceed limit for the deviation between measurements and real-life emissions. In the scenario WLTP (↓), an absolute WLTP target value is defined by applying the ICCT’s conversion factor of 1.05 to the Parliament’s proposed NEDC-based target value. Additionally, a maximum deviation of 10% between WLTP measurements and real-world emissions is enforced.

The approaches are especially distinct in 2025: The conversion factor of 1.05 would yield an absolute WLTP target value of 77 g CO_2/km, while the percentage reduction over 2021 would lead to a WLTP target of 91 g CO_2/km. When comparing real-world emissions, the importance of enforcing a limit on real-world to type approval emissions deviations becomes apparent (120 g CO_2/km vs. 84 g CO_2/km in 2025).

Figure 0-1: Sample scenarios for the different procedures for setting CO_2 target values after 2020



2020: Conversion factor WLTP / NEDC: 1.25; Deviation of real-world emissions to NEDC: 1.35

Source: Öko-Institut assumption based on e.g. Tsiakmakis et al. (2017), Tietge et al. (2016), Miller (2016), Mock et al. (2014)

1. Introduction

The introduction of CO_2 emission standards (EG/443/2009 and EU/511/2011) was linked to the aim of ensuring that road transport makes an effective contribution to climate protection. While the specific type approval emissions from passenger cars and light commercial vehicles measured on a chassis dynamometer fall continuously and compliance with the target values for 2020 appear to be realistic, the vehicle emissions in real-world driving have only decreased to a smaller extent. Consequently, the regulations have so far turned out to be less effective than desired in achieving a contribution to climate protection from road transport. For this reason it was decided to transfer the regulation to emission measurements using the WLTP, which will take place at the same time as the decision on the continuation of the CO_2 emission standards up to 2030. This is linked to the idea of reducing the flexibilities and unsuitable framework conditions of the New European Driving Cycle (NEDC) to a level where future consumption and emissions measurements for vehicle type approval under the Worldwide Harmonized Light Duty Test Procedure (WLTP) lie closer to the real-world CO_2 emissions. Additionally, the WLTP's speed profile is supposed to be a better representation of real-world driving situations than the NEDC.

However, with the amendment to the CO_2 regulation in 2014 (EU/333/2014) it was also stipulated that the same requirements should be placed on the manufacturers to achieve fleet targets under the WLTP as in the NEDC[1]. Under the NEDC, the status of the regulation agreed in 2014 provides for a target value of 95 g CO_2/km from 2020 which will remain valid for manufacturers until a new target value becomes obligatory. In order to meet the target of "comparable stringency", a method for converting measurements under WLTP to NEDC will be required during the transition phase. Similarly, a transfer of the regulatory regime will require existing target values for the NEDC to be "translated" to the WLTP. The procedure for doing this was determined in a number of regulations in summer 2017.[2]

This paper examines which effects arise due to the agreed procedure for changing from the NEDC to a regulation in the WLTP regime, and what recommendations for action appear conducive to an effective future regulation.

2. How does the transfer of the regulation from the NEDC to the WLTP work?

The WLTP is mandatory for the type approval of new vehicle types from September 2017 (Figure 2-1). A year later, from September 2018, all new vehicles will have to be measured using WLTP for type approval[3]. Due to the definition of the target values in the NEDC, the CO_2 emissions measured in the WLTP are converted to NEDC equivalent emission values using a method called correlation.

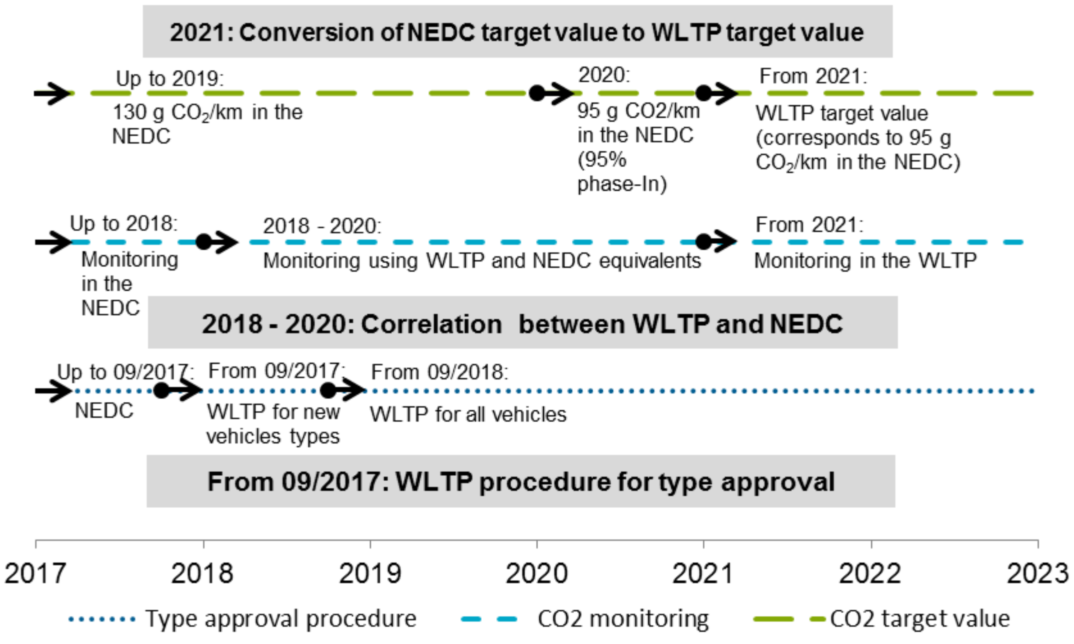
[1] "… while ensuring that reduction requirements of comparable stringency for manufacturers and vehicles of different utility are required under the old and new test procedures." from Article 13 (7) of the regulation EC/443/2009 (incorporated in the regulation through EU/333/2014)

[2] Commission Implementing Regulation (EU) 2017/1153 of 2 June 2017 setting out a methodology for determining the correlation parameters necessary for reflecting the change in the regulatory test procedure and amending Regulation (EU) No 1014/2010, OJL from 7.7.2017, L 175 Page 679.

Commission Delegated Regulation (EU) 2017/1502 of 2 June 2017 amending Annexes I and II to Regulation (EC) No 443/2009 of the European Parliament and of the Council for the purpose of adapting them to the change in the regulatory test procedure for the measurement of CO_2 from light duty vehicles (draft regulation).

[3] Vehicle categories N1 Class 2 and Class 3 are exceptions for which the introduction of the WLTP is obligatory one year later.

Figure 2-1: Overview of the timeline for the changeover to CO_2 emission standards for cars in the WLTP



Source: Öko-Institut overview based on EC (2017)

The central element of the correlation between the measured type approval WLTP values and the NEDC equivalent CO_2 values is the CO_2MPAS software tool which is used to carry out an individual conversion for each vehicle. Monitoring the emissions in the transition phase of the NEDC to WLTP is therefore determined by

1. the individual CO_2 emissions measured in the WLTP and
2. the NEDC equivalent CO_2 emission values determined using the CO_2MPAS tool.

During the type approval procedure the NEDC equivalents are compared with the NEDC values which the manufacturer declares for a specific vehicle. If the NEDC equivalent determined using CO_2MPAS is more than 4% above the manufacturer's declared value, the manufacturer can accept the NEDC equivalent emission value or up to three retests of the vehicle can be performed on the chassis dynamometer.[4] If these retests show that the CO_2 value measured on the chassis dynamometer is more than 4% above the value declared by the manufacturer, then the CO_2 value measured on the chassis dynamometer applies.[5] In addition, the manufacturer's CO_2 fleet average is adjusted upwards according to the deviations of all the manufacturer's vehicles. In all other cases, the value declared by the manufacturer is taken as the NEDC equivalent value of the vehicle (Figure 2-2).

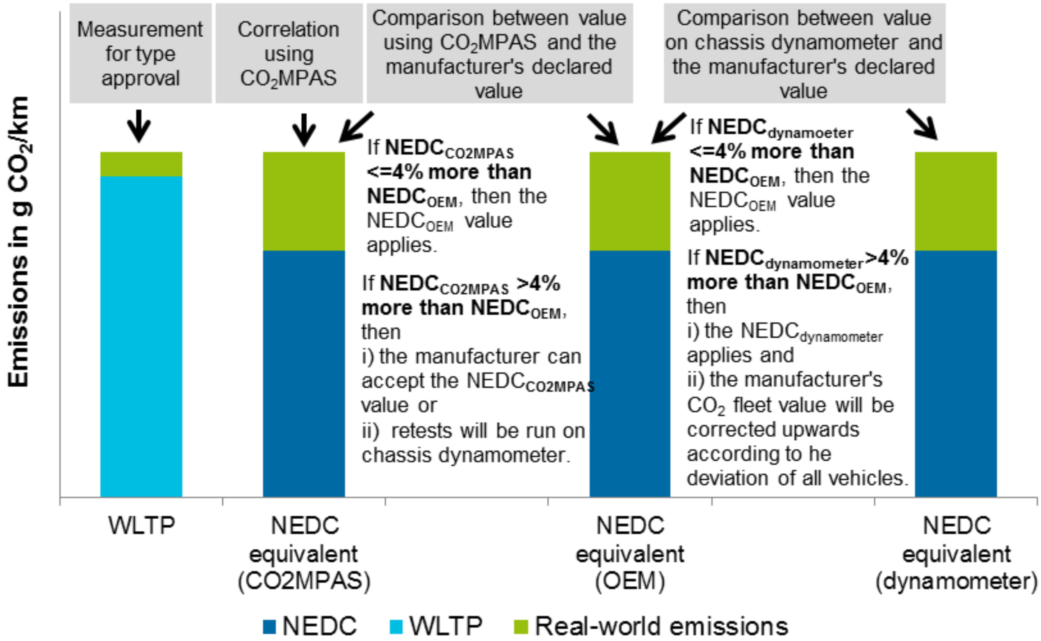
The CO_2MPAS tool used is an open source model which was developed specially by the Joint Research Center (JRC) for the conversion of WLTP to NEDC equivalent emission values (JRC 2017).

[4] In addition, the CO_2 emissions of 10% of the vehicles which do not show a deviation of more than 4% will be retested on the chassis dynamometer. The regulations on the maximum deviation of the emissions and a possible correction of the manufacturer's CO_2 fleet value are the same as those specified in the text.

[5] The same test conditions apply to the physical test as for the CO_2MPAS simulation.

Input data for the conversion are specific vehicle characteristics (including engine characteristics, rolling resistance parameters) and certain measurement data from the on-board diagnostics system which are recorded during the WLTP.

Figure 2-2: Schematic overview of the correlation procedure between WLTP and NEDC emission values (NEDC equivalents)



Source: Öko-Institut

The NEDC target value of 95 g CO_2/km remains valid up until 2020 and will be used to derive the manufacturer-specific target values. The changeover to manufacturer-specific CO_2 targets in the WLTP is foreseen for 2021 (Figure 2-1). Thus, there will be no need for conversion using the CO_2MPAS tool after this date. The CO_2 values in the monitoring procedure will also only be recorded in accordance with the WLTP from 2021 onwards.

From 2021 a manufacturer-specific reference target value will be determined using the following formula:

$$WLTP_{2021,target,\ reference} = WLTP_{2020} / NEDC_{2020} * NEDC_{2020,target}$$

The WLTP emission values given by the "2020" index and their NEDC equivalents denote the recorded average CO_2 emissions of a manufacturer in the WLTP and NEDC for 2020 (see above for conversion method). The variables defined by the index "target" are the manufacturer-specific NEDC target for 2020 resulting from the manufacturer’s average vehicle mass and the WLTP reference target to be achieved in the for 2021. After 2020, the year-specific manufacturer target in the WLTP will be given by the following equation:

$$WLTP_{202x,target} = WLTP_{2021,target,reference} + a * [(M_{OEM,202x} – M_{all,202x}) – (M_{OEM,2020} – M_{all,2020})]$$

This methodology for determining the target value will remain in force for the vehicle manufacturer after 2020 until a new target value becomes mandatory. *M* represents the average masses of the particular manufacturer's car fleet (OEM) and of all new registrations in the particular year (all); the factor *a* is a constant.[6]

- For type approval from September 2018, the CO_2 emissions of all new passenger cars will be determined using the WLTP.
- Up to 2020 a conversion of the WLTP into NEDC equivalent emission values will be carried out, because the target for CO_2 regulation is defined in the NEDC. These values will be verified using the CO_2MPAS simulation tool.
- The changeover to a WLTP target value will take place in 2021. This will be based on the emission values of new vehicles in 2020.

3. How does the effectiveness of CO_2 regulation change by switching to the WLTP?

3.1. Impacts on the effectiveness of CO_2 regulation up to and including 2020

The correlation between the CO_2 values measured on the chassis dynamometer in the WLTP and the NEDC equivalents used for monitoring does not lead – despite the principle of "comparable stringency" – to identical NEDC equivalent emission values and the NEDC values of the previously valid procedure. Flexibilities in the NEDC (e.g. tolerances in the drive profile, determination of the road load) which have been exploited for the lowest possible CO_2 emission values on the chassis dynamometer cannot be used in the CO_2MPAS simulation tool. Slight changes to the framework conditions of the procedure have also been defined (e.g. test temperature of 25 °C, tyre pressure specification).

The NEDC equivalent emission values lie above the NEDC values of the previously valid test procedure and reflect the real-world vehicle emissions slightly better than the present NEDC values. In Tsiakmakis et al. (2017) the JRC uses a similar simulation tool to CO_2MPAS. The NEDC equivalents which they defined for newly registered cars in 2015 lie 9% above the official NEDC emission values for that year. Even if the above-mentioned values are not based on the official correlation procedure between WLTP and NEDC equivalent emission values, it can be assumed that the deviations between the NEDC equivalent emission values and those of the previous test procedure will be of this order of magnitude.

According to this, the correlation procedure gives an approximately 10% increase in the manufacturers' NEDC fleet emission values, so that it may be more difficult for the manufacturer to reach the NEDC target using the agreed correlation procedure. This increase in the fleet emission values is supposed to be unimportant for reaching the targets in 2018 and 2019, as the manufacturers already have to reach the new target of 95 g CO_2/km (NEDC) in 2020. Accordingly, their average fleet emissions should be far below the applicable target of 130 g CO_2/km (NEDC) for these years.

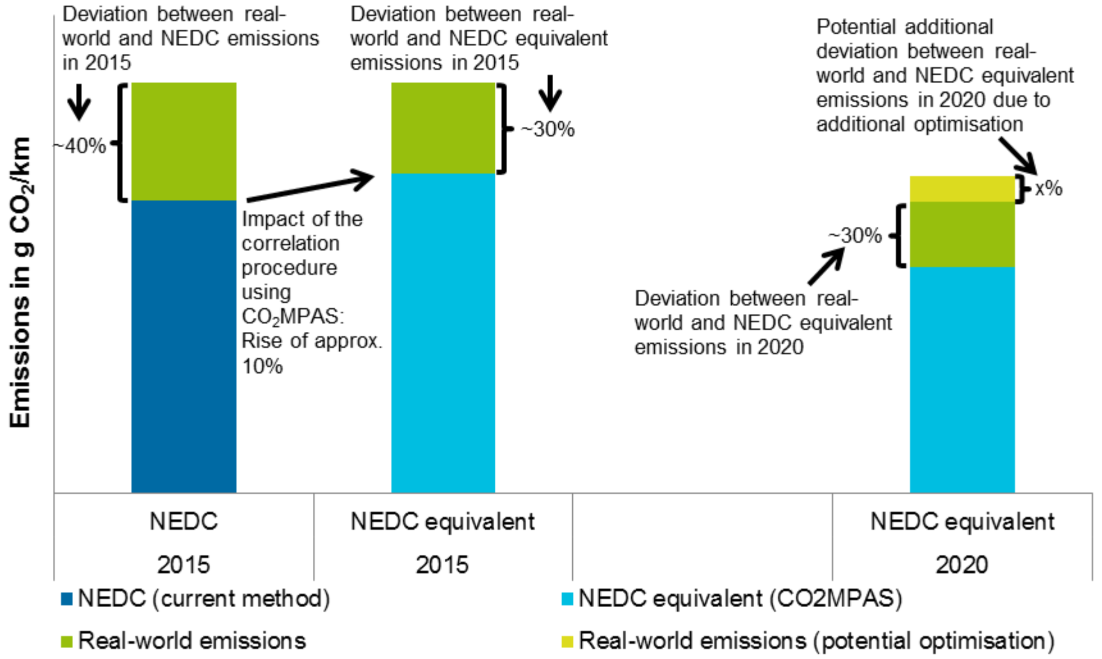
Changing the test procedure therefore only has an impact on 2020, but the precise effect is difficult to foresee (see Figure 3-1). The incentive remains for manufacturers to optimise the emission values to the NEDC equivalents and the correlation procedure using CO_2MPAS (see also Section 3.2). A detailed assessment of the particular technical opportunities for this purpose is not possible. A systematic exploitation of the maximum 4% deviation between the NEDC equivalent emission

[6] The full formula is the following:

$WLTP_{202x,target} = WLTP_{2020} / NEDC_{2020} * [95 \text{ g CO2/km} + a * (M_{OEM,2020} – M_{all,2020})] + a * [(M_{OEM,202x} – M_{all,202x}) – (M_{OEM,2020} – M_{all,2020})]$

values from CO_2MPAS and the declared CO_2 values in the NEDC cannot be ruled out (see Chapter 2 and Figure 2-2 for an explanation) in order to achieve the lowest possible NEDC fleet values.

Figure 3-1: Illustration of the impact due to the correlation of WLTP to NEDC equivalents in 2015 and 2020



Source: Öko-Institut estimates based on Tsiakmakis et al. (2017) and Tietge et al. (2016)

The changeover to the WLTP does not alter the effectiveness of the regulation up to and including 2019. To what degree the effectiveness of the CO_2 regulation will increase in 2020 as a result of the correlation procedure, i.e. how much the deviation between the NEDC equivalent values used for monitoring and the real-world emission values will decrease, is not clear due to the above-mentioned reasons and opposing effects. However, based on current knowledge, the NEDC equivalents used for monitoring should be maximum approximately 10% above the NEDC values used so far. If the manufacturers optimise further for the test procedure, the positive impact in terms of effectiveness could turn out to be less or disappear completely in extreme cases.

- The NEDC fleet emission values increase due to the conversion from WLTP to NEDC equivalent emission values. Based on current knowledge, an increase of approximately 10% can be estimated for the new vehicle fleet in 2015.
- There is an incentive for the manufacturers to continue to optimise towards the NEDC and the conversion using CO_2MPAS. Besides technical optimisation options, the rule on the deviation between the NEDC equivalent emission values from CO_2MPAS and the manufacturers' declared NEDC values could be systematically exploited for this.
- Achieving the target in 2020 could become slightly harder for the manufacturers due to the changeover in procedure. To what degree the effectiveness of the CO_2 regulation increases in 2020, i.e. how much the deviation between the NEDC equivalent values used for monitoring and the real-world emission values will decrease, is difficult to estimate due to previously mentioned opposing effects.

3.2. Impacts on the effectiveness of CO_2 regulation after 2020

A crucial factor for the effectiveness of CO_2 regulation after 2020 and the resulting reduction in real-world emissions is the impact of the "translation" process from the NEDC target value (95 g CO_2/km) to a WLTP target value. The set procedure for changing to the target value in the WLTP is based on the CO_2 emission values in the WLTP, their NEDC equivalents and the manufacturer's average vehicle mass in 2020. The 2020 new vehicle fleet is consequently of great importance, giving a considerable incentive in 2020 to

- maintain as high a correlation as possible between the CO_2 emission values in the WLTP and their NEDC equivalents (see formula for determining the reference target value) and
- register vehicles with as great a mass as possible (see formula for determining the year-specific target value in the WLTP and the target value in the NEDC).

In consequence, vehicle manufacturers not only have an incentive for optimising towards the smallest NEDC equivalents possible (see Section 3.1), but also towards the highest possible correlation factors between the WLTP emission values and NEDC equivalents.[7]

The above-mentioned JRC study presents the differences between simulated WLTP emission values and the official NEDC values for 2015 (Tsiakmakis et al. 2017). For the 2015 new vehicle registrations, the simulated WLTP type approval values are on average 1.22 times above the official NEDC values. It also appears that the correlation between the simulated WLTP and the official NEDC CO_2 values rises steeply for registrations with low CO_2 values (Figure 3-2). In the range around 95 g CO_2/km (NEDC), the WLTP values are around 1.3 times above the ones in the previously valid NEDC. Additionally, proportionally lower deviations between the WLTP and NEDC values occur for more powerful and heavier cars.

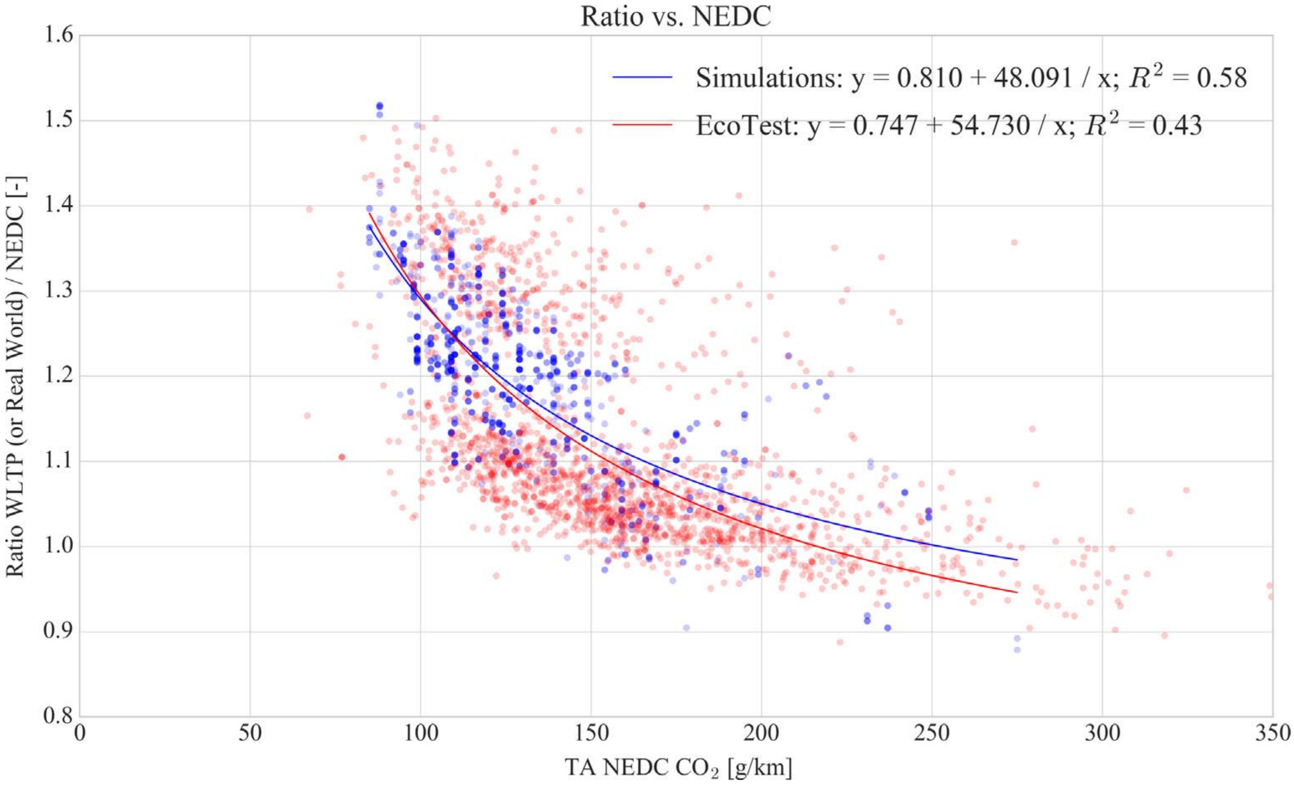
These effects can be interpreted in different ways. On the one hand they show the effectiveness of the WLTP in terms of a better representation of the real-world emissions, i.e. the CO_2 values determined using the WLTP are higher and therefore closer to the real-world CO_2 emissions.

On the other hand, it indicates that typical measures to reduce CO_2 (e.g. downsizing, start/stop) have resulted in a reduction in CO_2 especially in chassis dynamometer measurements in the NEDC. However, in real-world driving (and to a great extent also in the WLTP), they contribute far less to reducing emissions. The increasing correlation between the simulated WLTP emissions and the official NEDC values at low NEDC CO_2 values also indicate that this effect becomes more pronounced, the more CO_2 reduction technologies are used and the closer the vehicles get to the target value for 2020. This effect is seen to be greater in less powerful and lighter vehicles than in more powerful and heavy cars.

The following conclusion can be drawn for the changeover to WLTP target values: the correlation between WLTP and NEDC emission values increases with the vehicles which the car makers will require to meet the 2020 NEDC target. High WLTP target values for 2021 and the years following will be achieved if as many vehicles as possible with a high impact for the NEDC equivalent values and low impact in the WLTP are registered in 2020.

[7] In what follows, the conversion factor or correlation factor denote the correlation between WLTP and NEDC equivalent emission values for 2020 which are used for monitoring CO_2 regulation.

Figure 3-2: Correlation between WLTP and NEDC emissions for new vehicles from 2015 in relation to the level of NEDC emissions



Quelle: Tsiakmakis et al. (2017)

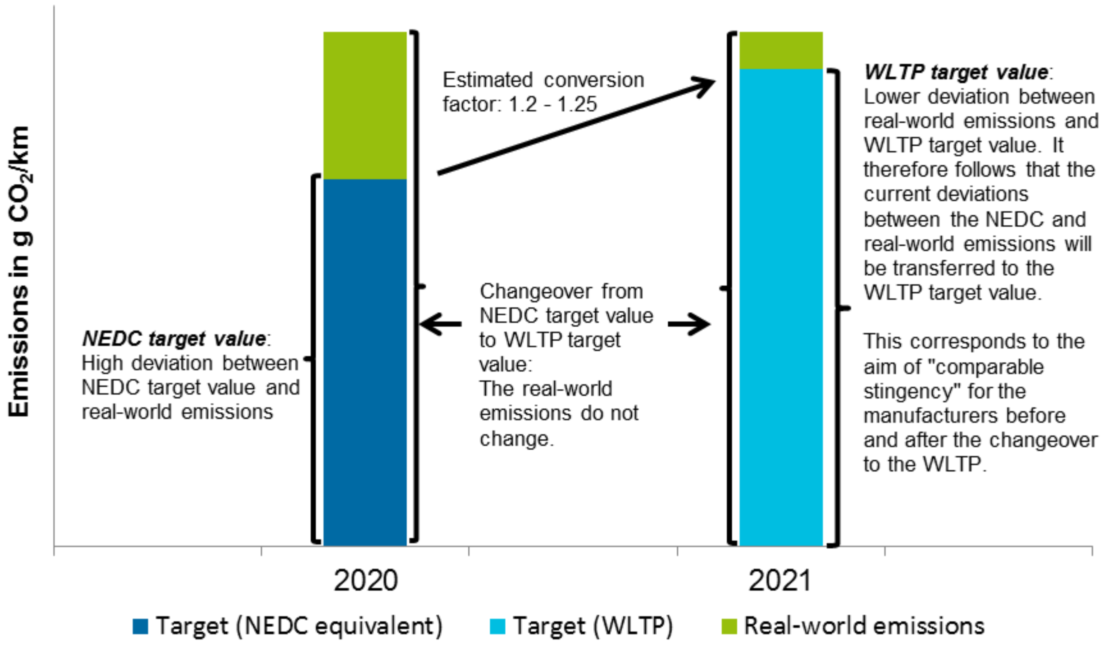
In addition to technical options there could be a targeted marketing strategy for 2020. As a one-off, conventional vehicles with a particularly high conversion factor between WLTP and NEDC equivalent emission values and especially high vehicle masses could be given preference in the pricing strategy.[8] Battery electric vehicles with a high vehicle mass could additionally provide the one-off possibility of registering as heavy low-emission vehicles as possible in 2020. The impact of hybrid and plug-in hybrid vehicles which have high deviations between real-world and NEDC emissions is unclear.[9] Another option is provided by the 5% phase-in of the 95 g CO_2/km target in 2020: 5% of the new registrations in 2020 can be excluded from the calculation of the fleet emission value and the assessment of the 2020 target compliance. However, all vehicles will be included in the calculation of the WLTP target from 2021. The vehicles which are excluded from target compliance in 2020 could therefore be vehicles with a conversion factor which is as high as possible.[10]

8 Manufacturers, which increase the average vehicle mass of their fleet more than the average vehicle mass of the complete vehicle fleet over all manufacturers, obtain an increased WLTP target value (see full formular for the calculation of the WLTP target). The effect is small if all manufacturers make use of this strategy.

9 The correlation factors for PHEV and HEV are highly dependent on how the conversion of the WLTP measurement values into NEDC values is done. No process has so far been developed in full for these types of vehicles. In the NEDC both types of vehicles exhibit high deviations to real-world operation, even more so than pure combustion engine vehicles.

10 According to Tsiakmakis et al (2017) cars with high CO_2 emissions which, due to the 5% phase-in, are not used to calculate the average emissions, usually have a low correlation between WLTP and NEDC emission values. However, manufacturers could give preference to cars with high correlation factors for this emission range in their pricing strategy.

Figure 3-3: Illustration of the impact from the changeover to a WLTP target value in 2021



Source: Öko-Institut estimates based on Tsiakmakis et al. (2017)

It is difficult to estimate the level to which the conversion factors between the WLTP and NEDC equivalent emission values will increase and what the effect of a targeted marketing strategy could be (see Figure 3-3). Based on Tsiakmakis et al. (2017), a conversion factor of approximately 1.2[11] can be estimated for the new vehicles of 2015 with emissions around 95 g CO_2/km (NEDC). This does not take account of the possibilities for optimising individual vehicles for high correlation factors plus the opportunities from a targeted marketing and sales strategy. Consequently, it is not implausible that higher conversion factors will be reached in 2020.

Real-world emissions of a vehicle will not decrease as a result of the changeover to the target value in the WLTP. In terms of the real-world CO_2 reduction, the procedure for the changeover actually provides an incentive to meet the NEDC target value for 2020 in an ineffective way, as it relates to high conversion factors between the WLTP and NEDC equivalent emission values. In addition, the low effectiveness of the current regulation will be transferred via the conversion factor to the WLTP target value valid from 2021. It corresponds to the requirement of "comparable stringency" for the manufacturers before and after the changeover. However, the target value used after the changeover represents the real-world CO_2 emissions more realistically than before.

[11] $(WLTP_{TA} / NEDC_{TA}) / (NEDC_{sim} / NEDC_{TA}) = 1.3 / 1.08 = 1.19$

- The procedure for converting the NEDC target value into the WLTP target value presents a major incentive in 2020 to register vehicles with as high a conversion factor between WLTP and NEDC equivalent emission values as possible, and with the highest possible weight.
- High conversion factors between WLTP and NEDC equivalent emission values will be achieved especially if the vehicles exhibit a CO_2 reduction in the NEDC, but this is less pronounced in the WLTP (and in real-world operation). The chosen conversion procedure therefore provides an incentive to register vehicles in 2020 which are rather ineffective in terms of actual CO_2 reduction.
- Simulations carried out by the JRC for the 2015 new vehicle fleet show that increasing conversion factors between WLTP and NEDC could arise for vehicles with low NEDC emission values. Thus, the vehicles with low NEDC emissions have a smaller effectiveness for real-world CO_2 reduction. In consequence, the conversion factors for the changeover to the WLTP target would also increase due to target compliance with the “95 g”-target in 2020.
- Through a targeted marketing and sales strategy, in 2020 vehicles which show high conversion factors between WLTP and NEDC equivalent emission values and have as high a mass as possible could be registered as a one-off.
- It can be estimated that the WLTP target values could be 1.2 – 1.25 times above the NEDC ones for 2020.
- The changeover to the WLTP target value does not lead to reduced real-world emissions. The deviations between the NEDC and real-world emissions to date will therefore be transferred to the WLTP target value. This corresponds to the requirement of "comparable stringency" before and after the changeover to the WLTP.

4. Recommendations for updating the CO_2 regulation after 2020

The study by Tsiakmakis et al. (2017) show that the WLTP is better than the NEDC at reflecting the real-world CO_2 emissions on the chassis dynamometer (see also Figure 3-3). As a result, applying the WLTP provides the potential for developing a more effective CO_2 regulation than previously. The chosen method of changing over to a WLTP target value also means that the target value for 2021 will better reflect the real-world CO_2 emissions than previously.

However, previous experience with the air pollutants and CO_2 emission regulations suggests that manufacturers will use possible optimisation opportunities in the new WLTP test procedure. This would result in an increase in the deviation between real-world and chassis dynamometer emissions in the WLTP, and the effectiveness of a regulation based solely on the WLTP would decrease again over time. For a future effective regulation the following measures are required, irrespective of the target level:

- Introduction of a Real Driving Emissions (RDE) test procedure with not-to-exceed limits to the deviations between the chassis dynamometer and RDE CO_2 emissions.
- Introduction of an in-use test procedure with a not-to-exceed limit to the deviations between the chassis dynamometer and real driving CO_2 emissions.

It also appears worthwhile to introduce an official monitoring of the real-world consumption and real-world CO_2 emissions as an information platform. A database of this kind could also be used to introduce an appropriate adaptation to the target when changes in the deviation between the chassis dynamometer and real-world emissions occur.

When the target values are updated after 2020 it should be borne in mind that the CO_2 regulation has so far had less effect on the avoidance of real-world CO_2 emissions than expected. In order to achieve the aim of the changeover to the WLTP – the introduction of an effective CO_2 regulation – the regulation should not transfer the rather low effectiveness to the post-2020 regulation. It is clear from Section 3.2 that this is exactly what will happen through the NEDC to WLTP target conversion in 2021. The rationale of the principle of “comparable stringency” is plausible for 2020 and 2021. However, the regulation should not maintain the shortcomings of the existing regulation after 2021. For this reason the following principles should be applied when deriving the WLTP target values after 2020:

- A new target value for 2025 should be defined as the 2021 target value will remain valid until a new target value has to be reached. The effectiveness of the regulation can only be increased when there is a new target value.
- The target values after 2020 should be formulated as absolute values and not as relative reduction target values with reference to 2020. Choosing a relative target would relate back to the rather low effectiveness up to 2020 and therefore transfer it to the post-2020 regulation. Defining an absolute target value for 2025 would reduce the incentive to reach a WLTP target value in 2021 which is as high as possible.
- If the target values are derived from NEDC values (e.g. the European Parliament's suggested target corridor), then the 2020 conversion factors used for changing the target value should not be applied. These serve to define a new target value through which the efforts made by the manufacturers do not change. With a procedure of this kind the low effectiveness of the current CO_2 regulation would be transferred to the post-2020 regulation.

In Mock et al. (2014), the ICCT has reported conversion factors from 1.05–1.07. These factors relate to the technical differences of the two test procedures and appear to be suitable for a conversion of the NEDC targets to the WLTP. Factors of this order of magnitude should be taken into account when WLTP target values are derived from NEDC values.

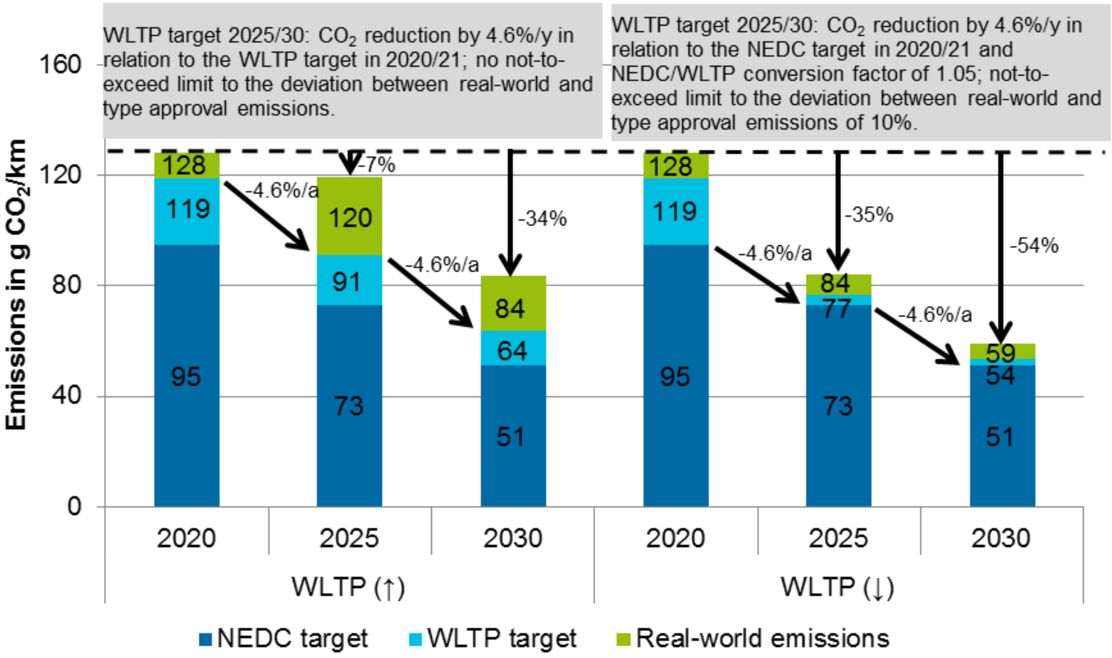
Figure 4-1 illustrates the possible impacts of the different approaches for updating the CO_2 target value after 2020. The illustration is based on the EU Parliament's suggested target corridor of 68–78 g CO_2/km (NEDC) in 2025, with the reduction rates continued up to 2030.[12]

In the WLTP (↑) scenario, the 2025 and the 2030 target value are defined in relation to the 2020/21 target value according to the proposition of the European Parliament (approx. 5% p. a.). The scenario does not stipulate a not-to-exceed limit for the deviation between measurements and real-life emissions. Accordingly, a deviation between the real-world and WLTP emission values of 1.31 is assumed in line with Miller (2016).

The WLTP (↓) scenario represents a rapid return to an effective CO_2 regulation, but corresponds to the intention of the EU Parliament for the last amendment of the CO_2 regulation. In this scenario the proposed NEDC target value of the EU Parliament is transferred to a WLTP target value using the suggested conversion factor 1.05 from the ICCT (Mock et al. 2014). Additionally, a maximum deviation of 10% between WLTP measurements and real-world emissions is enforced.

[12] The average value of the target corridor (73 g CO_2/km) is used for 2025 by way of illustration.

Figure 4-1: Sample scenarios for the different procedures for setting CO_2 target values after 2020



2020: Conversion factor WLTP / NEDC: 1.25; Deviation of real-world emissions to NEDC: 1.35

Source: Öko-Institut assumption based on e.g. Tsiakmakis et al. (2017), Tietge et al. (2016), Miller (2016), Mock et al. (2014)

The greater effectiveness of the WLTP (↓) scenario in terms of real-world CO_2 reduction becomes apparent when comparing both scenarios. In contrast to the WLTP (↑) scenario (-7%), the real-world CO_2 emissions will be reduced by 35%. In the WLTP (↑) scenario a similar reduction will only be reached in 2030. At 59 g CO_2/km in 2030, the real-world emissions per kilometre in the WLTP (↓) scenario would be less than half of those of 2021. These reduction rates show the lower than expected effectiveness of the CO_2 regulation up to 2020 and how high the real-world CO_2 reduction rates need to be in order to reach the CO_2 reduction intended by the EU Parliament.

- The WLTP reflects the real-world emissions of passenger cars better than the current NEDC procedure. The changeover to the WLTP has therefore the potential for making the regulation more effective. However, previous experience with the existing regulation suggests that manufacturers will use potential optimisation opportunities in the WLTP procedure. In future, the CO_2 regulation should therefore be linked to a suitable RDE and in-use test procedure including a not-to-exceed limit for an effective CO_2 reduction.
- When determining a target value after 2020, the following principles should apply:
  - A new target value for 2025 should be defined as the 2021 target value will remain valid until a new target value has to be reached. The effectiveness of the regulation can only be increased when there is a new target value.
  - The target values after 2020 should be formulated as absolute values and not as relative reduction target values with reference to 2020. Choosing a relative target would relate back to the rather low effectiveness up to 2020 and therefore transfer it to the post-2020 regulation. By defining an absolute target value for 2025, the incentive to reach a WLTP target value in 2021 which is as high as possible would be reduced.
  - If the WLTP target values are derived from NEDC values (e.g. the European Parliament's suggested target corridor), the factors used for converting NEDC target values into WLTP target values in 2020 should not be applied. These serve to define a new target value through which the efforts made by the manufacturers do not change compared to the existing NEDC regulation. With a procedure of this kind the low effectiveness of the current CO_2 regulation would be transferred into the post-2020 regulation.
- In Mock et al. 2014, the ICCT specifies values of 1.05–1.07 as appropriate conversion factors for changing the NEDC target value to a WLTP one.
- Due to the rather low effectiveness of the CO_2 regulation up to 2020, high real-world CO_2 reduction rates are necessary in order to join the previously intended CO_2 abatement path.

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