
Mind
the
GAP
2016

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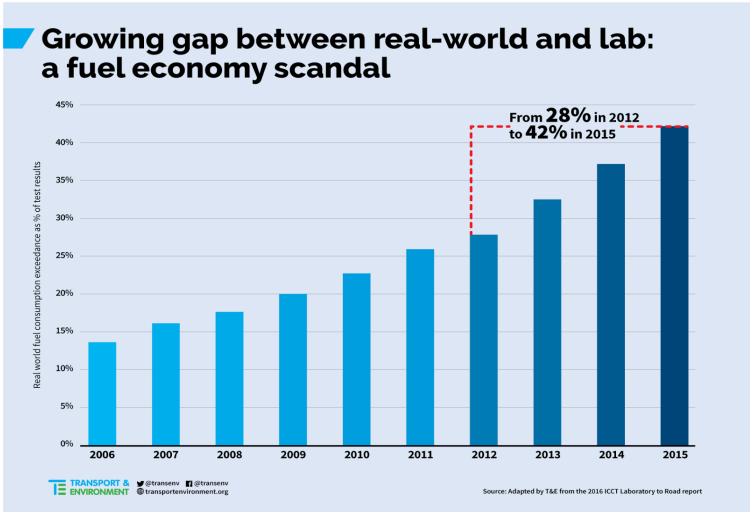
Mind the Gap 2016

Fixing Europe's flawed fuel efficiency tests

December 2016

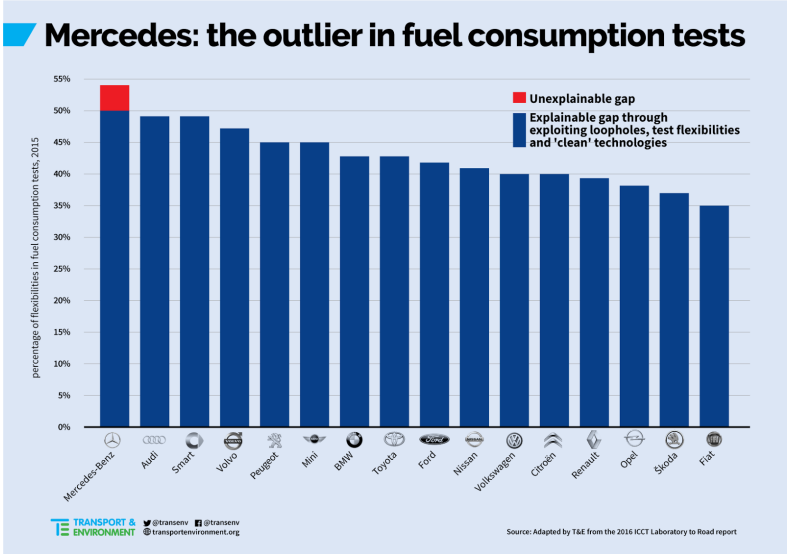
Executive summary

This report examines the difference between the official laboratory test results and real-world CO2 emissions and fuel economy of cars. It shows the current system has totally failed and explains how to fix the problems. The difference between official laboratory test results and real-world car performance is growing uncontrollably jumping from 9% in 2001 to 28% in 2012 and 42% in 2015. It is expected to reach 50% before 2020. New cars have not become more efficient, as carmakers claim; on the road, progress in reducing emissions having stalled for four years. Carmakers, not drivers, are the cause of the problem by exploiting testing loopholes and possibly in some cases through the illegal use of defeat devices. In 2002, exploiting test flexibilities accounted for just five-percentage points difference between test results and real-world performance. This grew to 15 points in 2010; and 24 points in 2014. Technology that reduces emissions more in the test than on the road contributes an additional three percentage points to the gap; the failure to switch on auxiliary equipment during tests adds around eight points. Exploiting test flexibilities is therefore the dominant cause of the growing gap. In addition, new evidence emerging from the Dieselgate scandal shows some cars detect laboratory fuel economy and CO2 tests and illegally put the car into a low emission mode thereby cheating the test.



Mercedes cars have the biggest average gap between test and real-world performance, with real-world fuel consumption exceeding test results by 54%, Audi and Smart are second with a gap of 49%. A lot is known about how carmakers manipulate tests, in part because manufacturers themselves have insisted allowances for "test flexibilities" have been accounted for in the way the new WLTP test is introduced. But the cumulative contribution of every known flexibility can only account for a gap of around 50%. The Mercedes gap is significantly larger than this and that achieved by every other carmaker and needs to be investigated by the German Type Approval Authority (KBA) and the European Commission.

Distorted test results deceive drivers who achieve much poorer fuel economy than is promised in glossy marketing materials, costing a typical motorist around €549 [1] a year in additional fuel costs compared to what might be expected from official test results. The more money drivers spend on fuel, the less is available to buy other goods and services, reducing growth and employment. By 2030, the widening gap will require drivers to cumulatively spend €1 trillion more on fuel and the EU to import 6 billion extra barrels of oil, worsening energy independence and the EU's balance of payments. The distorted test results undermine EU regulations designed to lower CO2 emissions, adding 1.5bn tonnes of CO2 to the atmosphere by 2030 as a result of the widening gap, increasing the prospects of dangerous and uncontrollable climate change. They also reduce government car tax receipts, distorting sales in favour of the carmakers best able to manipulate tests rather than those making the most efficient cars. On average, two-thirds of the gains claimed to have been made since 2008 when car regulations were introduced have been delivered through manipulating tests with only 14.6 g/km of real progress on the roads set against 25.5 g/km of 'hot air'. Without exploiting test flexibilities only Toyota would have met its 2015 target, whereas on paper all the major carmakers have comfortably achieved their limits.



The implementation of the new WLTP test from 2017 is only a partial solution. By 2025 there is expected to be an average gap between WLTP results and real world performance of nearly a third. Action is needed to close the gap and ensure emissions reductions are delivered on the road and not just in the laboratory. There are four key steps that need to be taken:

1. The Commission should propose a 2025 car CO2 target based on the WLTP test of 80g/km. This test should be complemented by a real world CO2 test that should be no more than 10% higher than the WLTP value. This would encourage carmakers to fit technology that delivers emissions reductions on the road and discourage excessive test manipulation;

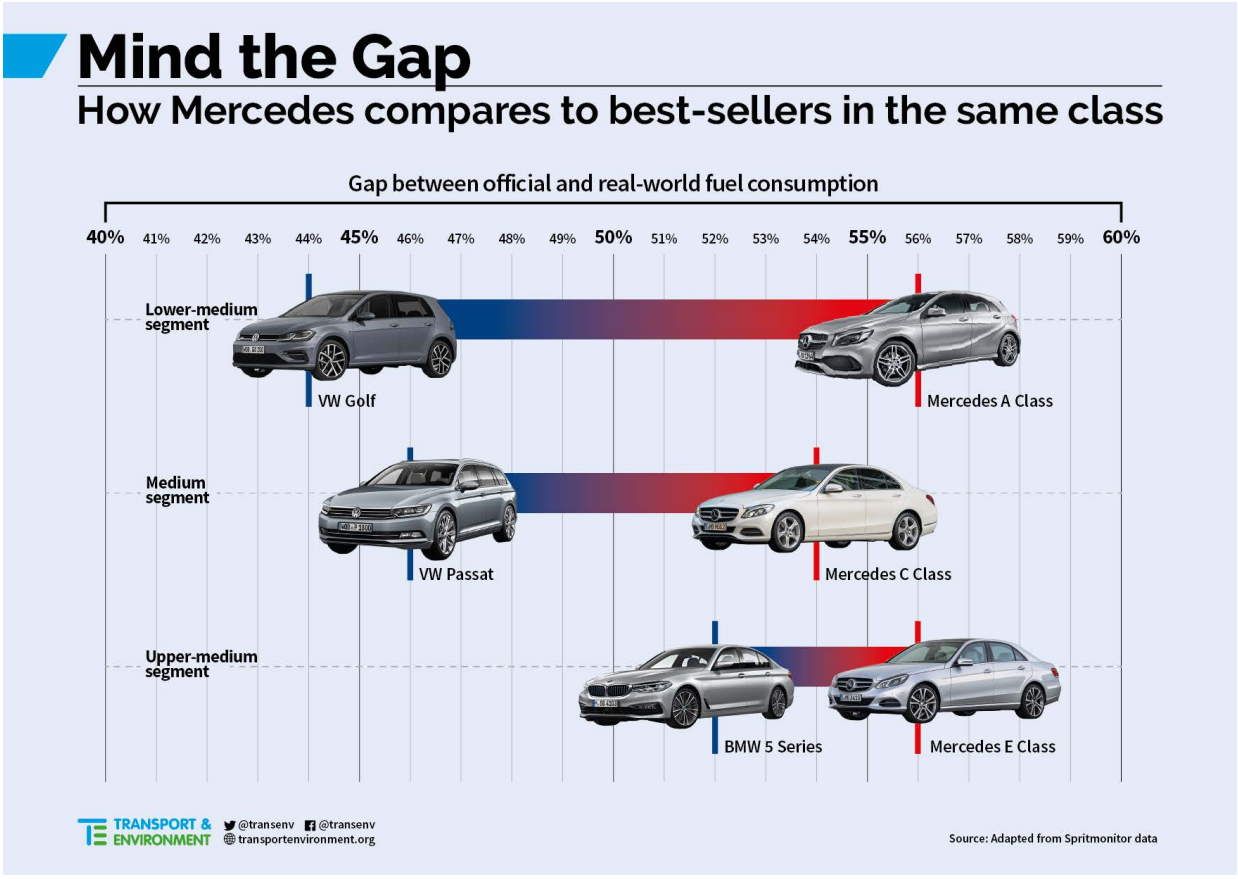
2. The system of national approvals that has been shown through the Dieselgate scandal to lack independence and rigor must be strengthened with the creation of a European Vehicle Surveillance Authority to ensure performance of vehicles on the road match the original type approval results. In addition, there must be a strengthening of conformity of production checks and increased surveillance and in-service conformity checks;

3. There must be an investigation into the possible use of defeat devices to manipulate CO2 tests. This should begin with the Volkswagen Group and Daimler (Mercedes and Smart brands);

4. The Commission must bring forward proposals to ensure consumers are provided with more robust information about fuel economy and CO2 emissions on the road as drivers cannot choose efficient vehicles based upon flawed data. There should be no further delays to the

[1] Compared to official test results ; assumes 20 000 km/yr, gap 42%, fuel price 1.35 €/L

planned update of the obsolete car labeling Directive – if there are, it should be repealed to allow Member States the flexibility to develop better systems.



1 The widening gap between official CO_2 and fuel consumption data and performance on the road

1.1 Background

The Dieselgate scandal has continued to cast a shadow over the car industry in 2016. It is now clear Volkswagen's cheating represents the tip of an iceberg of illegality and malpractice as manufacturers circumvent regulations designed to tackle nitrogen oxide emissions from diesel cars, perpetuating the high air pollution in cities. This report focuses on another area in which carmakers manipulate emissions tests – those used to measure fuel economy and CO_2 emissions. It is the fourth that T&E has produced on this issue [1,2,3] and highlights the problem continues to worsen.

Whilst laboratory tests cannot perfectly reproduce car CO_2 emissions the gap between the fuel economy measured in laboratory tests and those achieved by the average driver of the same car are widening at staggering rate. The overwhelming cause is carmakers manipulating the undemanding and poorly prescribed emissions tests; and choosing to fit technology to improve the efficiency of the car that works much better in the test than on the road. The widening gap is not the result of cars being driven in a significantly different way from in the past. Nor can the widening gap be explained by the addition of additional auxiliary equipment (like heated seats) being fitted to the car (although it makes a small contribution). Neither is it a statistical anomaly as the result of cars becoming significantly more efficient as the industry claims, nor the use of an obsolete test that does not explain the widening gap.

The gap is now so wide (over 50%) for some models and manufacturers that T&E and other experts are unable to explain how carmakers are able to achieve such incredibly low test results. This report therefore presents evidence of a further way carmakers are probably manipulating tests – through the use of defeat devices. These detect when the car is being tested and switches the engine map and possibly automatic gear shift strategy into a low emission model to defeat the test.

Section 1 of the report outlines the evidence for the growing gap between test and real world performance and the causes; and Section 2 the problems the growing gap creates. Section 3 describes specific features including the gap for different models and manufacturers; and Section 4 the policy solutions to fix the problem for good including the need for truly independent vehicle approval authorities.

[1] https://www.transportenvironment.org/publications/mind-gap-why-official-car-fuel-economy-figures-don%E2%80%99t-match-reality

[2] https://www.transportenvironment.org/publications/2014-mind-gap-report-manipulation-fuel-economy-test-results-carmakers

[3] https://www.transportenvironment.org/publications/mind-gap-2015-closing-chasm-between-test-and-real-world-car-co2-emissions

1.2 The growing gap in fuel economy and CO_2

The gap between official test results for fuel efficiency and CO_2 emissions and real-world performance of new cars continues to grow at a staggering rate. The average gap has jumped from an average of 9% in 2001 to 28% in 2012 and 42% in 2015. The evidence is undisputable based upon a meta-analysis by the International Council on Clean Transportation (ICCT), comparing the laboratory and real world emissions of near 1 million vehicles from across the EU contained in 13 different datasets.[4] The trend is consistent between datasets and for private motorists the gap has grown from around 14% in 2006 to 40% in 2015. For company car drivers the gap is estimated to be even larger at 45%. The average gap is now estimated at 42% and this figure has increased by 14 percentage points in the past three years alone – by far the fastest rate of increase to date.

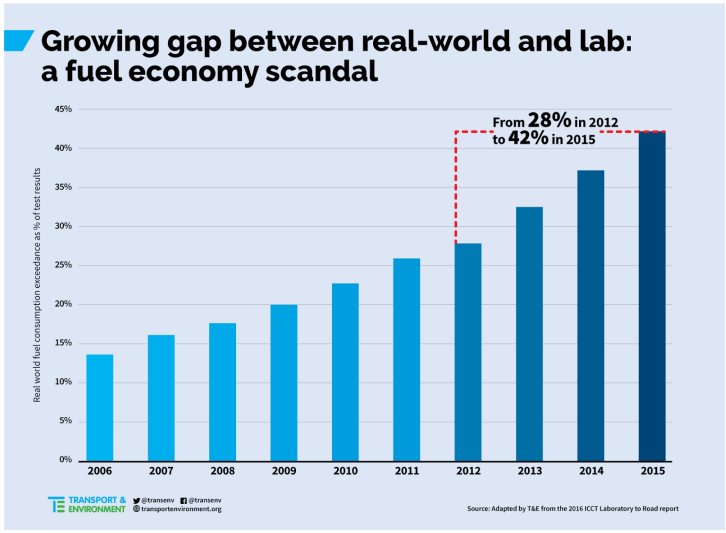


Fig 1: The gap between official fuel economy and CO2tests and real world driving 2015 (derived from ICCT, 2)

As a result of the widening gap, official test results no longer have any credibility even as a basis to compare between models The Spritmonitor data (from a German website) analysed by the ICCT showed that in 2001, 14% of drivers could match official test results for fuel economy but by 2014, practically nobody could drive their car this economically. At the other end of the spectrum, the least economical drivers now report using about twice as much fuel as the official figures suggest they should.

1.3 The causes of the widening gap

The ICCT[5] has examined the contribution of the widening gap between test and real-world results and quantified the contribution of each of these elements to the widening gap. This included separating the use of flexibilities in the laboratory test and road load determination, which is used to configure the chassis dynamometer (rolling road) to account for air and rolling resistance. Figure 2 illustrates the contribution of each flexibility in different years and test cycles. The overall estimated gap corresponds closely to the top-down estimates from real-world emissions data described above.

The ICCT estimate test flexibilities in 2002 contributed 5 percentage points to the divergence between test and real-world results. By 2010, this had grown to 15 percentage points; and by 2014, 24 points. In contrast the effect of technology that over-performs in the test is still relatively low at around 3 percentage points; and auxiliary equipment increased slightly from around 5 to 8 percentage points. Test flexibilities are now the dominant cause of the growing gap. The ICCT has forecast that all the test flexibilities currently deployed will continue to increase to 2020 if the NEDC procedures continue to be used, reaching 49%. The most recent figures suggest this forecast is entirely realistic and could even be an under-estimate.

[4] http://www.theicct.org/laboratory-road-2015-update

[5] ICCT, 2015, *Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans*, for UK Committee on Climate Change

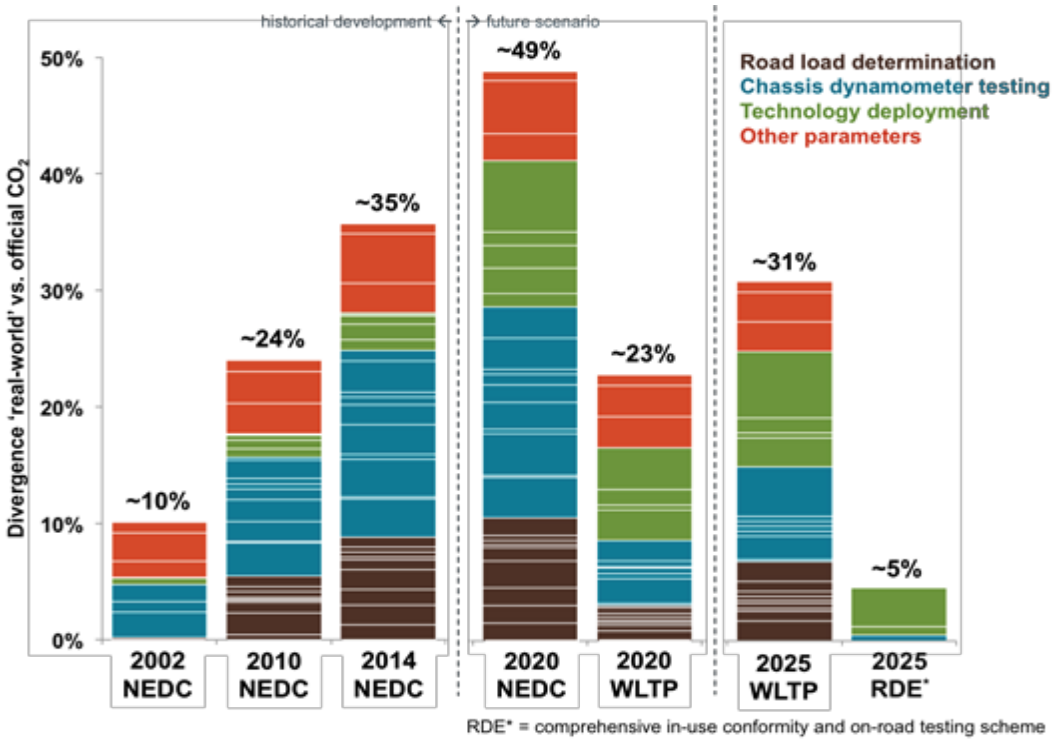


Fig 2: Causes of the gap between CO_2 test results and real-world driving

The introduction of the WLTP test will reduce, but far from eliminate, the gap between test and real-world, indicating that this is only part of the solution. Once introduced there will continue to be a divergence between the WLTP test and real-world performance of around 23% in 2020. This is mainly due to the inappropriate test procedures for plug-in hybrid vehicles. However the contribution to the gap from testing flexibilities in WLTP will fall to around 10%. There is also a strong likelihood that manufacturers will then begin to exploit new flexibilities in the WLTP procedure. By 2025 the gap between WLTP and real-world performance is expected to have increased again to around 31%. Four key conclusions can be drawn from the analysis:

1 The widening gap since 2008 when regulation was introduced is mainly due to the way tests have been manipulated;
2 The gap will keep growing – largely due to the increasing share of plug-in and hybrid cars that have a particularly wide gap;
3 The WLTP will not entirely resolve the issue of a large and growing divergence between test and real-world conditions – although it will help;
4 The introduction of a complementary real world test will significantly lower the gap between test and real world performance.

2 Why test manipulation must be stopped

Official figures on new car fuel economy and CO_2 emissions[6] show steady progress year on year from 2008 (when regulations were introduced). This is represented by the solid blue line in Figure 3 below. If the gap between these official figures and real-world results had remained as it was in 2008 there would have been a corresponding improvement from over 180 g/km to just above 140 g/km in real-world emissions by 2015 (the dotted blue line in Figure 3).

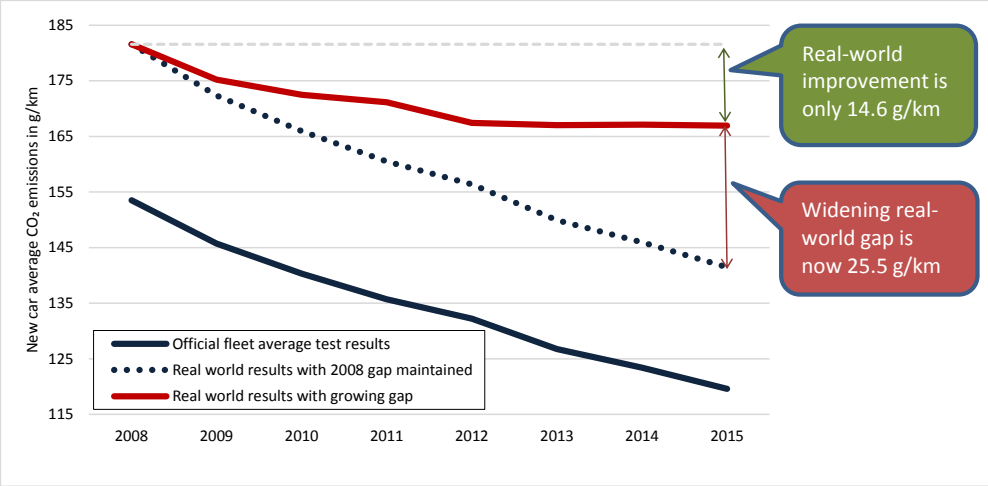


Fig 3: Official CO_2 test results *versus* the real world outcomes in 2014 for private motorists (derived from ICCT, 2016 and EEA official CO_2 data)

Instead, this progress on paper was accompanied by a marked and rapid increase in the size of the gap between test and real-world emissions (shown in Figure 1). Combining these two trends using the ICCT data for private motorists (a more conservative estimate of the size of the gap) shows nearly two-thirds of the gains claimed to have been made since 2008 have been purely theoretical ones, with only 14.6 g/km of real progress on the roads set against 25.5 g/km of 'hot air'. The red line on the graph also illustrates that since 2012 there has been no progress in reducing CO2 emissions in the real world. This is important for four main reasons:

- Fuel is the biggest cost of running a car and drivers are not getting the benefit of the fuel economy that they have been promised. Projecting forward to 2030 the cumulative additional fuel consumption arising from the widening gap will be nearly 600 billion litres[7], costing motorists around €1 trillion.[8]
- More oil is imported into Europe – by 2030, because of the widening gap, 6 billion additional u barrels of oil must be imported into Europe costing €360 billion at current prices,[9] with a third of the money going to Russia;[10]
- CO_2 emissions are significantly raised compared to what was planned. The Car CO_2 Regulation is a major plank of the EU's climate policy, and has been rendered much less effective by the manipulation of the test procedure. As a result, by 2030 the widening gap will cause 1.5bn additional tonnes of CO_2[11] compared to the level of emissions if the gap had remained at 15% as in 2008;
- If car buyers cannot get reliable information about fuel economy, they cannot make informed choices about the cars they buy. Drivers and the media are increasingly aware of the growing discrepancy between labelled fuel economy and what happens on the road, leading to a loss of credibility for the whole of the EU's car labelling and regulatory system. This is not in the interests of consumers, policymakers or the environment – and ultimately not of the car industry either.

[6] http://www.eea.europa.eu/data-and-maps/data/co2-cars-emission-10
[7] 13k km pa; 2.481kgCO2/l; assumes the gap grows to 50% by 2030 & 225k km lifetime mileage
[8] €1.6/l
[9] $50bbl
[10] $60/bbl; 55% road transport fuel per barrel.
[11] 225k km lifetime mileage; 2.481kgCO2/l

VW claims[12] each gram of CO_2 emissions it is required to reduce by costs it €100 million (equivalent to €33.3 for every car sold for each g/km of CO_2 reduced.[13] By extrapolation, the entire car industry has saved at least €11 billion. This cost is met by carmakers' customers who as a result are paying on average around €3,100[14] for additional fuel that is being burned over the lifetime of the car. In one year the cumulative cost of additional fuel consumed by newly manufactured cars is around €40 billion.[15] Carmakers are effectively cheating their own customers. VW's figures show the costs of making cars more efficient is four times less than the cost of the additional fuel that will otherwise be burned.

Assuming by 2021 the gap has grown to 50%, the cumulative additional cost of fuel that motorists are required to buy as a result of test manipulation will amount to nearly a trillion euros in 2030 – oil the EU must import, damaging balance of payments and lowering growth as the expenditure on oil reduces expenditure and jobs in their sectors. Carmakers' manipulation of tests is therefore also damaging the EU economy. Society also pays a price for carmakers achieving targets by manipulating tests. The cumulative CO_2 emissions arising from test manipulation by 2030 are estimated to be about 1.5 billion tonnes. Test manipulation is increasing the risk of dangerous climate change.

3 Features of the widening gap

3.1 Which carmakers are the best at using flexibilities in tests?

An expert study for the European Commission[16] and a report by T&E[17] demonstrate the many ways carmakers are able to manipulate test results (Figure 4). By testing a 'golden vehicle' and creative interpretation of the test procedures, carmakers are able to achieve multiple small improvements that lower the test results. Cars tested using the official procedure without utilising flexibilities or specially preparing the car produce results 19-28% higher than type approval values.[18]

As Figure 5 illustrates, all the major carmakers have been exploiting ever more flexibilities in the current official tests during 2013 to 2015, but detailed results from Spritmonitor in Germany show that cars produced by Daimler exhibit by far the biggest gap of 53%. In the past two to three years *all* major carmakers (with the possible exception of Fiat) appear to have become more adept at using flexibilities in the tests such that all carmakers now have an average gap of 38% or more (as against a maximum gap of only 10% in 2001) - see infographis below.

[12] http://www.reuters.com/article/2014/10/02/autoshow-paris-carbon-idUSL6N0RX5S520141002

[13] VAG sells about 3 million vehicles in Europe each year. A cost of €100 million is therefore equivalent to an average of €30 per gram per vehicle. Reducing emissions by 35g/km to meet 95g/km will therefore cost about €1,050 – very similar to the estimate of the European Commission.

[14] Assumes the gap remains at current levels; fuels costs €1.6/l; 250,000km vehicle lifetime.

[15] Assumes 13 million sales per year

[16] TNO 2012, Supporting Analysis regarding Test Procedure Flexibilities and Technology Deployment for Review of the Light Duty Vehicle CO_2 Regulations: Note on options for reducing test cycle flexibilities, Framework Contract No ENV.C.3./FRA/2009/0043, European Commission DG Clima, Brussels

[17] T&E 2013, Mind the Gap

[18] TNO 2012a, Road load determination of passenger cars, TNO report TNO 2012 R10237, Delft

Fig 4: Common ways carmakers manipulate tests for CO_2 emissions and fuel economy

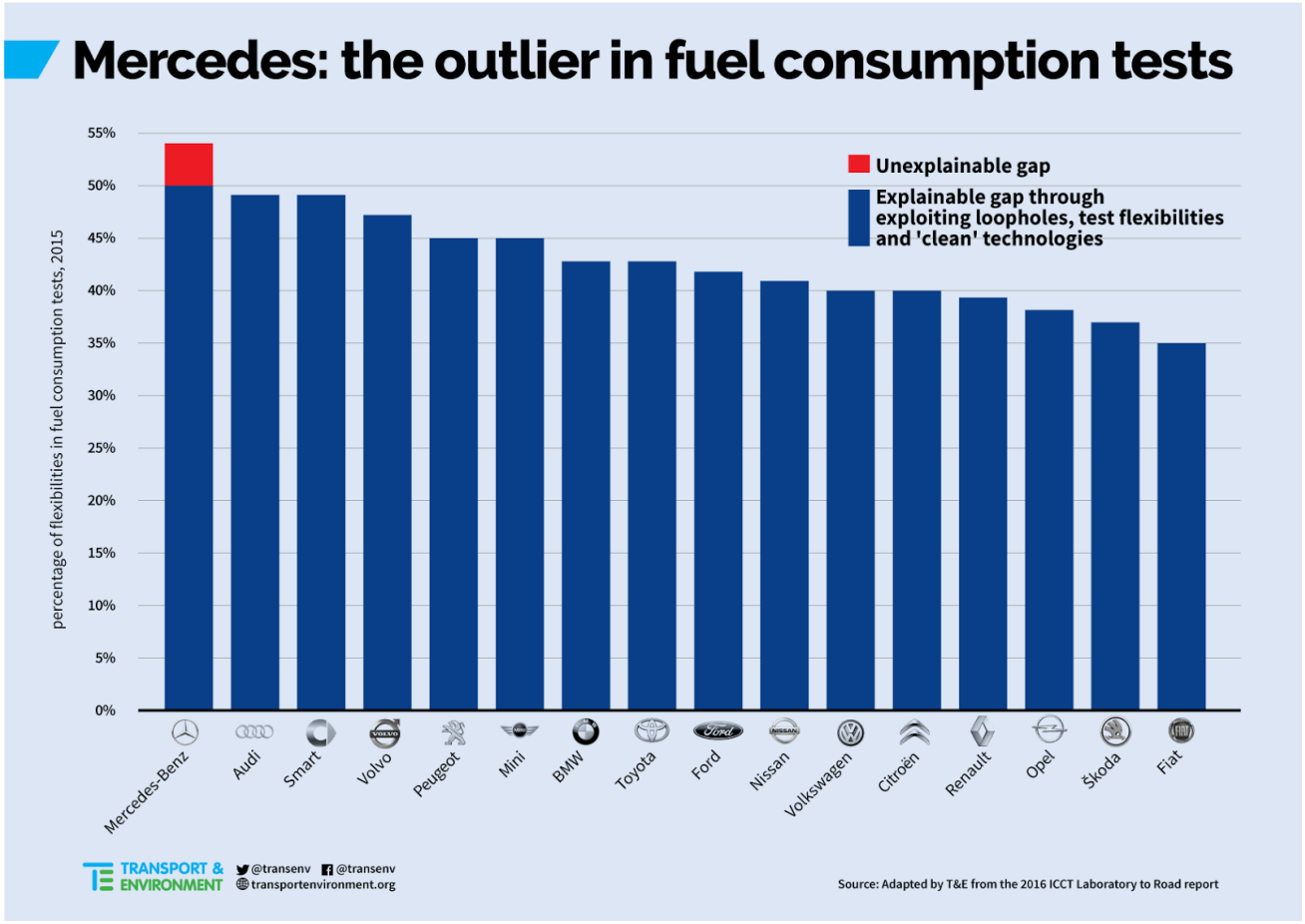


Fig 5: Difference between manufacturers test results and average real-world driving in 2015 (derived from ICCT, 2016)

3.2 The gap for specific car models

Analysis of the gap between test and real-world performance for a range of high volume models (based upon the Spritmonitor data from Germany) shows wide disparities as illustrated in Figure 6. This highlights that the current NEDC test does not provide a robust basis to compare between models as the car industry frequently claims. For Mercedes the gap is more than 50% for all models.

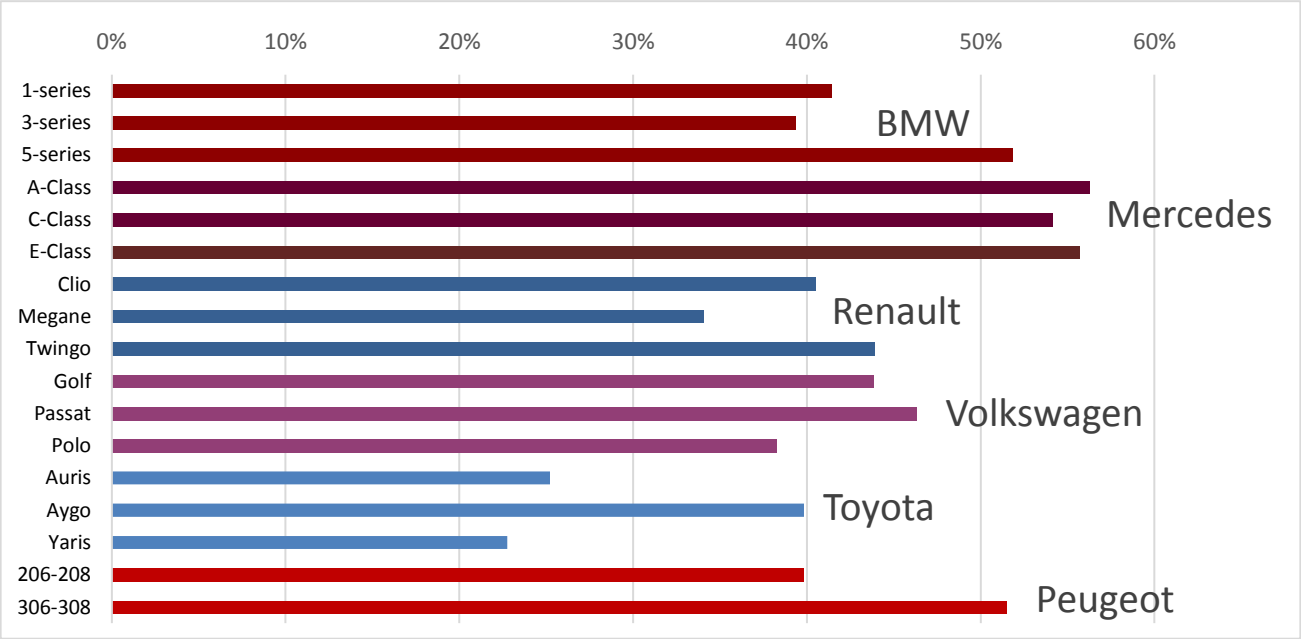


Fig 6: Real-world 'gap' for most popular car models in 20145(derived from Spritmonitor data from ICCT, 2016)

The data is striking for two reasons: it indicates there is considerable opportunity for most carmakers to achieve an even bigger gap in the future by exploiting all flexibilities on all models; and that test flexibilities are massively distorting the car market since competing vehicles have widely varying gaps and are therefore marketed, sold and taxed on a completely unfair basis.

A more detailed breakdown looking at the most popular models in each market segment highlights these points. The most popular models in the **Small** segment include the Renault Clio, Volkswagen Polo, Toyota Yaris and the Peugeot 200 series. In the mid-2000s, all of these models exhibited quite low gaps between test and real-world emissions at around 10 to 15%. From 2008 this increased sharply. As a result, the Renault, Volkswagen and Peugeot all went from a gap of less than 20% in 2010 up to around 40% in 2015. The one exception was the Toyota, where the gap has been quite stable for several years and still stands at a little over 20%.

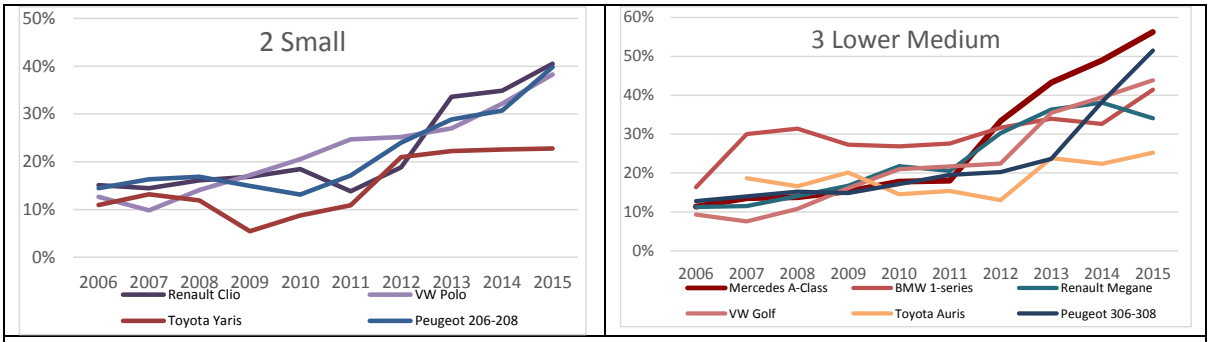


Figure 7: Gap for the Small and Lower Medium segments

In the **Lower Medium** segment six popular models are compared: the Mercedes A-Class, the BMW 1-Series, the Renault Meganne, the VW Golf, the Toyota Auris and the Peugeot 300 series. In 2006 there was a 10 to 15% gap for each of these models. The BMW which took an early lead with a gap growing rapidly to 30% in only two years when the Efficient Dynamics range was launched but most of the others have increased fairly steadily to a gap of 40 to 50% by 2015. For the Mercedes the gap exceeded 55% in 2015. There has also been a rapid increase from the Peugeot over the past two years.

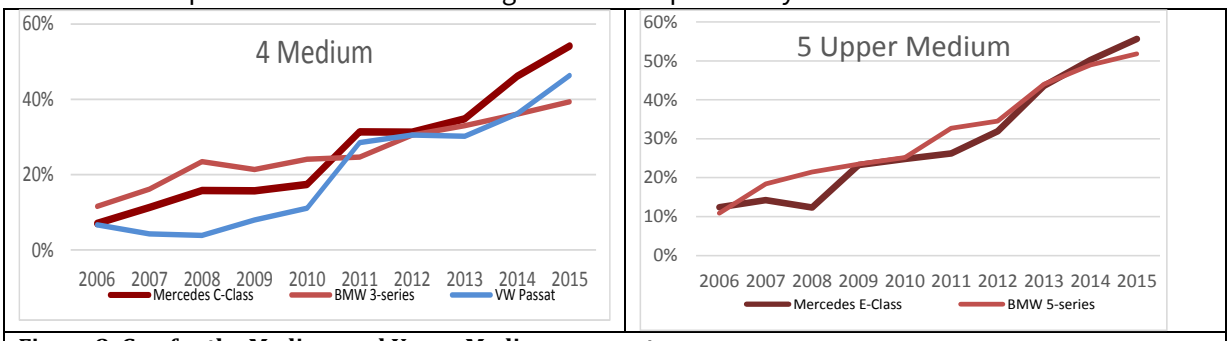


Figure 8: Gap for the Medium and Upper Medium segments

The main models in the **Medium** segment are the Mercedes C-Class, the BMW 3-Series and the Volkswagen Passat. Again, all began with a 10% gap in 2006 but the Mercedes and the BMW in particular increased quite rapidly and all reached the mid-30s by 2013. Again it is the Mercedes which is clearly the leader at the moment, with the gap having increased rapidly from 2010 to reach the mid-50s by 2015.

The **Upper Medium** segment is typified by the Mercedes E-Class and the BMW 5-Series. Again these began with a gap of only around 10% in 2006 both of which exceed 50% by 2015.

3.3 The gap for specific engine types

The ICCT data provide estimates of the different size of the gap for different engine/fuel configurations. For petrol and diesel, Figure 9 illustrates that the relative gap size has changed over time. In the early 2000s, diesel vehicles exhibited a larger real-world gap than petrol. This situation reversed around 2005 but then switched again after 2010, since which time diesels have been showing a steadily growing excess relative to petrol cars – growing to 6 percentage points, with the average gap for petrol engines now 36% but that for diesel at 42%. This is important, because over the same period the supposed CO_2 advantage of diesel as measured in the new car test results has been shrinking and now extremely small; averaging 119 g/km for diesel against 123 g/km for petrol in 2015. If the growing gap is factored into the analysis, real-world CO_2 emissions of all the diesels sold in 2015 was 170 g/km, and that of petrol only 167g/km – a gap of more than 2 g/km in favour of petrol. While this is in part the result of differences in market segmentation (more larger diesel cars) it illustrates that the real-world benefits of diesel are less than is commonly claimed relative to gasoline cars.

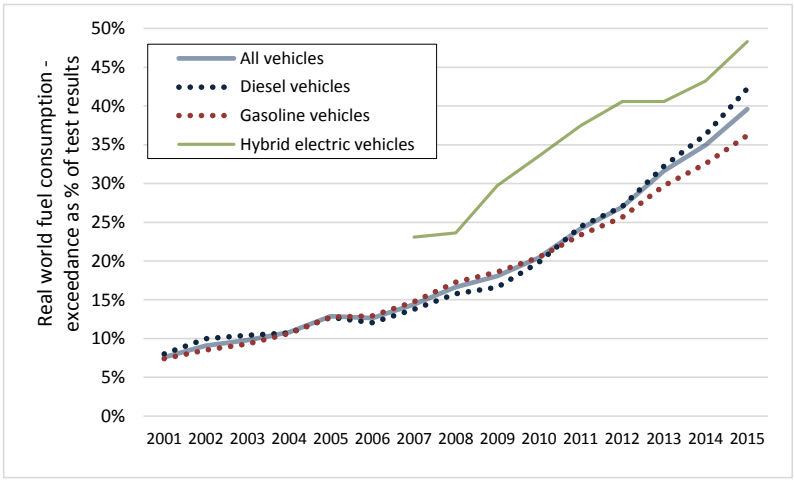


Fig 9: The gap for each vehicle/fuel type

Sales of hybrid vehicles are relatively small and still developing, so it is difficult to draw firm conclusions from the rather erratic time track of gap size to date shown in Figure 9. Nonetheless, it seems clear that

the gap is consistently larger for all hybrids, and growing in much the same way as for conventional cars. Hybrids do offer fuel economy benefits relative to their conventional equivalents. The same issue exists for plug-in hybrids. This is important, as from 2015 plug-in hybrids accounted for more than half of all the electric vehicles sold in Europe and in some countries benefit from generous tax breaks. Early indications suggest that many PHEVs are not being used extensively in electric mode, and are not therefore delivering the scale of environmental benefits that the test results imply. It is essential that test procedures are updated with more realistic use cycles and procedures for these vehicles so that incentives are not misallocated.

3.4 How much of the claimed improvement is actually achieved on the road?

T&E has reanalysed the latest Spritmonitor data to compare how much of the improvement in emissions claimed by the main manufacturers between 2008 and 2015 has actually been delivered on the road (Figure 10). According to this dataset, on just a third (36%) of the improvement claimed in tests resulted in lower emissions and fuel consumption on the road. There are substantial differences between carmakers with GM's emissions on the road appearing to have actually increased over the period (and hence the negative index); while less than 20% of the progress reported by Mercedes (Daimler) is achieved on the road. In contrast BMW and Toyota have delivered more than half of their claimed improvements on the road. Most companies are now delivering less of their test improvements on the road each year.

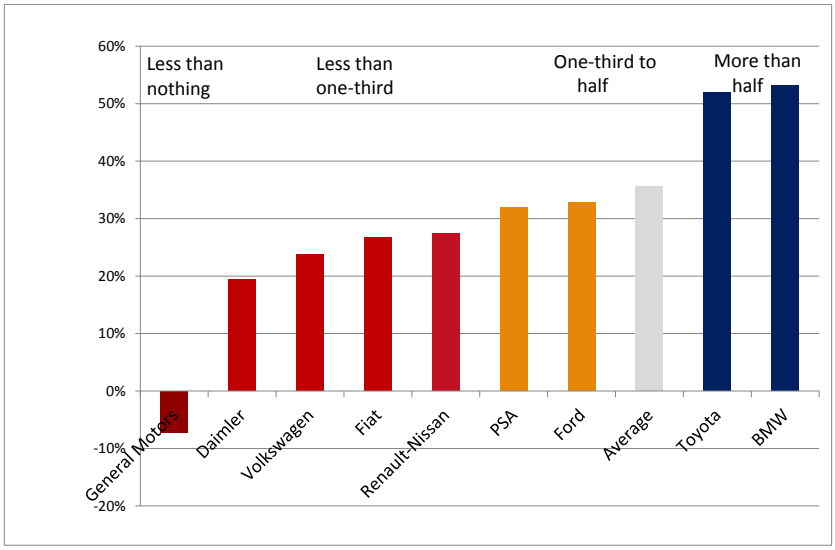


Fig 10: Percentage of the improvement in test emissions 2008-2015 actually realised on the road

3.5 Would the 2015 targets have been met without test flexibilities?

All the major carmakers comfortably achieved their 2015 CO_2 targets by 2014 according to official test results.[19] But T&E has reanalysed the data to assess whether carmakers would still be on track to achieve their 2015 targets on the road *without exploiting test flexibilities.* On average, two-thirds of the gains claimed to have been made since 2008 have been through manipulating tests with only 14.6 g/km of real progress on the roads set against 25.5 g/km of 'hot air'.

Analysis of what progress carmakers would have made towards achieving their targets if their real-world gaps had remained at the level in 2008 (Figure 11) shows only Toyota would come even close to meeting its target without abusing test flexibilities - with 80% of its target achieved. Almost all the companies appear to be relying heavily on measures that help then to achieve their targets in the laboratory but not on the road, rather than delivering truly more efficient vehicles as was intended. Most companies

[19] T&E 2015, How Clean are Europe's cars?

achieved less than half of their target reduction in the real world, showing that the EU's climate goals are not being met in road transport.

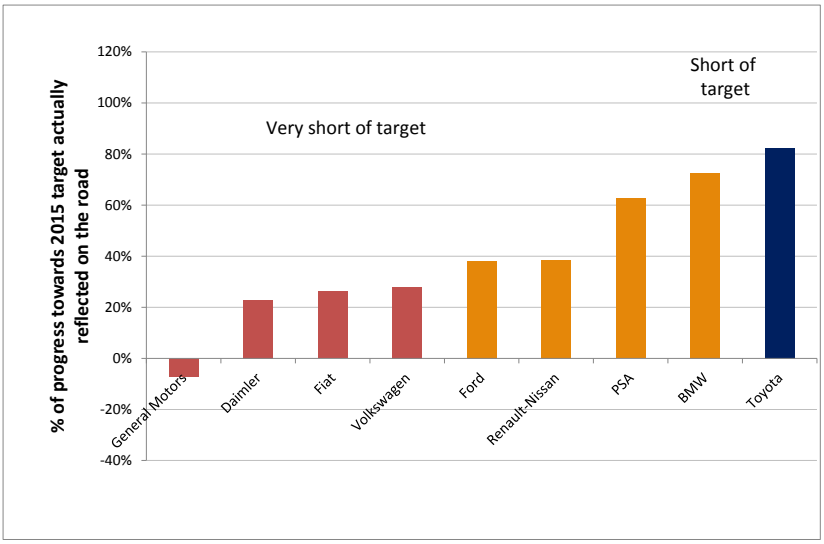


Fig 10: Percentage of progress towards 2015 CO2 targets achieved on the road (2008-15)

4 Policy conclusions

This report has highlighted the growing gap between test and real world CO2 emissions and fuel economy and the causes. This section addresses the solutions. There are 6 principal fixes to ensure improvements are delivered on the road:

1. A Commission proposal for a 2025 CO_2 target
2. A real world CO2 test & not to exceed limit
3. Strengthening the testing framework
4. An investigation into the use of defeat devices to distort CO_2 tests
5. A Commission proposal to improve consumer information
6. Actions at the national level.

4.1 A Commission proposal for a 2025 CO_2 target

The failure of the current testing system makes setting a 2025 car CO_2 target essential to reduce emissions on the road and help to deliver 2030 climate goals. As Figure 11 illustrates, only a third of the measured improvement in emissions delivered through regulation to date has been achieved on the road. This has created a huge benefit for carmakers who in practice have been able to deploy much less technology on vehicles to achieve their targets saving an estimated €7 billion in

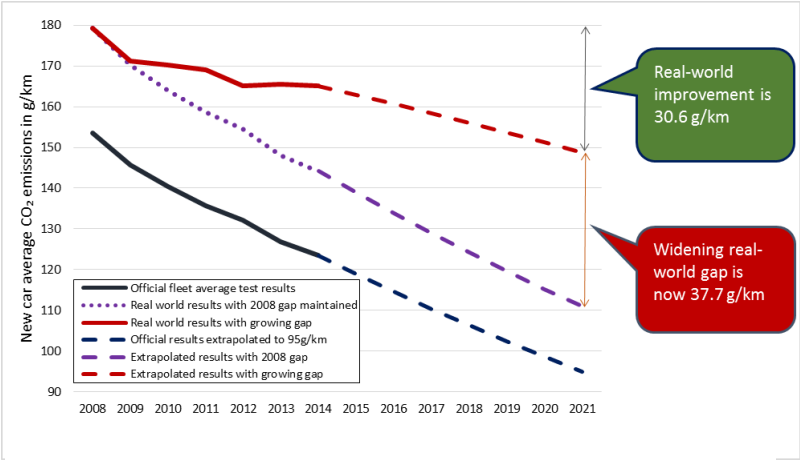


Fig 11: Projection of the widening gap to 2020 based upon past trends and bottom up analysis

costs. By 2021 emissions on the road will still be 150-140g/km. This is a more modest on-the-road reduction in overall emissions than was envisaged when the regulation was adopted when the then gap indicated emissions of around 110g/km on the road by 2020.

Why the introduction of WLTP won't close the gap before 2021

A new global testing system (the World Light Duty Test Cycle and Procedures – WLTC/P) will be introduced for all new Types of vehicles in the autumn of 2017 and for all new vehicles in autumn 2019. This test cycle is more representative of real-world driving and the test procedures are more robust when compared to Europe's NEDC; but will require the 95g CO_2/km average target for new cars in 2020/21 to be modified because this is based on the NEDC test. The agreed approach is to correlate between the NEDC and WLTP tests using a computer simulation tool. This will convert the WLTP test value into an NEDC equivalent CO_2 value for each car sold. In 2020/1 all new cars registered will have both a WLTP measured CO_2 value and simulated NEDC equivalent. From this it will be possible to calculate the average CO_2 emissions for each manufacturer based on both measured and simulated values. The simulated values will be compared to the present company targets to assess compliance with regulation. It will also be possible to derive a WLTP equivalent target for use after 2020 (based on the measured WLTP value and ratio of the NEDC simulated average CO_2 value and the company NEDC target).

The correlation tool takes account of test flexibilities in the NEDC procedure that are not allowed in the WLTP procedure. For example the pre-charging of the battery before the test and use of inertia classes. This is intended to ensure "equivalent stringency" between the current NEDC based targets and measurements made using the WLTP target but is interpreting this to mean every flexibility in the NEDC test is included in the correlation method and new WLTP-based targets, effectively weakening the regulation. Analysis by the ICCT and T&E shows legitimate differences between the NEDC and WLTP test cycle and procedures leading to a 10g/km difference between the two tests. But the final methodology includes some abuses of the NEDC test procedure that will increase the average correlation to about 18g/km. The introduction of the WLTP test will therefore not lead to any tightening of the CO2 regulation until a new target is established that is expected for 2025

There is therefore a significant opportunity to continue to reduce emissions using conventional technology that delivers emissions reductions on the road. The introduction of the WLTP test is a step forward but it has been agreed that it is accompanied by an effective weakening of company targets for 2021 to account for the stricter testing procedures (see box). The benefit of introducing the WLTP test will not therefore be realized until a new post-2020 target is set based upon WLTP. The Commission is expected to make a proposal in the third quarter of 2017 for 2025.

4.2 A real world CO2 test and 110% not to exceed limit

By 2025, a new fleet average target of 80g/km based upon the WLTP test (equivalent to around 70g/km on the NEDC test); would still mean emissions on the road of about 105g/km (assuming a 31% difference between WLTP and real world performance (see Figure 2). To bring down the real world emissions and avoid a widening of the gap using the WLTP test a real world test should be introduced to complement measurements made in the laboratory using the WLTP test.

Real world measurements are not as reproducible as laboratory tests – but T&E work with Peugeot Citroen (PSA) has already developed a real world efficiency test that is sufficiently reproducible when combined with a not to exceed limit. The post 2020 regulation would be based upon the WLTP test figure but, in addition, an on road test using a portable emissions monitoring system (PEMS) would make a second measurement. This would need to be no more than 110% of the WLTP value. If the gap is more than 110% the WLTP test would need to be repeated or the value adjusted to be no more than 10% lower than the road test value. This would have 3 benefits:

1. The use of test flexibilities will be curtailed to prevent excessively low and unrepresentative test results
2. The car will be configured to produce low emissions during real world test and not just for the WLTP. This will include fitting technology with real world benefits

3. Manufacturers will be encouraged to fit technology that optimizes on road performance – so called eco-innovations such as LED headlights.

Figure 12 illustrates how the WLTP test combined with a real world test and 110% not to exceed limit can bring down real world emissions. In the example illustrated a 2025 target of 80g/km (equivalent to around 70g/km on the NEDC test) will result in real world emissions of about 105g/km. But adding a real world test and 10% not to exceed value reduces on road emissions to 88g/km thereby ensuring effective emissions reductions on the road.

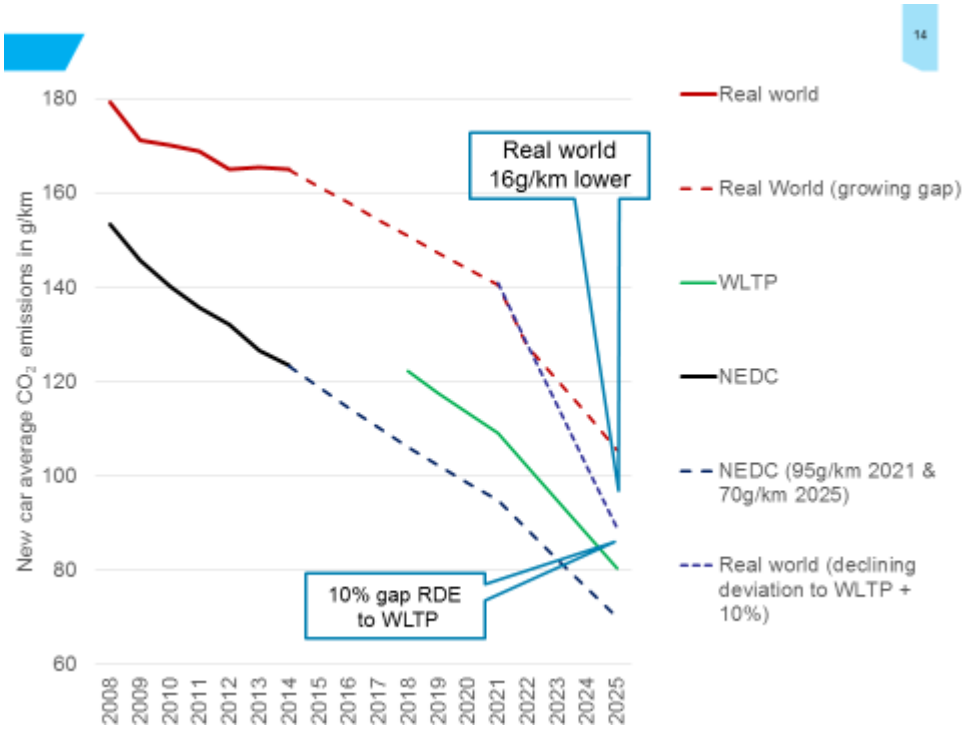


Fig 12: WLTP and real world test with a 10% not to exceed limit

A recent report by the Commission's High Level Group of Scientific Advisors has delivered its own analysis of the problem, published in November 2016[20]. This was a broad evidence-based review, and confirmed not only that this fuel economy gap is both large and growing, but also that there is a growing body of reliable evidence to substantiate this. They also recommended the Commission consider linking real world fuel economy test to the post 2020 car CO_2 regulation

4.3 Strengthening the testing framework

The problems with the NEDC test have been exacerbated by a number of serious failings in the overall framework by which vehicles are tested. These include:[1]

1. That carmakers test prototype or pre-production cars that are unrepresentative of production vehicles and have been specially prepared to produce very low test results;
2. There are no effective independent checks to ensure that vehicles actually sold or used on the road later achieve similar results to those of the tested vehicles;
3. Carmakers pay the Type Approval and Testing Services that oversee the test and usually perform these in their own laboratories. Since the organisations overseeing the test are in competition with other testing authorities across Europe they are not sufficiently independent or demanding in terms of scrutinising how the test is performed;
4. During the test, energy-hungry accessories such as air-conditioning, navigation and media systems, and heated screens and seats remain switched off, thereby giving lower test results than would be found in real-world conditions.

[20] High Level Group of Scientific Advisors, *Closing the gap between light-duty vehicle real-world CO2 emissions and laboratory testing*, Scientific Opinion No 1/2016

[1] http://www.transportenvironment.org/publications/mind-gap-why-official-car-fuel-economy-figures-don%E2%80%99t-match-reality

These issues will not be addressed by the introduction of the WLTP but must be to reduce future systematic abuse of the tests.

In the US, Hyundai-Kia, Ford, Mercedes and BMW-Mini have all been caught by the US Environmental Protection Agency (EPA) providing incorrect fuel economy information. Some have been required to compensate drivers, and huge fines have been levied where wrongdoing was clearly apparent. The US system works because there is an effective system of checking test results and accurate fuel economy information. In the US the focus is on surveillance testing of sold vehicles to ensure these comply with regulations. In the EU the focus is on initial Type Approval, which is more open to abuse.

The USEPA has recently strengthened its system of oversight and introduced an additional random test for carmakers, it performs much more intensive audits of the carmakers' own tests. It conducts its own random retesting programme at its laboratory at Ann Arbor, and also checks the test results on models for which it receives a significant number of complaints from motorists. Overall it has increased the share of audits of manufacturer test results, to the extent that 15-20% of models on the market are now retested by the EPA. At the start of 2015 the EPA issued revised rules for the conduct of coastdown tests. It may also require manufacturers to verify their own pre-production test results using production models[21]. The EPA response is proactive and comprehensive in contrast to the slow and piecemeal progress in the EU. The European system could be improved by:

- Establishing a European Vehicle Surveillance Authority to check performance of vehicles on the road and in sales rooms complies with the original type approval results. The Authority should also oversee the work of national regulators to ensure they perform tests consistently and independently and end the market in which testing services compete to offer carmakers the most highly optimized service. By levying a charge of €20 per new vehicle sold the Authority could be funded and the contractual link between the manufacturers and testing organisations broken;
- Strengthening the system of conformity of production checks to ensure production cars match emissions measured during type approval. This should include tests performed on the road using Portable Emissions Monitoring Systems (PEMS) to extend the air pollution emissions tests. These tests, which could include approaches to normalise the data to account for different routes and driving conditions, should require road and laboratory test results to be within a given margin of tolerance;
- Requiring increased surveillance and in-service conformity checks done independently, including by third parties, to ensure vehicles continue to perform on the road in a similar way to models being type approved for a minimum of 100,000 km. At least 20% of new EU models on the EU market each year should be subject to such market surveillance.
- Putting in place a public online database of all EU type approvals with easy access and in a digitally searchable format. Such a database should also include key testing specifications necessary to verify original type approval test results (e.g. coast-down coefficients), and a portal for consumers and third-party testers to upload their test results and substantiated complaints.

4.4 An investigation into the use of defeat devices to distort CO_2 tests

Since the #dieselgate scandal emerged it has become clear that most manufacturers design exhaust after treatment systems to produce low NOx emissions in tests but generate much higher emissions on the road. Evidence has also emerged that CO2 tests may also be similarly manipulated. First VW announced in November 2015 that, "During the course of internal investigations, unexplained inconsistencies were found when determining Type Approval CO2 levels …... Based on present knowledge around 800,000 vehicles from the Volkswagen Group are affected."[22] A month later the company reduced the estimate,

[21] http://www.autonews.com/article/20141018/OEM11/310209867/epa-plans-more-scrutiny-of-mpg-tests
[22] https://www.ft.com/content/aa35f24c-8259-11e5-a01c-8650859a4767

without explanation to 36,000 vehicles with minor discrepancies. But a year later there are still unanswered questions including from the European Commission was until very recently unable to finalise the car CO2 emissions for 2015 that was due on the 30th June because "further clarifications are needed in the context of possible CO2 irregularities concerning vehicles of the Volkswagen Group."[23] The European Environment Agency report has now been published but with no apparent mention of the irregularities and how these have been resolve.[24]

More recently reports have emerged of Audi[25] distorting CO2 tests in the US. The report originally in Bild am Sonntag said software had been discovered by the Californian Air Resources Board (CARB) in vehicles with certain automatic transmissions. The software detected whether a car's steering wheel was turned more than 15 degrees and if not turned on a gear-shifting program which produced less carbon dioxide than in normal road driving. The reports suggest Audi stopped using the software in May 2016, just before CARB discovered the manipulation in an older model. Several engineers are reported to have been suspended. VW Group has now confirmed the reports stating "Adaptive shift programs can lead to incorrect and non-reproducible results" during emissions testing. VW has also confirmed Audi "has made available technical information" about the software, known as adaptive shift programs, to Germany's Federal Motor Vehicle Authority KBA, which is investigating the matter.[26]

The data presented on the gap between test and real-world performance for some individual models raises serious suspicions that other carmakers are also deploying similar techniques to lower test CO2 results. T&E testing and work by the ICCT suggest that a gap of 30% can be achieved through 'normal' test manipulation – i.e. programming the engine carefully to ensure that it produces very low CO_2 emissions under test conditions but less so on the road, and employing some of the other test procedure loopholes outlined above. However, some models now achieve gaps much more than this, at well over 50%. Such a large gap cannot be explained through known test manipulations and suggests another cause; most obviously a technology or software fix being used specifically to reduce test cycle CO_2 emissions. The largest gaps observed are for the Mercedes A, C and E class vehicles, the BMW 5 series and Peugeot 308, each of which now has a gap greater than 50%. Further investigations are needed into these models and the VW Group to explain the high discrepancies.

4.5 A Commission proposal to improve consumer information

The Commission also needs to bring forward proposals to ensure consumers are provided with more robust information about fuel economy and CO_2 emissions. Figure 2 illustrates that WLTP test results for fuel consumption are estimated to be about 23% lower (in 2020) than are typically achieved in real-world driving; and this gap is forecast to grow. Drivers will not be motivated to buy the most fuel-efficient vehicles if the official data is not considered representative. Proposals to reduce the gap (described in the sections above) are unlikely to ever completely align test and average real-world performance. The Commission should therefore examine the use of real world driving emissions tests (such as those developed by PSA together with T&E. This could provide a reliable real world CO2 performance figure for the purposes of vehicle labelling, advertising and potentially vehicle taxes levied by EU Member States. For plug-in vehicles it will need to accurately represent the average balance of driving performed on the electric motor and combustion engine. It might also reflect the very different road, driving and climatic conditions in each Member State, which have an effect on real-world fuel consumption. The update to the obsolete Car Labelling Regulation[27] should encompass online information and ensure information is easily

[23] Personal Communication from DG Climate Action to T&E
[24] http://www.eea.europa.eu/publications/monitoring-co-2-emissions-from
[25] http://www.reuters.com/article/us-volkswagen-emissions-audi-idUSKBN1300V7
[26] http://www.theverge.com/2016/11/14/13620606/volkswagen-audi-emissions-cheating-software
[27] http://ec.europa.eu/clima/policies/transport/vehicles/labelling/docs/directive_en.pdf

understandable for car buyers. It should ensure comparisons are on a absolute emissions basis and benefits in terms of lower running costs are emphasised.

The Commission has once again delayed updating its obsolete car labelling directive. A decade after it acknowledged the system is not fit for purpose it continues to fail to address the issue – largely out of an unwillingness to address the question of the degree to which the label should be harmonised across member states and specifically whether the label should be a relative system (such as in Germany) or absolute approach (as used in most of the rest of Europe. If the Commission continues to refuse to revise the obsolete existing requirements it should repeal the current Directive and allow Member States to produce their own improved systems.

4.6 Actions at the national level to "Close the Gap"

There needs to be a concerted effort by Member States to complement the actions of the Commission and ensure the gap between test and real-world performance is not allowed to grow both before and after the introduction of the WLTP test. This requires a number of policy interventions that could include:

- Higher fuel taxes – to compensate for low oil prices – and encourage more efficient driving;
- High circulation and registration taxes to reduce sales of high CO2, high performance models that encourages excessive acceleration;
- Better enforcement of speed limits – such as by using connected vehicle technology, automated and average speed cameras;
- Company car tax schemes that encourage users of plug-in hybrid vehicles to recharge their vehicles frequently and require them to pay for their fuel.
- Taxing vehicles based upon their average emissions *in use*. With technology to constantly monitor fuel consumption this is now practicable. A higher rate of circulation or company car taxation or a supplementary tax bill for drivers with a particularly wide gap between test and real-world performance would act as a powerful incentive for drivers to moderate their driving style and companies to train their drivers.

Member States also need to support Commission proposals to strengthen the inadequate testing framework and ensure Type Approval Authorities robustly scrutinize CO2 tests.