REAL WORLD FUEL ECONOMY MEASUREMENTS:

TECHNICAL INSIGHTS FROM 400 TESTS OF PEUGEOT, CITROEN AND DS CARS

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1. SUMMARY

In 2015, Groupe PSA, Transport and Environment (T&E), France Nature Environnement (FNE) and Bureau Veritas announced plans to measure and publish real-life fuel economy information for PSA vehicles. Unlike most other fuel economy measurements, the tests were to be performed on the road using a Portable Emissions Monitoring System (PEMS). The intention was to provide customers with robust information about fuel economy that was representative of the typical driver for each model selected. The first results were published in 2016 and by the end of 2017 the aim was for the whole fleet to be covered, including pollutant measurements. In order to ensure robust, repeatable and representative measurements, a testing 'Protocol' was developed[1]. This procedure has now been used to conduct more than 400 tests on more than 60 PSA vehicles and over 1,000 model variants[2]. This report provides a meta-analysis of the results and provides valuable insights on real-world driving emissions, differences compared to laboratory test procedures and the real effectiveness of different technologies on the road.

One of the challenges of real-world testing is that it is potentially less repeatable than laboratory tests. However, the Protocol results are accurate overall to within +/−0.3 l/100km, that is, within 5% upper and lower bounds for a vehicle with a 6 l/100km fuel consumption.

This high level of repeatability has been made possible by using a standard route and a limited amount of data normalisation, but with different drivers. The results show the extent to which PEMS systems have advanced in terms of accuracy of the accuracy of the measurements.

The Protocol results show that for an average car achieving 6 l/100km measured using the Protocol in real world, there is a 10% deviation from Worldwide Light Vehicles Test Procedure (WLTP) measurements (which did not fully reproduce the test procedure); 3% with an adjusted WLTP (including more urban driving, more representative of a PSA Group car driver) and 42% with the New European Driving Cycle (NEDC).

The Protocol was inspired by Real World Driving Emissions (RDE) legislation that is now used to meet the Euro 6 emission standards. The procedures are similar but, as the report shows, the Protocol is more robust and provides insights into how representative of real-world driving the RDE tests are. One of the key factors affecting RDE test results is the driving style that is defined using dynamic boundary conditions. The test results show that even the most passive driving styles used during the tests (including those considered far too passive to be part of a legitimate Protocol test) are permitted by the RDE test and, importantly, that the measurement is not subsequently adjusted to take into account of the low relative positive acceleration (RPA).

An average PSA driver of large and higher performance vehicles driving on motorways would be classified as excessively aggressive by the RDE criteria. The Protocol results also show that the way the RDE test defines urban, rural and motorway driving (using an approach based upon the speed of the vehicle) significantly exaggerates the proportion of the drive defined as urban. Modifying the method to use a topographic approach would be more representative.

A legitimate test must represent the driving style of a 30th to 70th percentile driver. The RDE

1 http://media.groupe-psa.com/en/press-releases/group/realworld-fuel-consumption-protocol-publication

2 http://media.groupe-psa.com/en/press-releases/group/psa-publishes-real-world-fuel-consumption-data

test is designed to represent approximately 90% of EU driving, but these results suggest it does not reflect it. Additionally, the results illustrate that the more demanding urban driving fraction is being underestimated.

The Protocol results also demonstrate a number of important characteristics of car fuel economy:

1. A pairwise comparison of a 1.2 PureTech 130 gasoline engine and a 1.6 BlueHDi 120 diesel engine on the same vehicles showed that:

a. Diesel engines have a 1.5 l/100km lower fuel consumption (1.65 l/100 km in urban conditions and 1.15 l/100 km in non-urban conditions).

b. In urban conditions, the gap between the certification and real life is equal for diesel (2.4 l/100km) and gasoline (2,5 l/100km) when expressed in l/100km, but it is higher for diesel (53%) compared to gasoline (42%) when expressed as a percentage.

c. Diesel engine efficiency also tends to be less sensitive to driving styles than gasoline models, which implies that the Protocol results will be accurate for a higher proportion of diesel car drivers than gasoline car drivers.

2. NEDC test values are particularly unrepresentative of larger vehicles both in absolute and relative terms. This assertion also applies to Multi-Purpose Vehicle (MPV) / Sport Utility Vehicle (SUV) body shapes relative to a traditional hatchback, and holds for most driving conditions.

3. A comparison of the same vehicles with the same engines shows a fuel consumption 0.4 l/100km lower for manual gearboxes compared to automatic transmissions. For diesel cars in urban areas this difference increases to about 0.7 l/100km. However, automatic transmissions produce more consistent fuel efficiency results than manual equivalents.

4. Stop & Start systems cut the engine when the vehicle is stationary, in order to reduce fuel consumption in urban driving conditions. A comparison between the same vehicle engine with and without Stop & Start shows a reduction of 0.3 l/100km in urban driving – much less than the benefits of the technology in an NEDC test, which measures at 0.5 l/100km.

5. For MPV/ SUV body styles with relatively poor aerodynamics, WLTP is more representative than NEDC, but MPVs/ SUVs are still favoured over hatchbacks or saloons.

6. When used and driven in the most favourable conditions, only a handful of models (predominantly small and low powered manual vehicles) are capable of reaching NEDC certification values in real life. Basing any policies on certification fuel economy or CO2 emissions implies some bias, such as favouring MPV/SUV body styles or automatic transmission.

7. The Protocol is repeatable within an acceptable tolerance of +/– 3%, which is higher for some vehicle specifications. Comparison with other on-road tests shows that most results are consistent with real-life fuel economy tests performed on the road. Such on-road tests are an additional and valuable piece of information to the WLTP test.

8. The WLTC makes significant progress to closing the gap between existing certification and real-life fuel economy. To be closer to real-life fuel economy, WLTC would need to have an urban, rural and motorway mix that is closer to real-life, with a bigger share of urban driving.

9. The onboard computer informs the user of the fuel consumption for a given trip. The tests show, on average, that the onboard computer gives reliable information to the customer, slightly overestimating the fuel consumption for both gasoline and diesel. However, there is considerable scatter in the results on a model-by-model and trip-by-trip basis.

Overall, the results clearly show PEMS tests for CO2 fuel economy provide a robust, representative and sufficiently repeatable basis for measuring the real-world fuel economy and CO2 emissions of vehicles. However, the measurement device does need to improve its reliability (8% of the tests failing for instrument reasons), especially the accuracy of the exhaust mass flow measurement for gasoline engines, particularly in challenging low mass flow environments such as urban environments.

2. INTRODUCING THE PROTOCOL

The gap between laboratory test results and real-life fuel efficiency has increased sharply over the past 15 years[3] . Official statistics are therefore misleading regarding the annual fuel costs and contribute to the consumers' lack of trust in official data on fuel use.

In the wake of the 'Dieselgate' scandal and the resulting loss of consumer confidence in car emissions testing, Groupe PSA initiated a programme of real-world fuel economy tests to provide its customers with more reliable information. Acknowledging that the new tests could be perceived as lacking in independence and credibility, the PSA Group invited the environmental groups Transport and Environment[4] and France Nature Environnement[5] to work on the development of the testing methodology. It was subsequently agreed that the tests would be independently witnessed and verified by Bureau Veritas[6] who would provide testing, inspection and certification services.

The details of the testing method (The Protocol for Real-World Fuel Consumption measurements, called "the Protocol" throughout this report) are detailed in an earlier report[7]. The present report provides a meta-analysis of the results as follows:

- Section 2.2 compares the Protocol with other test procedures such as the new Real Driving Emissions (RDE) test that has been developed to measure on-road emissions of air pollutants (currently nitrogen oxides and particle numbers) and that demonstrates that the approach is equally robust for the measurement of CO2.

- Section 3 compares the results with other ways of measuring car CO2 emissions, including laboratory tests and other real-world databases of fuel efficiency, and demonstrates the rigour, representativeness and reproducibility of the Protocol.

- Section 4 analyses in detail the results according to the size of the vehicle and to the powertrain and technologies fitted to the vehicle, also showing how these factors affect real-world fuel efficiency.

2.1 PROTOCOL DEVELOPMENT AND USE

Measurements are taken using a PEMS that directly measures the exhaust emissions. The car is driven on a standard route that is designed to be representative of typical customer use including urban, rural and motorway driving. The test is long enough to have a meaningful operation in each of the three phases (Figure 1). The route is based upon the requirements of the legislative RDE test that has entered into force early in 2016[8]. The driving style must

3 https://www.transportenvironment.org/publications/mind-gap-2016-report

4 https://www.transportenvironment.org/

5 https://www.fne.asso.fr/

6 http://www.bureauveritas.com/

7 http://media.groupe-psa.com/en/press-releases/group/realworld-fuel-consumption-protocol-publication

8 COMMISSION REGULATION (EU) 2016/427 of 10 March 2016 amending Regulation (EC) No 692/2008

be representative of a typical driver of the model being tested. The Protocol does not prepare the vehicle in any way for the real-life testing, which is performed on public roads, and Bureau Veritas ensures the vehicle cannot be tampered with. Average customer information has been obtained by Groupe PSA from a database that Groupe PSA is compiling on a regular basis to capture customer habits when using specially equipped vehicles. This procedure enables the results of the Protocol to be closely matched to real-world customer performance. Groupe PSA could have used internal customer surveys to provide the real-world fuel economy figures. However, they chose to develop the Protocol, as such an approach is more transparent and reproducible than utilising their own database.

The Protocol measures the fuel consumption and efficiency during each of the three parts of the tests (urban, rural and motorway) and measures the fuel consumption according to the typical use of the vehicle. Results are consequently representative of a typical owner of a particular model, but they are not directly comparable between models. The Protocol is similar to the legislative RDE test, although it is considered more robust in a number of important respects.

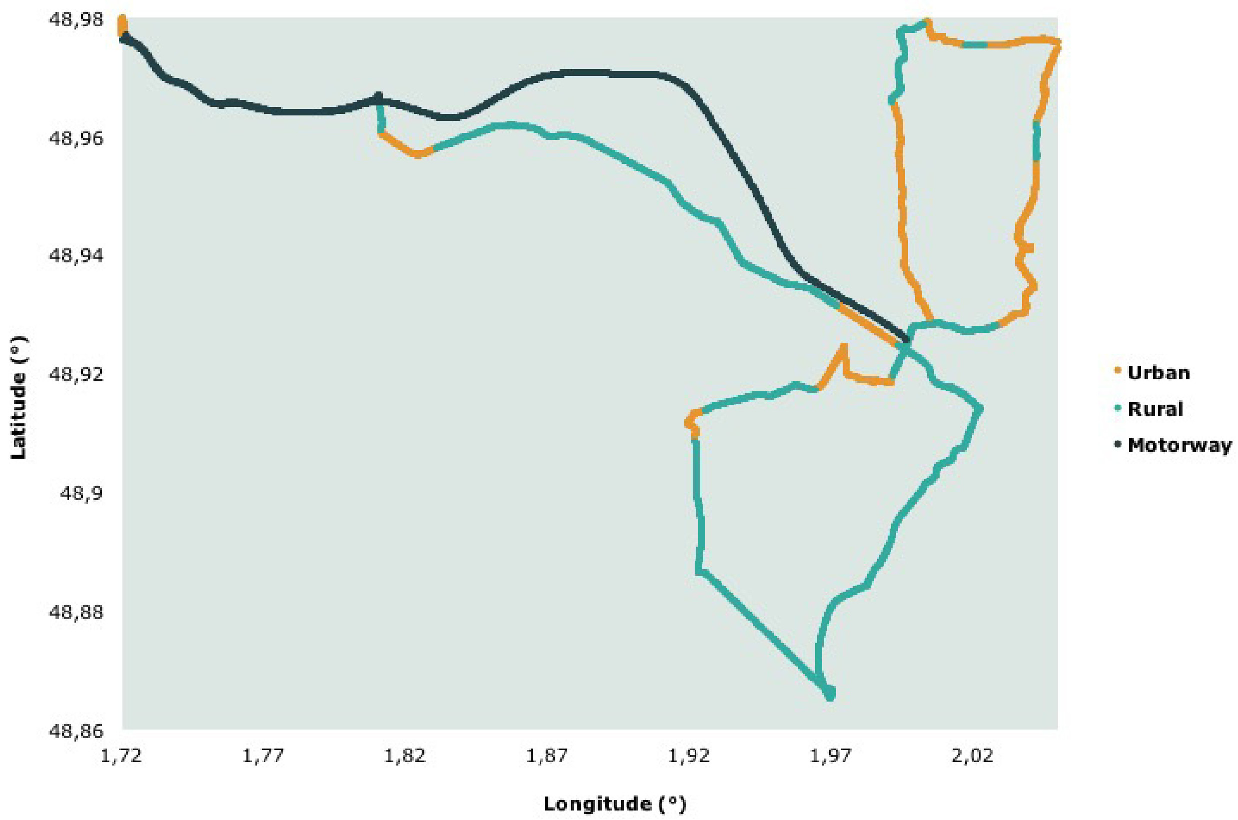

Figure 1: Urban, rural and motorway sections of the Protocol route in the outskirt of Paris

The development of the Protocol commenced late in 2015 and has involved a substantial testing effort with the objective of covering 80% of the sales of the three Groupe PSA brands, both for passenger cars and light commercial vehicles. For this report, only the results from passenger cars have been analysed. At the time of preparing this study, 60 passenger cars had been tested and all of the results are included in it. The complete list of the vehicles tested can be found in Annex I.

On top of the values published for approximately 1,000 of the Groupe PSA models, a fuel economy simulator has been released on the website of each of the brands for many EU countries[9]. These simulators aim at helping customers estimate their own average fuel economy

9 http://media.groupe-psa.com/en/press-releases/group/psa-publishes-real-world-fuel-consumption-data

by changing key criteria that have a significant impact on fuel economy, such as driving style, average trip distance, passenger numbers and luggage.

For each vehicle tested, the Protocol requires at least three valid tests driven by at least two different drivers. The results must be within agreed limits for speed and acceleration to be representative of the typical customer of the model. In total, more than 430 tests have been performed covering more than 40,000 km (Table 1).

Number of vehicles tested	60
Number of valid tests	234
Total number of tests	430
Mileage covered (km)	40,000
2016 sales covered	76.9%
Average fuel consumption (l/100km)	5.8
Average gap between Protocol and official type approval (l/100km)	1.74
CO_2 emitted during the tests (tons)	5.6

Table 1: Summary of the tests performed and overall results

2.2 COMPARISON OF THE PROTOCOL WITH OTHER EMISSIONS TESTS

2.2.1 Comparison with NEDC and WLTP laboratory tests

Tests to measure CO2 emissions and fuel efficiency are usually performed in a laboratory using a chassis dynamometer on which the car is driven through a test cycle. The current test cycle (NEDC) is now obsolete and is shortly to be replaced by a new test, the WLTP (World Light Test Procedure). Real Driving Emission (RDE) tests are now being used to measure pollutant emissions on the road[10], but are not yet used for measuring CO2. Compared with the NEDC and WLTP test cycles, the PSA route and average customer is driving substantially more in urban environments (Table 2).

10 ICCT, 2017, Policy update, Real-driving emissions test procedure for exhaust gas pollutant emissions of cars and light commercial vehicles in Europe, http://theicct.org/RDE-test-procedure-exhaust-gas-pollutant-emissions-cars-and-LCVs

Parameter	Test	Overall	Urban	Rural[11]	Motorway
distance (km)	NEDC	11	36%	64%	
	WLTP	23.2	13%	51%	36%
	PSA route[12]	92.4	25%	43%	32%
	Average PSA customer[13]	9.8	38%	38%	24%
average speed (km/h)	NEDC	33.6	18.7	62.6	
	WLTP	46.5	18.9	49.9	92
	PSA route	57.7	28.4	75	112.1
	Average PSA customer	64.4	25.2	74.8	110.9
Stop time (s)	NEDC	293 (25% of test duration)			
	WLTP	234 (13%)			
	PSA route	600 (9%)			
	Average PSA customer	10%			
Relative positive acceleration (m/s^2)	NEDC	0.11	0.14	0.09	
	WLTP	0.15	0.20	0.16	0.12
	Average PSA customer	0.16	0.25	0.12	0.08

Table 2 : Comparison of European test cycle versus the average customer key characteristics

As the Protocol is performed on open roads, the average speed and acceleration vary from trip to trip. This is not the case when performing a test cycle on a chassis dynamometer, when distance, speed and acceleration have tight tolerances, allowing for optimisation under those very specific operating conditions.

2.2.2. Comparison with the official RDE test

The PSA Protocol closely matches the RDE trip requirements, but there are several differences with the legal RDE requirements, many of them making the Protocol more realistic and demanding:

a. All the data needed is collected via the PEMS, GPS and weather station. No connection with the Electronic Control Unit (ECU) via On-board Diagnostics (OBD) is allowed prior to and during the test. This reduces the risk of the car detecting that it is being measured.

b. Only CO/CO2 are measured. Only the CO2 measurement is used to derive fuel economy as the CO and HC have a negligible effect (carbon monoxide and hydrocarbon emissions have been estimated to cause a measurement error of 0.4% for gasoline and 0.05% for diesel engines). Nitrogen Oxide (NOx) and Particle Number (PN) measurements commenced in the summer of 2017.

c. The cold start provisions are more comprehensive than those specified in the RDE 3rd-package.[14]

d. Urban,rural and motorway driving is defined on the basis of a map whereas the RDE legislation uses typical driving speeds on urban, rural and motorway environments. The

11 For WLTP, the rural part is the combination of the mid and high parts of the cycle.

12 Only average of the all valid tests is shown under PSA route.

13 The overall distance and Urban/Rural/Motorway mix is measured according to average PSA customer to derive average fuel consumption. See the detailed protocol (http://media.groupe-psa.com/en/press-releases/group/realworld-fuel-consumption-protocol-publication) for more details.

14 http://media.groupe-psa.com/en/press-releases/group/realworld-fuel-consumption-protocol-publication

cartographic approach defines the type of road according to the immediate surroundings to classify the type of operation (Figure 1).

The cartographic approach reduces the 'cross-polluting' effect when low speed driving occurs in a non-urban area (e.g. following a tractor on a rural road; or entering a highly congested motorway). Cross-polluting has a significant impact on the estimated share of urban, rural and motorway driving based upon the test results using the Protocol. Using the cartographic approach, the Protocol estimates 25% urban driving on the road (this is weighted upwards in the final assessment of the emissions, to be representative of the typical use of the model). However, when using the speed bin approach, urban driving would be estimated to be around 40%. (Table 3).

Approach	Urban	Rural	Motorway
Cartographic	25%	43%	32%
Speed bins	40%	35%	25%

Table 3: Urban Rural Motorway mix of the Protocol route for the cartographic versus speed bins approach

The results show the speed bin approach significantly overestimates the amount of time the car is being driven in urban environments compared to reality. This is an important aspect as urban fuel consumption tends to be much higher than in other driving environments. The speed bin approach actually implies that the urban fuel consumption is underestimated, although it is incorporated into other parts of the trip in which the fuel consumption is generally much lower.

There are other differences between the Protocol and a regulated RDE trip:

e. Drivers are obliged to respect French driving laws, so it is forbidden to exceed the legal maximum speed of 130km/h.

f. Real life Ki factors for diesel particulate filter (DPF) regeneration are used to correct fuel economy and to take into account intermittent regenerations. A stricter definition of continuous regeneration has also been adopted.

g. Tests have to be performed at an average atmospheric temperature between 0°C and 30°C. There are no extended temperature conditions. Operation of the Heating, Ventilation and Air Conditioning (HVAC) system outside of this temperature range would make it outside the range the average customer can expect.

h. The driver is requested to match the dynamic driving of the average customer, within a margin of tolerance; the metric is different compared with RDE, and the dynamic conditions depend on the type of vehicle driven to match the average customer behaviour for each vehicle category.

All other RDE requirements are met by the Protocol, such as cumulative altitude gain (the total uphill height achieved during the test), reaching about 1,000m/100km for the whole route, close to the legal limit of 1,200m/100km. It is notable that the test is performed in a rather flat area around Paris, and it suggests that the official RDE requirements are excessively restricted. The test lasts slightly less than 120 min, but it exceeded that duration on some occasions, mainly because an extra urban part has been added at the end of the drive to increase the urban mix to be closer to PSA's customer driving mix.

The case of RDE dynamic boundary conditions

Although stricter in many respects, the Protocol matches the RDE test conditions and, in the vast majority of cases, is RDE-compliant. The RDE test defines a lower and upper boundary condition for the driving style in order to ensure that the test is not driven in an excessively passive or aggressive driving style. Comparison of the Protocol tests and RDE dynamic boundary conditions provides an indication of how the agreed boundaries differ from the average PSA driver. The Protocol has been designed to replicate the driving of an average PSA customer, "customer 50%" for each vehicle segment. Each valid drive must correspond to an average speed and acceleration within the bounds of the 'customer 30%' and 'customer 70%'. Drives below 'customer 30%' are too soft and passive and drives above 'customer 70%' are too aggressive; when that occurs, the test is discarded and repeated. More than 100 tests were rejected because they were outside of the speed and acceleration limits defined in the Protocol.

Figures 2 and 4 show the results for each test performed plotted against the dynamic boundary conditions defined in the RDE 1st Package[15]. This uses speed and acceleration as metrics for the aggressiveness/passiveness of tests. All tests have been included in this analysis, including those driven outside of the acceptable dynamic limits (below 'customer 30%' or above 'customer 70%') of the Protocol.

The high dynamic boundary: V*apos

The high boundary limit curve shows that for urban driving most PSA drivers are close to, but below, the upper dynamic boundary line. This suggests that most moderately driven cars are considered to be driven relatively aggressively by the RDE test procedure. For rural driving, all drives are also close to the limit curve, and some average drives for sporty vehicles are above the limit curve. Even though such sporty, high-end vehicles represent a small share of PSA's and of the overall market, their average customer driving style is well above the limit curve, showing that the RDE excludes some vehicles from being driven as they would be in real-life (Figure 2).

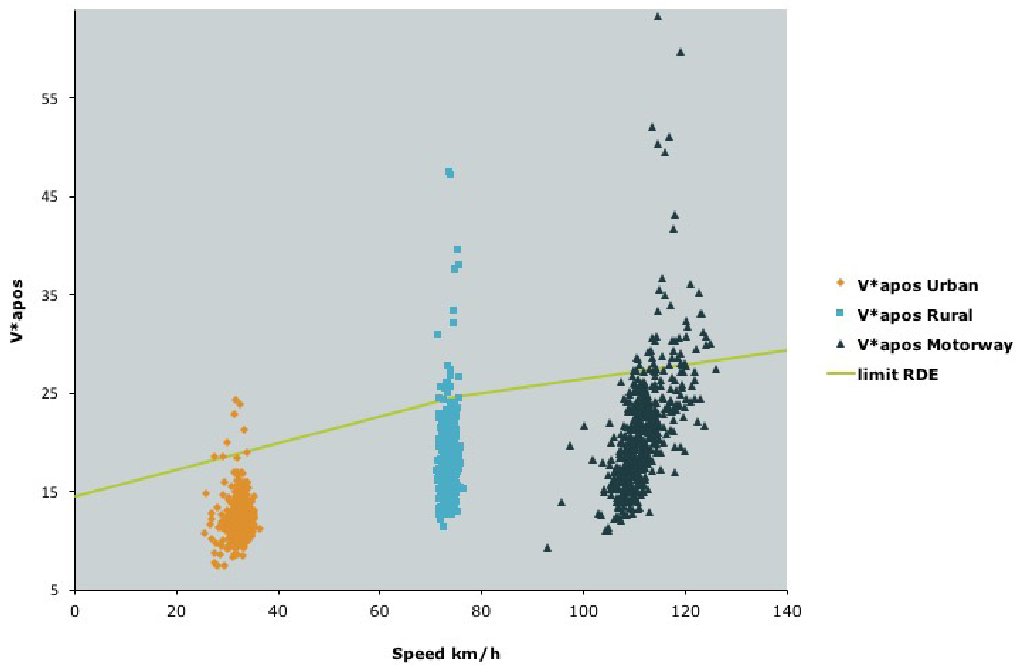

Figure 2 : 340 tests on the high dynamic condition limit curve

For the motorway section, many vehicles are driven close to or above the average customer dynamic conditions, making the RDE trip invalid, for being too aggressive. For the PSA vehicle range and average customer driving habits, the RDE dynamic boundary conditions for motorway driving have been set in such a way that large, high-powered vehicles (Figure 3)

15 COMMISSION REGULATION (EU) 2016/427 of 10 March 2016 amending Regulation (EC) No 692/2008

are driven too aggressively by an average PSA driver. In such motorway conditions, many tests that are considered as 'normal driving' by the Protocol would be rejected by RDE as too aggressive. This clearly shows that some RDE trips would be considered not valid when they are in fact representative of normal driving for such vehicles.

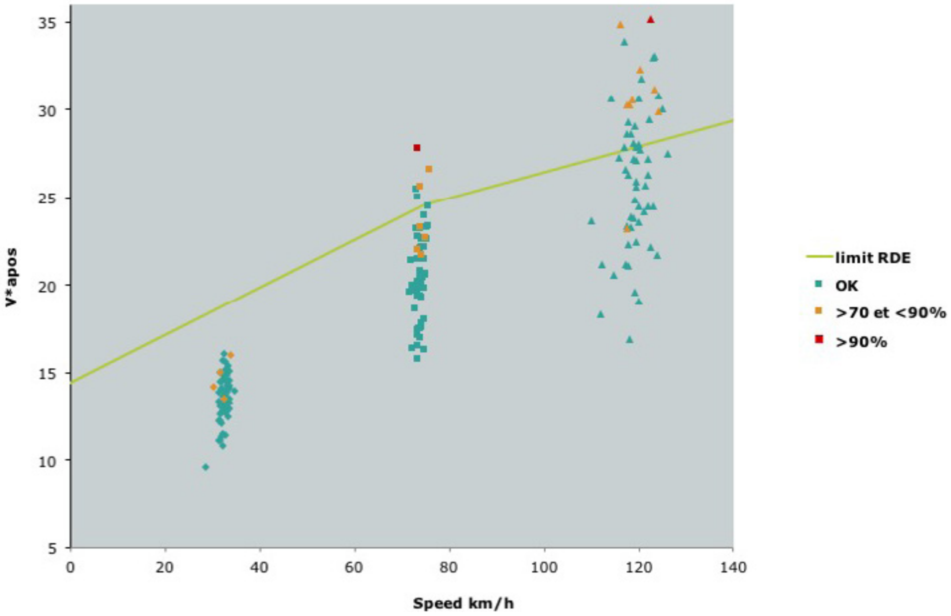

Figure 3 : Dynamic drives for large vehicles on RDE limit curves

High-powered vehicles (and high power-to-weight ratio vehicles) are usually driven with higher dynamics in real life. This indicates the RDE high boundary limit is not representative of real-lifedriving.

The low dynamic condition: RPA

Figure 4 shows the low dynamic condition and the Protocol test drives that were performed. The data shows all of the drives performed are well above the limit curve, including those that failed to meet the customer 30% limit for being too passive. Even a few drives that were close to smoothest customer 0% are well above the limit curve (Figure 4). With the current RPA line defined in the RDE legislation it is therefore very difficult to drive the vehicle too passively.

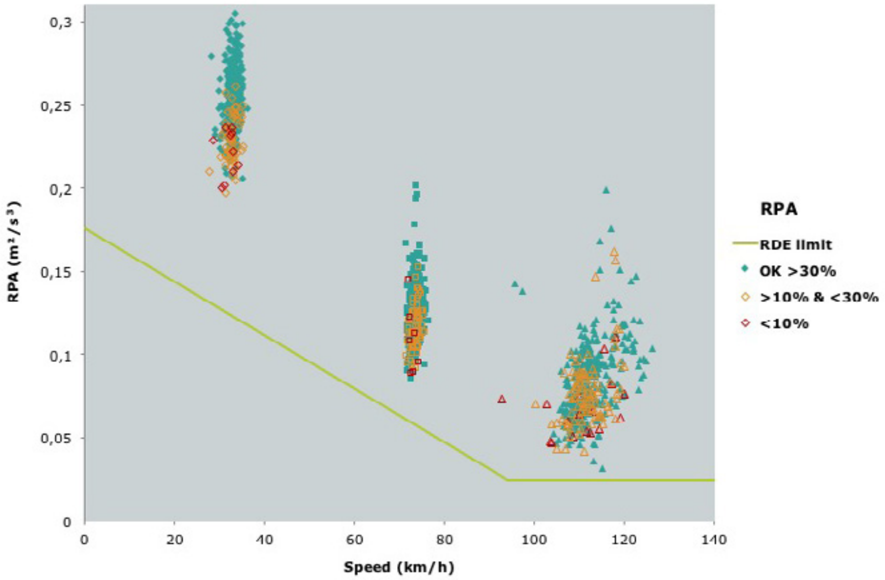

Figure 4 : 340 tests on the low dynamic condition limit curve

3. THE PROTOCOL: ROBUST, RELIABLE AND REPEATABLE

The Protocol provides the basis for customers to obtain a more realistic view of what fuel economy they can expect when driving their vehicle in everyday use. To make sure the test meets the average customer fuel economy, the first step in the validation of the Protocol was to compare it with internal PSA surveys where customers had been asked about their fuel economy via large samples. The Protocol matches closely the average customer fuel economy (Figure 5).

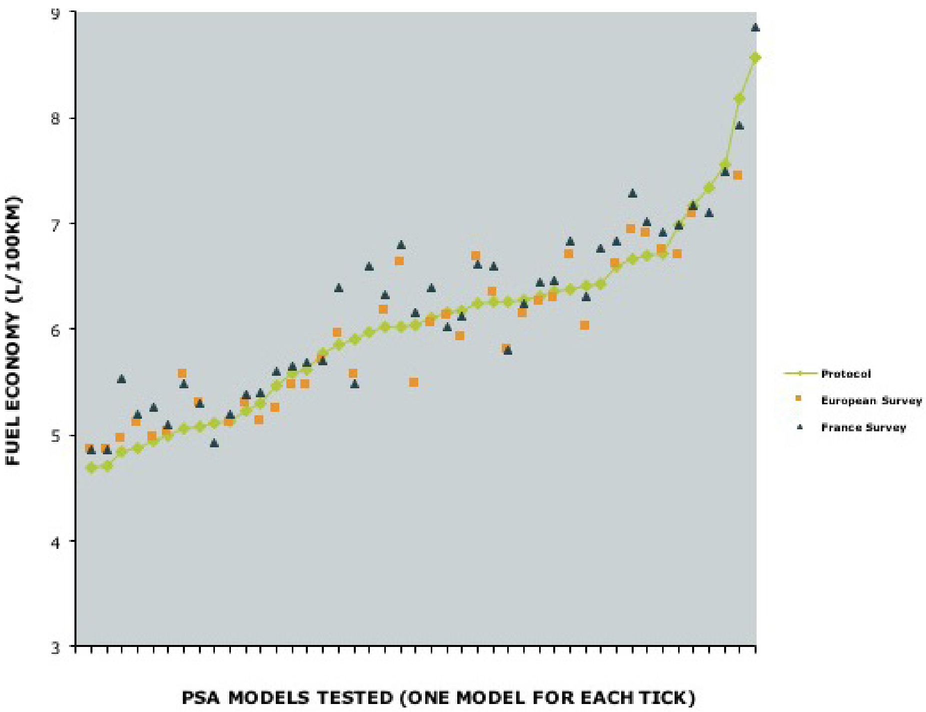

Figure 5: Protocol results compared with internal PSA surveys

A range of other tests and data sources provide information about vehicle fuel economy including the official (but outdated) NEDC laboratory test that is shortly to be replaced by the WLTC test (Worldwide Light Duty Test Cycle) and its subsequent procedure (WLTP) that will be used as from September 2017.

To evaluate the representativeness of the Protocol, other sources of real-life fuel economy for tested models have been compiled and assessed for each vehicle tested. Separately, after each test campaign, correlation tests have been performed to validate the PEMS measurements. Each vehicle was tested on the dynamometer performing a WLTC, but not reproducing the exact test procedure (Box 1).

Once the on-road tests are finished, each vehicle performs a correlation test on a chassis dynamometer in a laboratory completing a WLTC, in order to validate that the PEMS measurement equipment has been working correctly. Where the test results exceeded an agreed margin of tolerance defined in the Protocol, the road results were corrected to better match measurement made by the dynamometer.

The WLTC results obtained are not officially homologated WLTP values because:

- There is no soaking: vehicles should be soaked at 23°C.
- There is no preconditioning test: the day before the WLTP is performed and emissions measured, a test should be performed to make sure the vehicle is operating properly. As part of the Protocol correlation test, there is no preconditioning test on the dynamometer.
- The coastdown values are not the official ones: the setting of the dynamometer is done using real-life coastdown values that are expected to be more stringent than the official WLTP coastdown values.
- Ambient test temperature differs from the WLTP legal ambient temperature: the correlation test is performed at 23°C whilst official WLTP tests results will be reported at 14°C.

*Bo*x 1: Difference between PSA's correlation tests and official the WLTP

Figure 6 shows the comparative test results with other sources, including:

- **Sprit Monitor:** Sprit Monitor is a community website where registered car users enter their own real fuel economy, measured when refuelling the vehicle together with the distance driven between two full refills. The search engine allows the identification of specific vehicles identical to the ones tested under the Protocol. With more than 400,000 users, the sample size can vary for each vehicle, but it is usually around 20 users for the specific vehicle tested. However, for new models, data is typically available only one year after launch.

- **Emissions Analytics real MPG:** Emissions Analytics has measured more than 1,000 vehicles, primarily for the 'WHATCAR' magazine. Emissions Analytics has published its fuel economy database on line, as part of the EQUA index[16], which classifies vehicles in emissions classes.

When shown together, all sources are not always consistent, and the Protocol generally has higher results than other data sources (Figure 6). Sprit Monitor and Protocol values are very close in most cases, showing the robustness of both independent datasets[17]. Emissions Analytics and Protocol values are close for half of the vehicles tested; a vehicle-by-vehicle comparison is challenging, with significant dispersion in some cases that should be analysed in greater detail.

16 http://equaindex.com/

17 https://www.spritmonitor.de/

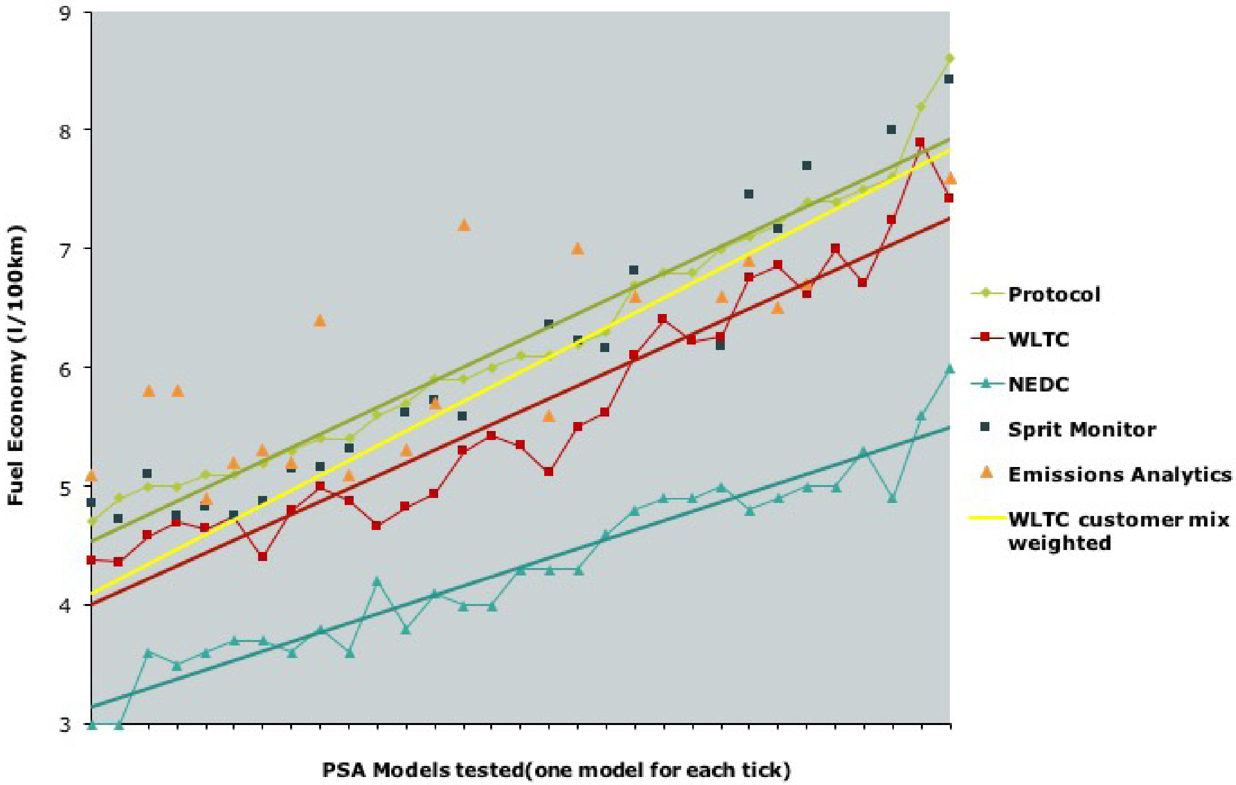

Figure 6: Protocol results for the 60 passenger cars tested, versus other sources

Note: For newest models, like new Citroën C3 or new Peugeot 3008/5008, no Sprit Monitor nor Emissions Analytics values were available

WLTC values are well below the Protocol's values, with about two thirds of the gap between real life and NEDC captured by WLTC tests. As shown earlier in Table 2, the urban, rural, motorway mix of driving in the WLTC differs markedly from that of the Protocol. Specifically, Groupe PSA customers typically undertake a much higher share of driving in urban environments. Applying Groupe PSA customer urban/rural/motorway mix, the WLTC values become much closer to the Protocol's values (Figure 6). The data suggests that a more representative urban/rural/motorway mix for the WLTC would provide much more representative overall test results.

For an average car achieving 6 l/100km measured using the Protocol in real world, there is a 10% deviation with WLTP measurements, 3% with an adjusted WLTP and 42% with NEDC. There is no significant percentage difference for a more efficient 5 l/100km car or a less efficient 7 l/100km model. The Sprit Monitor results are typically within ±0.2 l/100km, that is to say, around 3% of real-life average fuel economy for the vehicles concerned.

To date, no other manufacturers have attempted to reproduce the Protocol results for their own models. It is therefore not possible at present to assess the reproducibility of the Protocol for other manufacturers' models and alternative routes. However, the range of parameters tested to date indicates it is unlikely to produce markedly different results.

Emissions Analytics (EA) has a large database of vehicles tested in standardised real-world conditions, and these results can be compared to the results from the Protocol tests.

On average, the difference between the two datasets is 0.1 l/100km. However, there is a distribution of the variances around this mean, with approximately half of the vehicles in agreement within 0.3 l/100km (Figure 7). For the other half, EA's values are very far from the Protocol, especially for all the C4 Picasso models (EA underestimates the fuel consumption by around 0.7 l/100km) and for all the DS brand (EA overestimates the fuel consumption by around 0.9 l/100km). The sources of these differences have not been explained to date.

Of the 60 models tested by the Protocol, only two (identified with * in Figure 7) have been tested by EA in the 2016/2017 timeframe. However, EA has tested 14 Euro 6 PSA models in total (7 Peugeot, 4 Citroën and 3 DS). In order to perform a comparison between 48 models in both databases, the analysis uses values from a predictive statistical model developed by EA. Nevertheless, there is no public information on how the predictive model works, which might explain some of the differences.

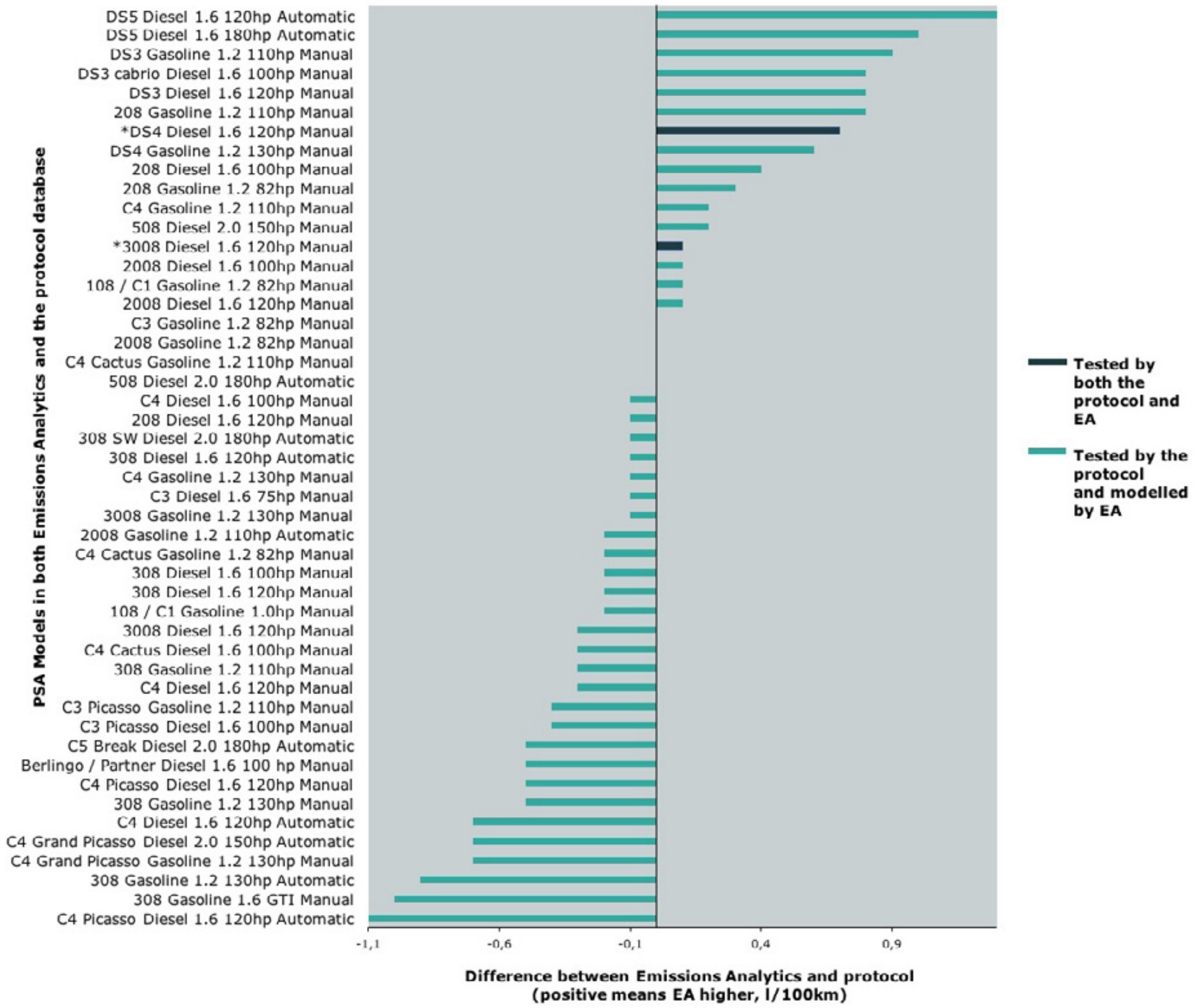

Figure 7: Difference between Emissions Analytics (EA) and Protocol fuel economy for the 48 vehicles published by both testing programmes

*Note: * indicates that the vehicle have been tested by both EA and the Protocol. All other vehicles' fuel economy values are the result of a predictive model in the EA database.*

3.1 PROTOCOL REPRODUCIBILITY

To assess the reproducibility of the Protocol, four parameters have been examined:

- The reproducibility of the trip
- Dispersion of real-life fuel economy of valid trips against the normalized published value, by vehicle attributes
- Driver variability
- Weather impact

Despite being conducted on open roads, the Protocol results are highly consistent and repeatable once post-treatment of the data and the normalisation procedures that are part of the Protocol have been applied. Using a different route with similar characteristics to the ones used by the Protocol is not anticipated to lead to significant differences, as long as care is taken to correctly categorise urban, rural and motorway sections, and that the cumulative altitude gain is similar, i.e. around 1,000m/100km.

For another party to use the Protocol, a standard set of customer conditions would need to be defined, in order to be able to compare values between vehicles. In its current form, the Protocol only allows for direct comparison between models within the same market segment, with similar customers. However, it would be possible to normalise it for a typical customer – although with some loss of representativeness to typical real-world values.

Ability to reproduce the trip

Since the Protocol is conducted on open roads, traffic levels, temporary road closures and weather variations all change the test conditions creating small variabilities in the test results. Figure 8 shows the average, minimum and maximum values over the 230 valid tests conducted at the time of preparing this report. Urban driving distances have a wider dispersion than other phases. The relatively large variation in motorway average speeds is mainly the result of varying traffic levels.

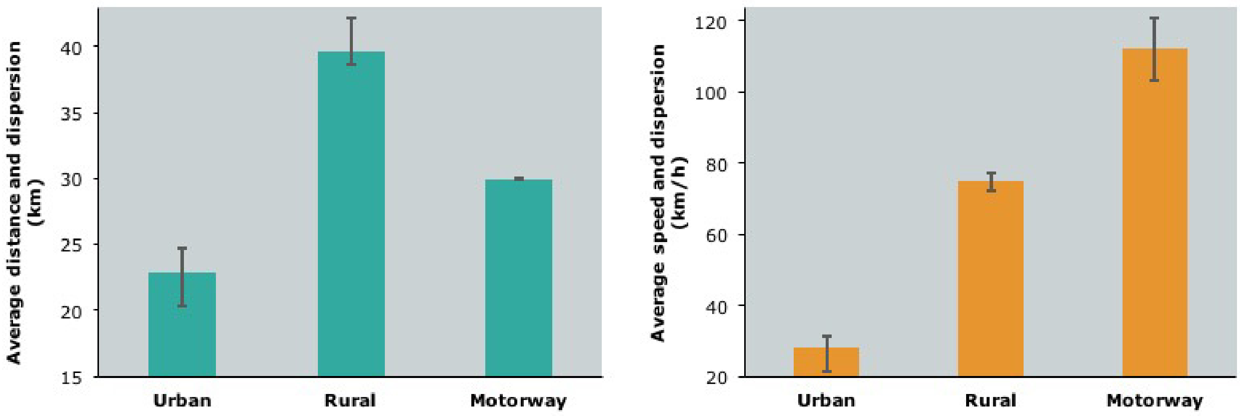

Figure 8: Average speed and distance with dispersion range for the 230 valid tests.

Note: error bar shows min and max values

Results variability

For all valid trips, the variability of the results by vehicle attributes is shown in Figure 9. Diesel engines, especially those fitted with an automatic gearbox provide the most consistent results with a standard deviation of 0.1 l/100km. The variability for gasoline manual transmission vehicles has the highest standard deviation, at around 0.2 l/100km. Variability is greater in urban areas than in rural and motorway environments.

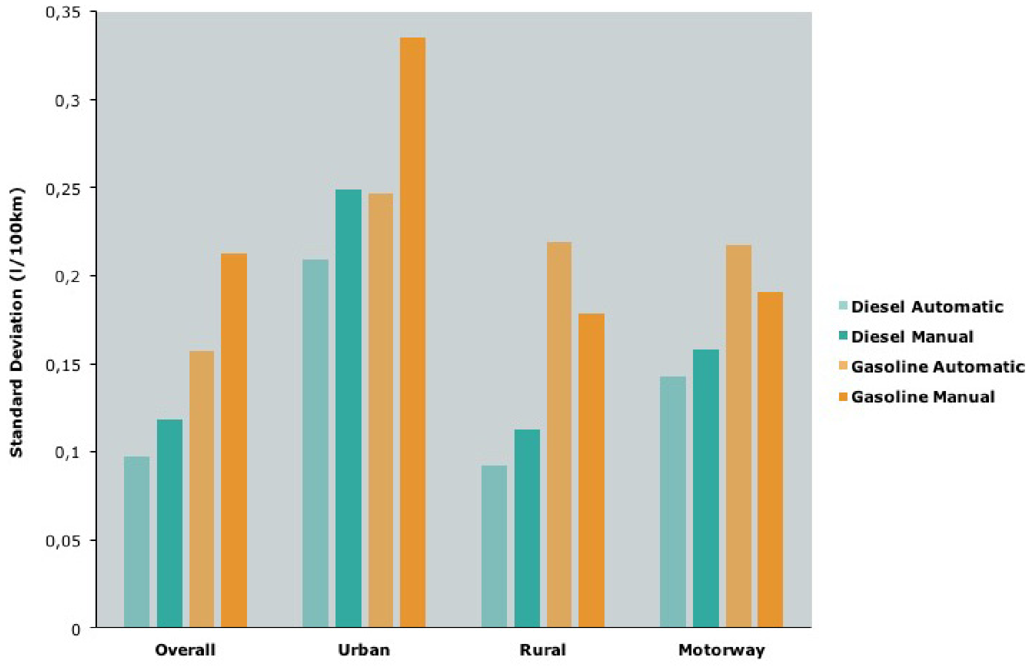

Figure 9: Standard deviation across Protocol results for all valid trips, by fuel and transmission type

The lower the standard deviation, the closer the Protocol result for any trip is likely to be to real-world performance. Automatic transmission and diesel engines are more resilient to driving style – and so are larger vehicles. The measured fuel consumption in small cars has the greatest variability – particularly in urban driving conditions (Figure 10).

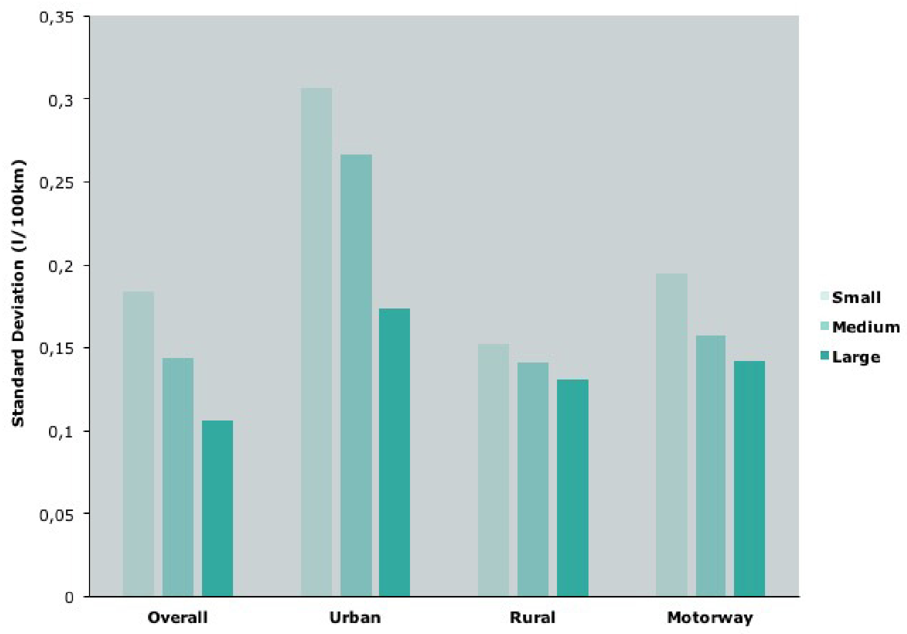

Figure 10: Standard deviation across Protocol results, for all valid trips, by vehicle size

The results show that undertaking a larger number of tests for small, gasoline and manual transmission vehicles may be desirable in the future to ensure the results are robust.

Driver variability

The Protocol requires that at least two different drivers drive a valid test for each vehicle. Different drivers have different habits, and tests performed with journalists showed that similar speeds and accelerations can lead to different results. In order to examine driver variability, we analysed tests done by 4 drivers, each of whom had driven a minimum of 10 tests with a combined total of 300 tests.

Overall, the driver's differences account for a variability in results of +/– 0.1 l/100km, except for urban driving conditions where one driver exceeds such tolerance levels with a variability of more than 0.2 l/100km (Figure 11). Some drivers, especially for certain vehicles, struggled to achieve the required dynamic conditions for the test, hence requiring this to be discarded and repeated.

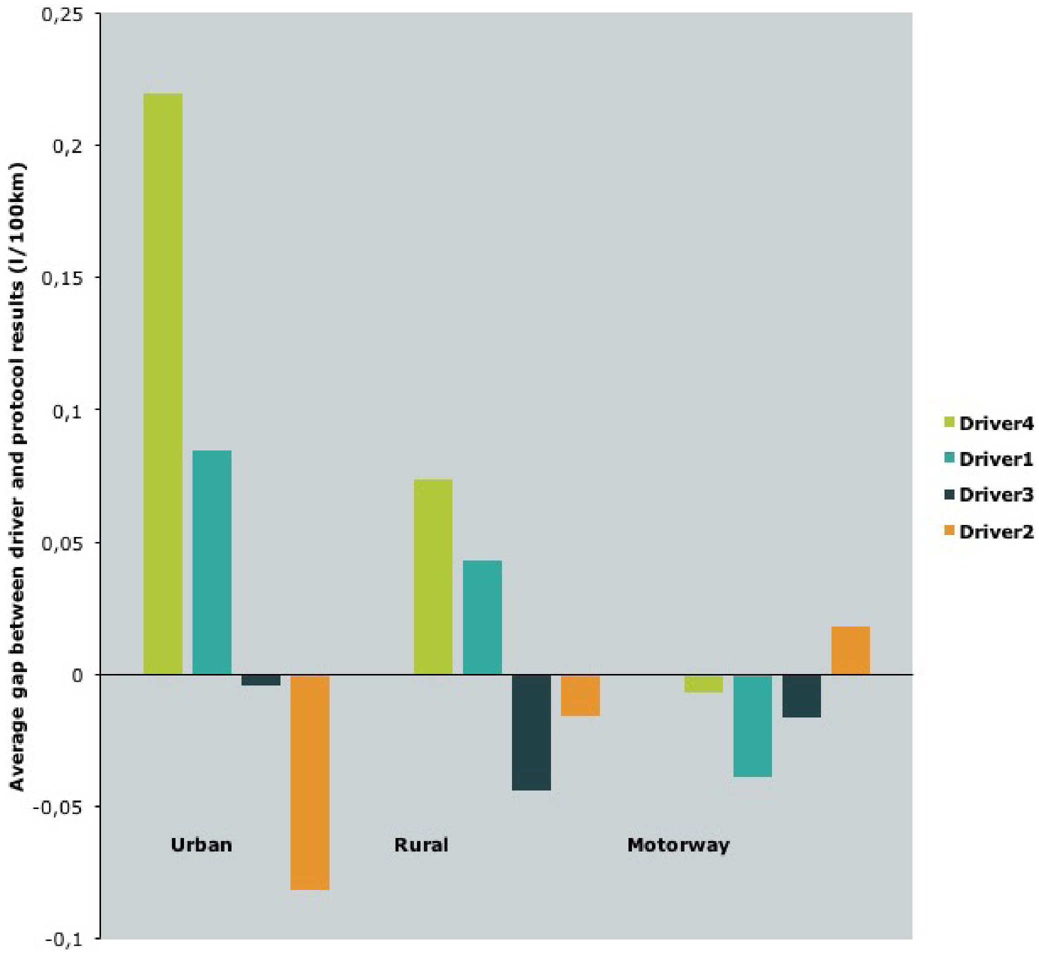

Figure 11: Driver sensitivity by phase for all trips

Weather impact

Weather conditions were recorded for all tests. The variability of the Protocol to different weather conditions is shown in Figure 12. Only a relatively small number of tests have been conducted in wet and dry conditions for the same vehicle. The sample is small, as only 7 vehicles and 19 valid tests have both wet and dry test results. However, wet roads are shown to have negligible impact on the urban phase, and the impact on the rural and motorway phases can be detected and estimated to be around 0.1 l/100km (Figure 12).

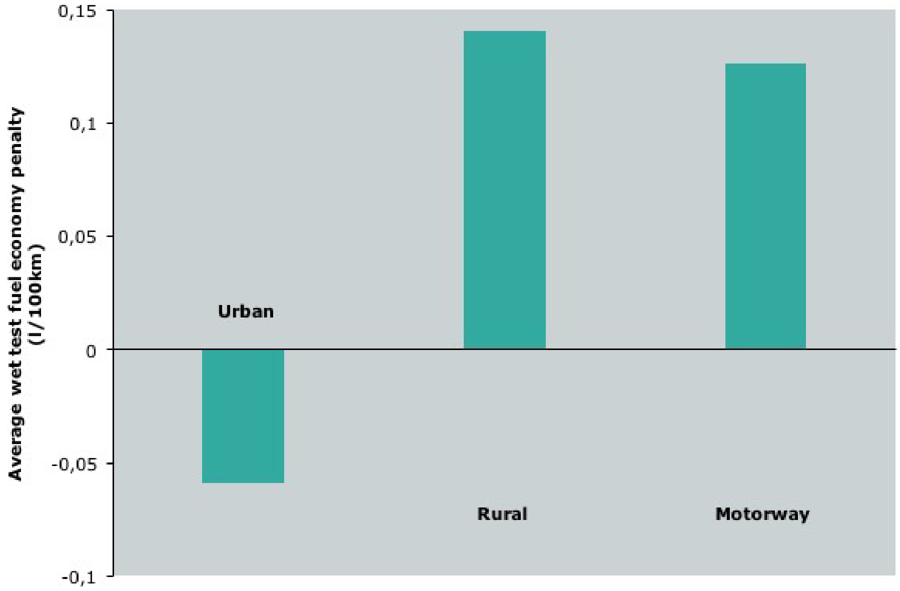

Figure 12: Impact of wet conditions on fuel economy for each urban, rural and motorway phases

3.2 TEST EQUIPMENT RELIABILITY

The establishment of the Protocol and test database has resulted in an intensive use of PEMS equipment to measure CO2 emissions, from which fuel economy has been derived. Such use of PEMS equipment for light duty vehicle applications is not yet mature, and significant progress has been made to increase the reliability and accuracy of the measurements over the testing programme that has made use of 4 PEMS from Sensors. In total, at the time of writing, 430 tests on the road have been performed on 60 vehicles. In addition to the road tests, 116 tests have been conducted on the chassis dynamometer to correlate the results. Reliability issues have been a challenge with 46 tests discarded because of a PEMS failure (28 tests) on the road, or because tests had to be redone since the PEMS failed the correlation test (18 tests), leading to an overall failure rate of 8% (Figure 13).

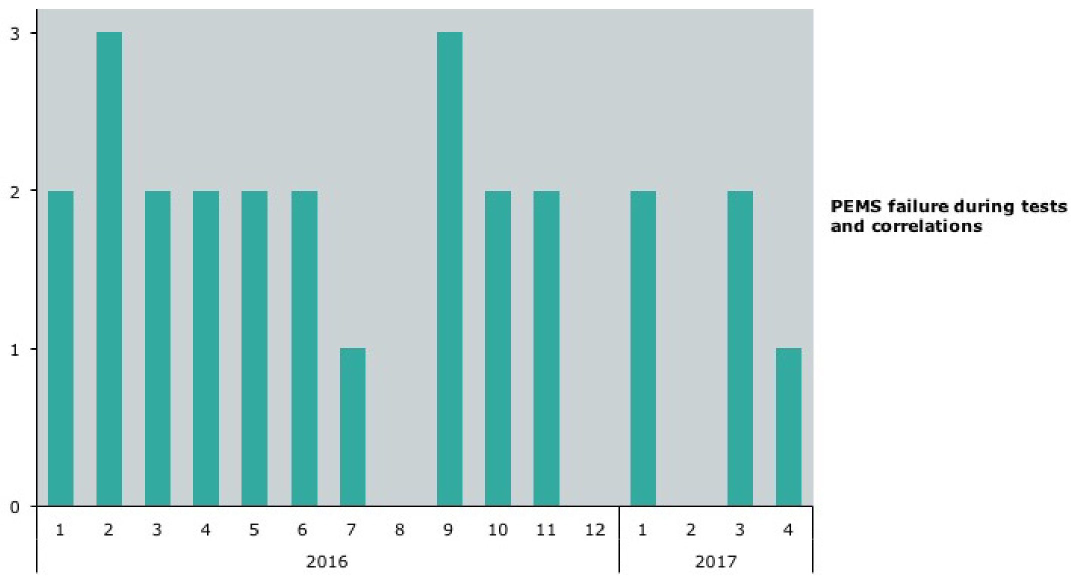

Figure 13 : PEMS reliability issues registered by PSA, by month

PEMS accuracy

At the end of each vehicle measurement exercise, correlation to check tests that check the PEMS sensors are operating correctly, were performed and the results were compared in each case with the dynamometer's results on a WLTC.

Testing gasoline engines, especially small gasoline engines, has proved to be particularly challenging because of high exhaust flow variations. Several flow meter diameters have been tested to attempt to find the best solution for the PSA Powertrain range. Such work has proved the benefits of performing correlation tests, especially during the development of the measurement procedure of the Protocol. Overall, PEMS accuracy is very satisfactory for diesel engines under each phase of the WLTC, but they seem to systematically overestimate the emissions of gasoline engines in the Low/Mid and High phases of the WLTC (Figure 14).

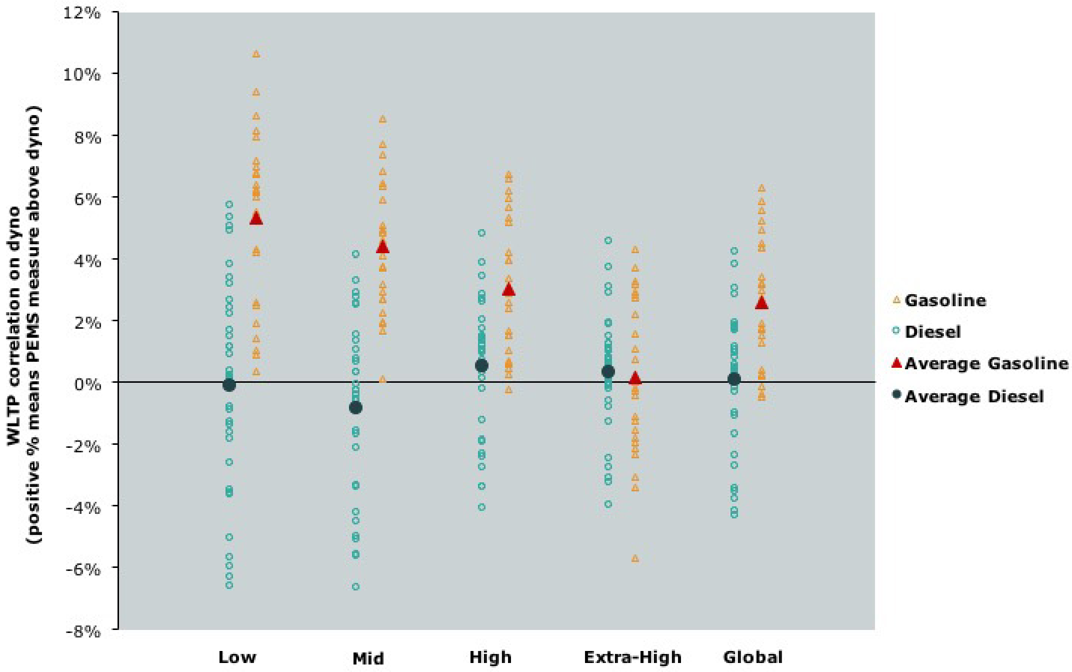

Figure 14 : CO_2 measurement difference by WLTC phase, PEMS and Dyno, for each of 116 correlation tests

Overall choosing PEMS to measure on-road fuel economy has been successful, and the instrument has proven accurate and reliable enough over the long run. Continuous improvement of the PEMS will make this device a mainstream and indisputable way to measure vehicles' exhaust emissions in the near term.

3.3 ACCURACY OF ON-BOARD FUEL CONSUMPTION METER

Before and after each test, the onboard fuel consumption meter (FCM) was reset and the fuel consumption for the trip recorded. Comparing the value from the FCM with those of the PEMS shows the accuracy of the FCM, which is currently under discussion as part of the future vehicle legislation. It should be noted that FCMs (and the complimentary accuracy provisions) are expected to be mandated in each new car in the future.

For the 60 models and 230 valid tests, it can be said that the FCMs show a good overall level of accuracy when correlating according to fuel type, overall slightly overestimating the real fuel consumption (Figure 15). There is nevertheless an average trend showing that the higher the real-life fuel consumption, the more accurate is the fuel consumption meter value. This trend is more accentuated for diesel engines and can lead to a slight underestimation of the fuel consumption.

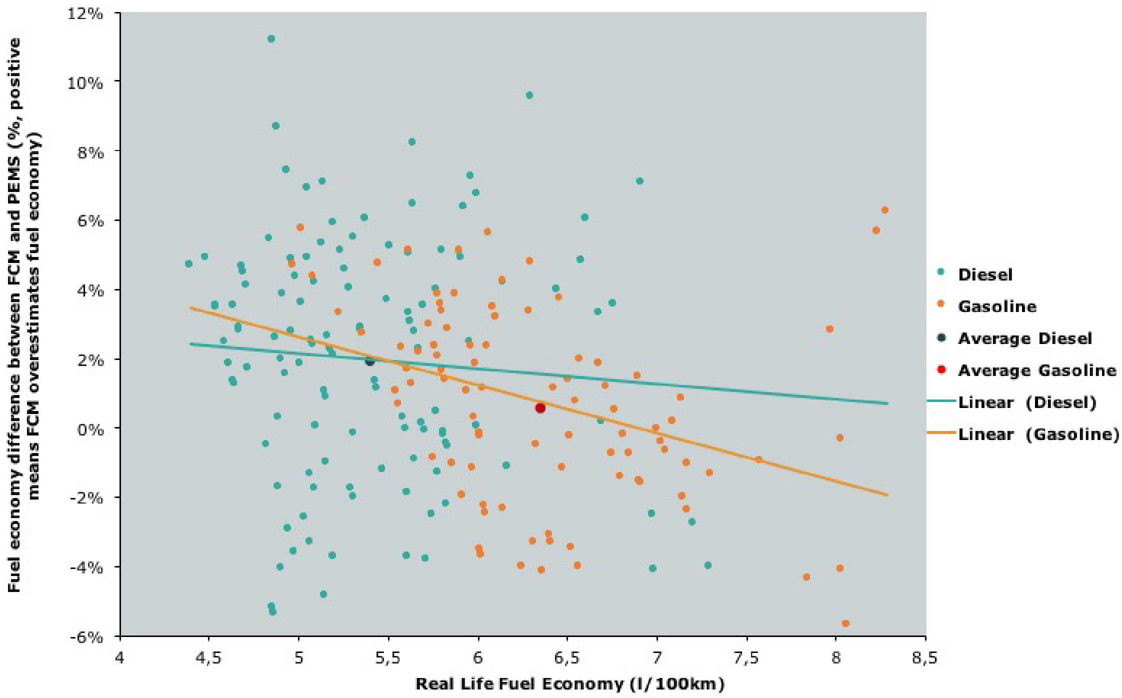

Figure 15: Comparison between Fuel Consumption Meter and PEMS measurements

4. DETAILED ANALYSIS OF THE TEST RESULTS

As highlighted in the previous section, real-life fuel economy is significantly higher than its official certification values. This section looks at some of the underlying reasons for this gap by considering the impact of different vehicle attributes. Two analytical approaches have been used:

- **The market approach**, where all attributes have been sales-weighted to better reflect the real composition of the Groupe PSA market. For example, automatic versus manual gearbox vehicles are sales-weighted, meaning that the average manual transmission vehicles are much smaller, less powerful, and tend to have a higher share of gasoline engines than the average automatic transmission vehicles, which conversely are bigger and more powerful, with a higher share of diesel engines. Such an approach gives an aggregate impact of the vehicle attribute considered, also including collateral impacts as the average vehicles have different specifications.

- **The customer approach**, where only the vehicle attribute is modified. When comparing automatic versus manual transmission vehicles, the same base vehicle is compared (with only with the gearbox modified): for example, a pair comparison of the 3008 1.6 HDi manual model versus the 3008 1.6 HDi automatic model is a more realistic comparison of existing options, but it does not take market forces into account. The 3008 manual and automatic versions have very different market shares that are not considered in such a one-to-one comparison approach.

4.1 REAL-LIFE FUEL ECONOMY CHARACTERISATION FOR DIFFERENT VEHICLE ATTRIBUTES

Over the 60 tests done on PSA's vehicles, an average gap of 1.74 l/100 km has been found between real-life and NEDC certification values. Such a gap can be explained by a combination of factors. The gap nevertheless varies significantly when looking at specific vehicle attributes and at the different phases of the Protocol.

Fuel type

Diesel engines represent 53% of PSA's 2016 sales in the 11 major European markets. The overall gap is higher for gasoline engines than for diesel engines on average, with a 1 l/100 km difference in absolute values for gasoline engines versus diesel engines (6.6 l/100km versus 5.6 l/100km respectively). However, when looking at each phase of the Protocol, compared to the NEDC phases (urban and non-urban), diesel engines have a higher gap than gasoline in urban areas. For larger vehicles, the diesel urban gap is 2.8 l/100km (Figure 16). The urban gap is also higher than the rural/motorway gap for gasoline engines. However, the difference between urban and rural/motorway is lower than that for diesel engines.

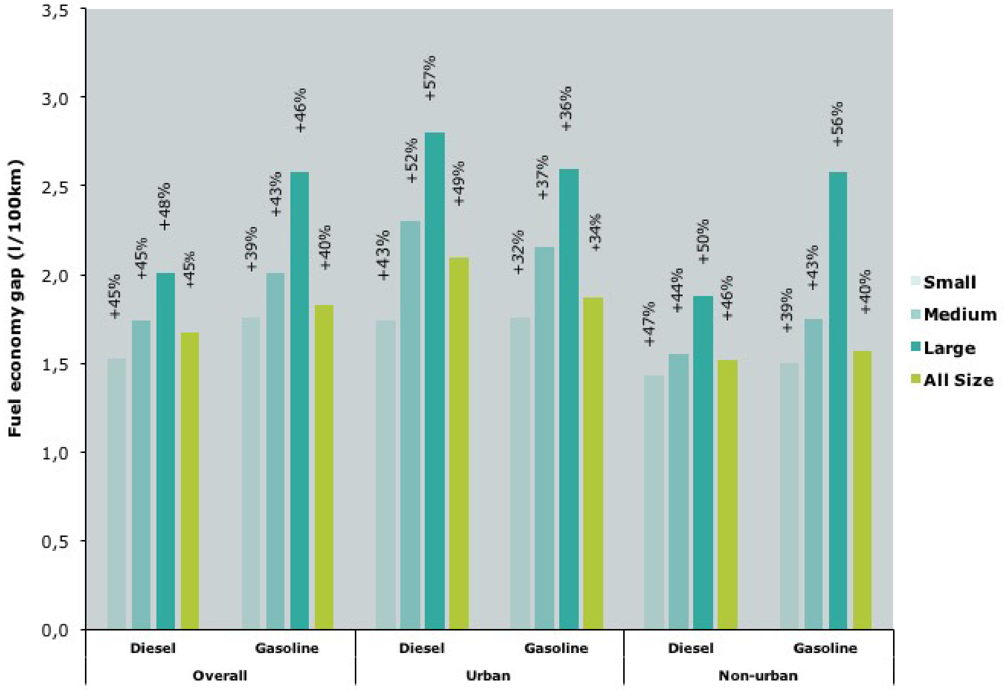

Figure 16: Fuel economy gap between the Protocol and certification, by fuel type and vehicle size.

There are two possible explanations for the reduction of the diesel benefits in urban conditions:

– The efficiency difference between diesel and gasoline engines is greater during the urban part of the NEDC than during real-life urban driving conditions. Under the low-load conditions of the NEDC, diesel engines work better, delivering very low certification values for the urban part of the NEDC. (Figure 17).

– On average, diesel cars have a higher share of MPV/SUV body styles, which tend to have a greater proportion of automatic gearboxes.

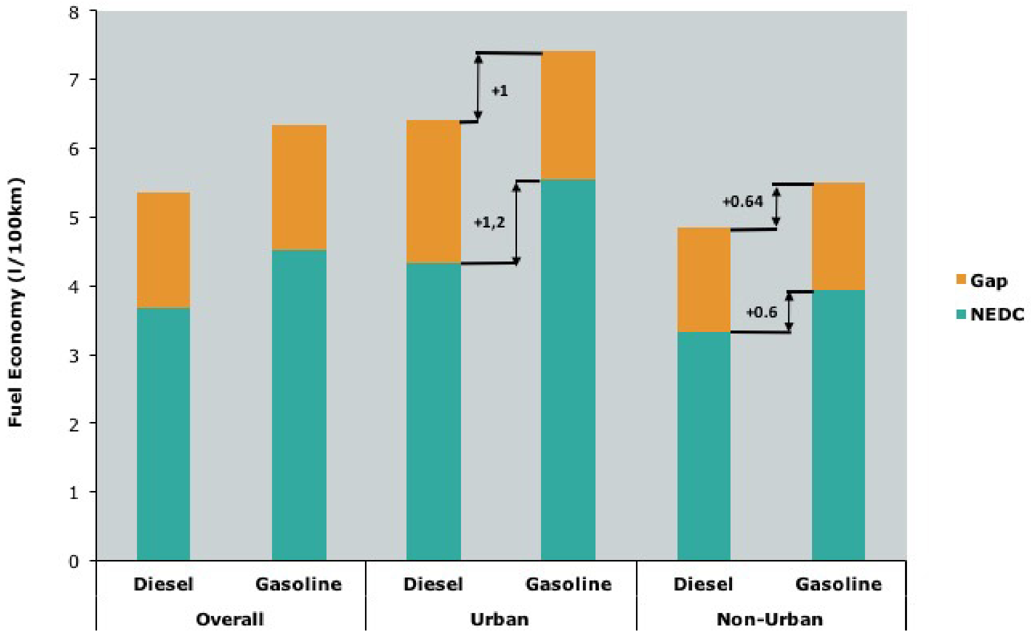

Figure 17 : Average fuel economy by fuel type and trip phase

Figure 18 compares the fuel consumption between the 1.2 PureTech 130hp gasoline engine and the 1.6 BlueHDi 120hp diesel engine on the same vehicle (comprising Peugeot 308, old and new 3008, the Citroën C4 Grand Picasso and DS4, all of which were tested with both engine configurations). The gasoline engine consumes more fuel than the diesel engine: 1.5 l/100km on the overall trip, and a little more in urban driving (1.65 l/100km). The absolute gap between the fuel consumption measured by the Protocol and the type approved value is greater for gasoline engines. Market and customer approaches are consistent in that diesel engines are always performing better than gasoline ones in real life, and are especially good in urban conditions. The main difference between the two approaches is that in the market approach, diesel-powered vehicles lose some of their advantage in real urban conditions, when, in the customer approach, such advantage is constant between certification results and real life. This can be explained by the fact that, in the market approach, the average diesel vehicle is larger and – with a higher share of automatic gearboxes being fitted in these vehicles – this leads to this performance loss over the average gasoline vehicle.

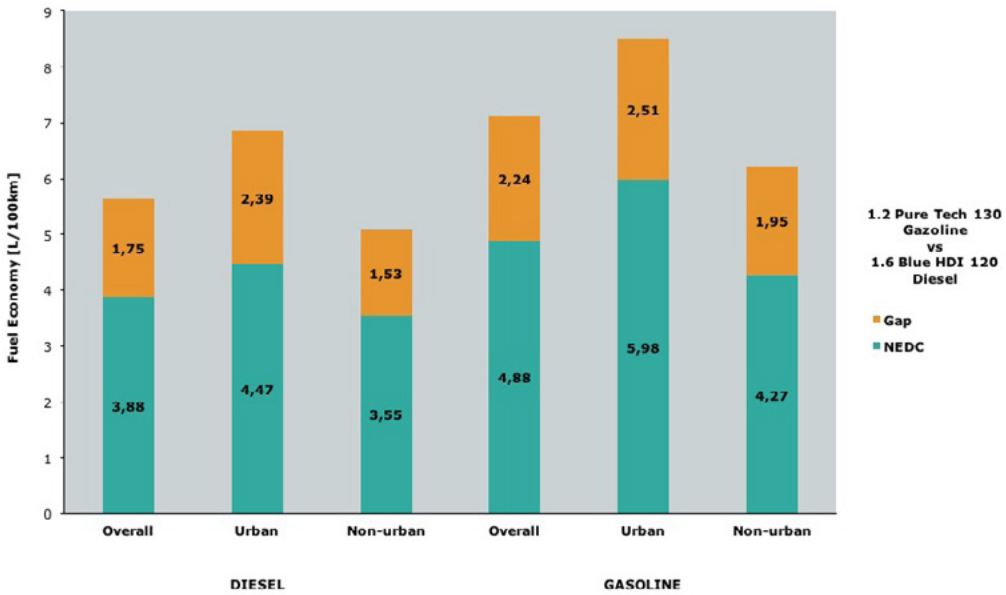

Figure 18: Fuel type comparison in the customer approach

Different market segments

An analysis by segment shows that, the larger the vehicle, the bigger the fuel economy gap (in l/100km) when tested in the Protocol (Figure 19). This would seem logical, as large vehicles have on average higher fuel economy certification results. More surprising is the fact that, when looking at percentages, larger deviation percentages are also found for larger vehicles, both in urban and non-urban conditions. This shows that the average larger vehicles customer is further away from NEDC conditions than the average small and medium vehicles customer. In 2016, large vehicles represented less than 5% of PSA's sales – however, the finding could be significant for other manufacturers, if it is replicated across brands.

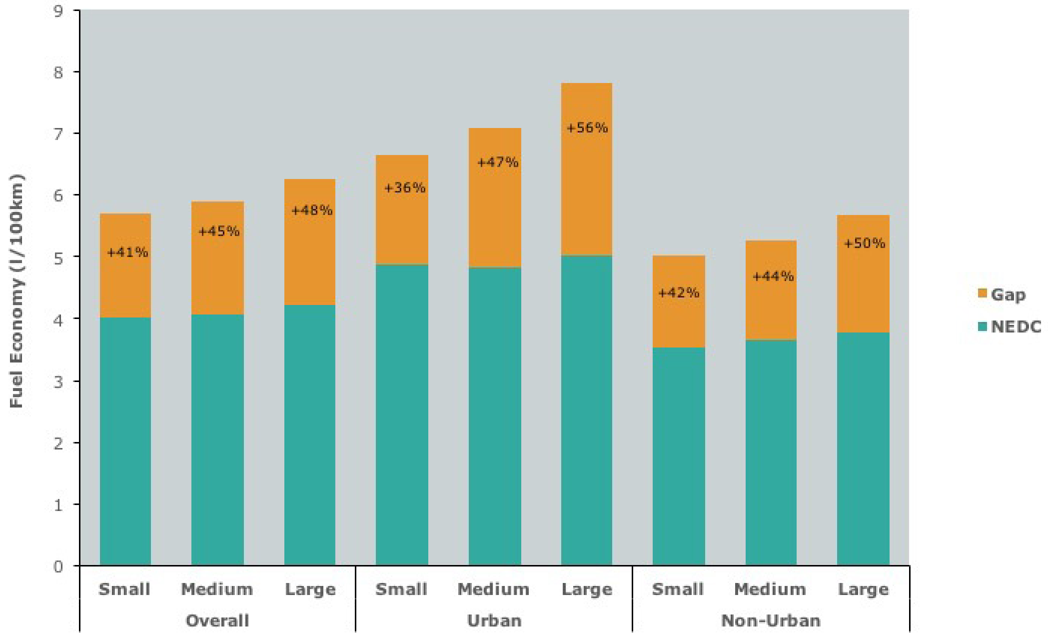

Figure 19 : Protocol average fuel economy by vehicle size

Body style

MPV/SUV vehicles are roomier and taller than traditional body types, and represent a growing share of the market globally and in Europe[18]. For PSA, MPVs/SUVs represent more than 30% of vehicle sales, with the vast majority (around 75%) powered by diesel engines. Due to the greater mass and poorer aerodynamics of MPVs/SUVs, these vehicles report higher fuel consumption levels and also a larger gap compared with traditional body shapes (hatchback, sedan ,station wagon), as measured by the Protocol or in the laboratory using the NEDC test (Figure 20) despite the high diesel share in the MPV/SUV vehicle segment.

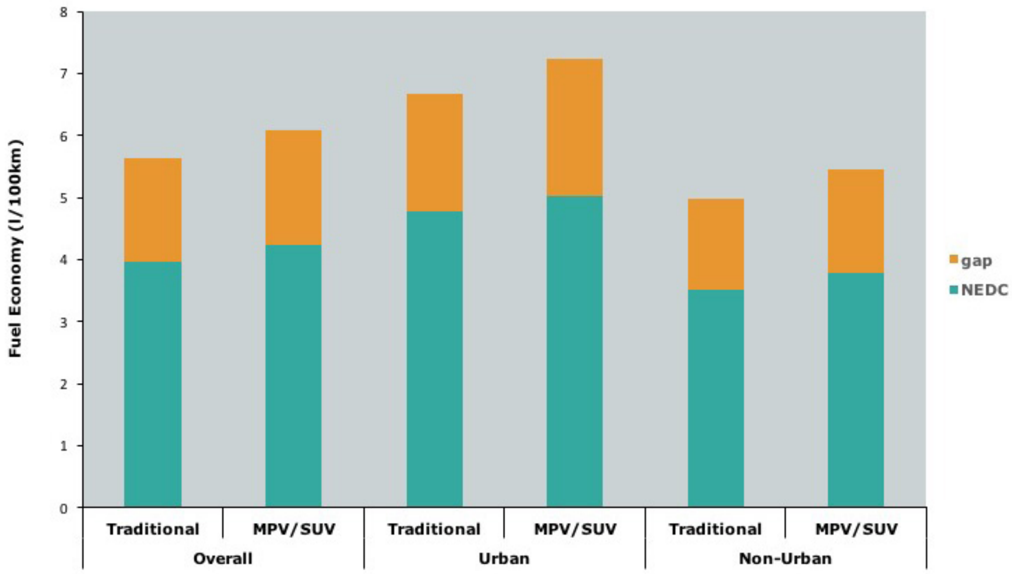

Figure 20: Body style comparison on NEDC and Protocol

The higher gap for the MPV/SUV body style is not only to be attributable to higher gap for diesel engines. Gasoline-powered MPV/SUVs also exhibit a higher gap when fitted to MPV/SUV

18 GFEI, 2017, International comparison of light-duty vehicle fuel economy, Ten years of fuel economy benchmarking, https://www.globalfueleconomy.org/media/418761/wp15-ldv-comparison.pdf

(Figure 21). With average customer driving habits being similar to those found in traditional and roomier body styles, the explanation is that aerodynamic losses are much more significant in real-life tests than those encountered under laboratory conditions. It is unlikely that this effect will be properly captured in future WLTP tests, as these also have lower average speeds than would be experienced in real life.than laboratory ones. It is unlikely this effect will be properly captured in future WLTP tests that also has lower average speeds than in real life.

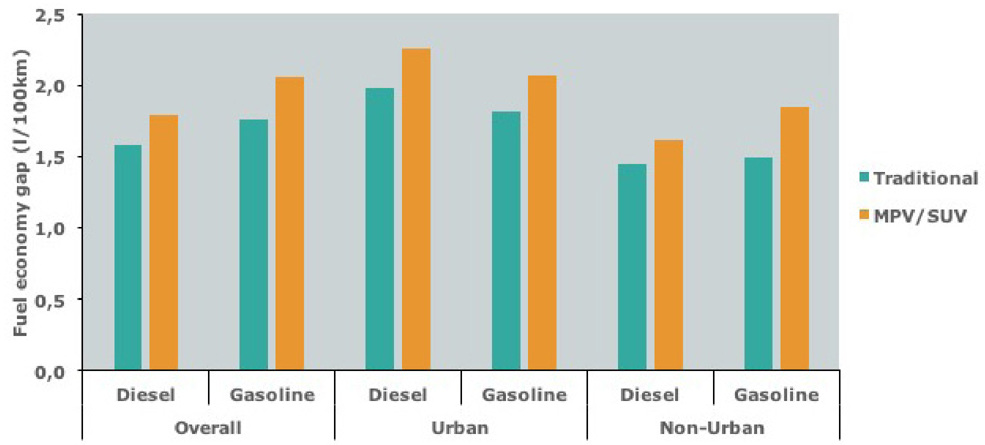

Figure 21: Gap analysis by body style and fuel type

Transmission type effects

Despite significant technical progress, automatic gearboxes continue to have higher fuel consumption than manual ones. The gap between the NEDC test and Protocol results is also greater for automatic transmission, particularly in urban driving conditions (Figure 22).

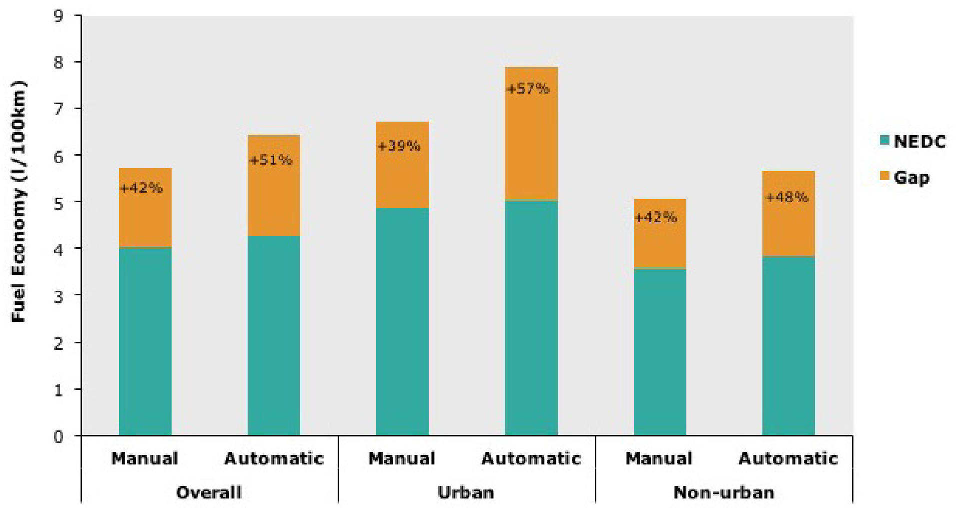

Figure 22: Protocol gap by transmission type

Higher gaps between manual and automatic transmission occur for both gasoline and diesel powertrains and can be as much as 3 l/100km for an automatic diesel car in urban driving (Figure 23). Improving the operation of automatic gearboxes fitted to diesel engines would reduce the performance gap identified in Figure 16 and Figure 17. Higher average vehicle weight might partly explain these differences, with weight being an important driver of fuel economy in urban environments.

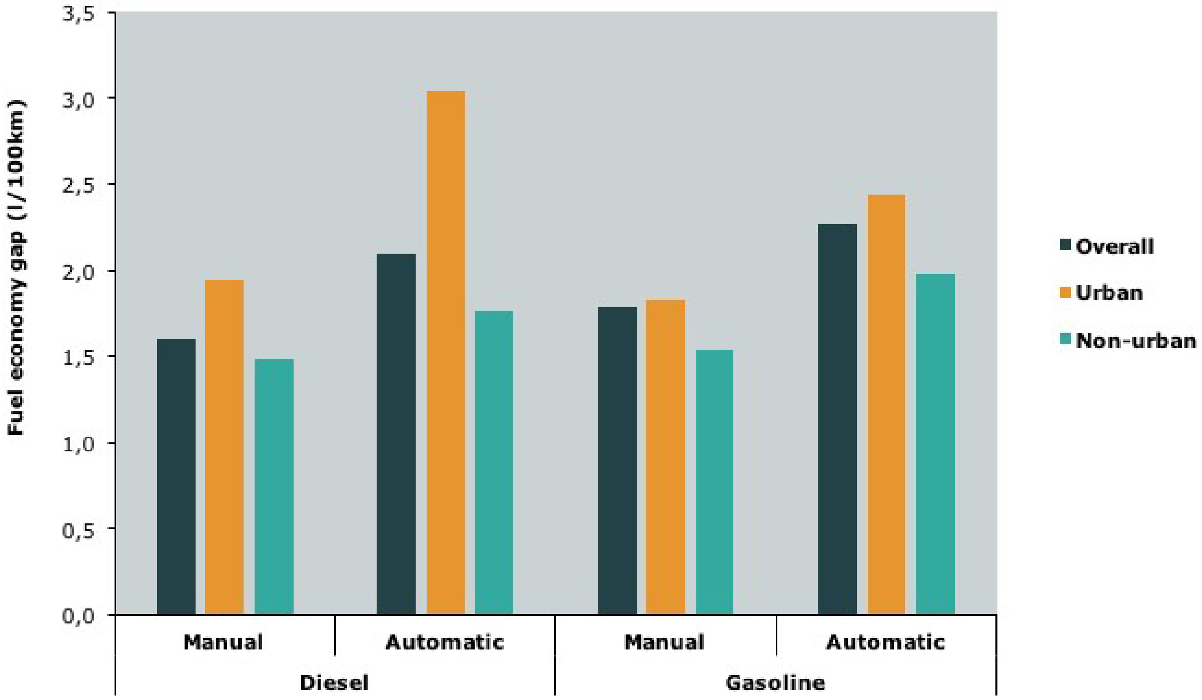

Figure 23: Fuel economy gap by fuel type and transmission type

Figure 24 compares the fuel consumption between automatic and manual gearboxes for the same vehicles and engine types. The automatic gearbox consumption is higher than the manual gearbox: 0.4 l/100km on the overall trip and slightly higher in urban driving (0.6 l/100km). The gap between the Protocol and the type-approved fuel consumption is greater for the automatic gearbox, particularly in urban driving. Both market and customer approaches are fully consistent.

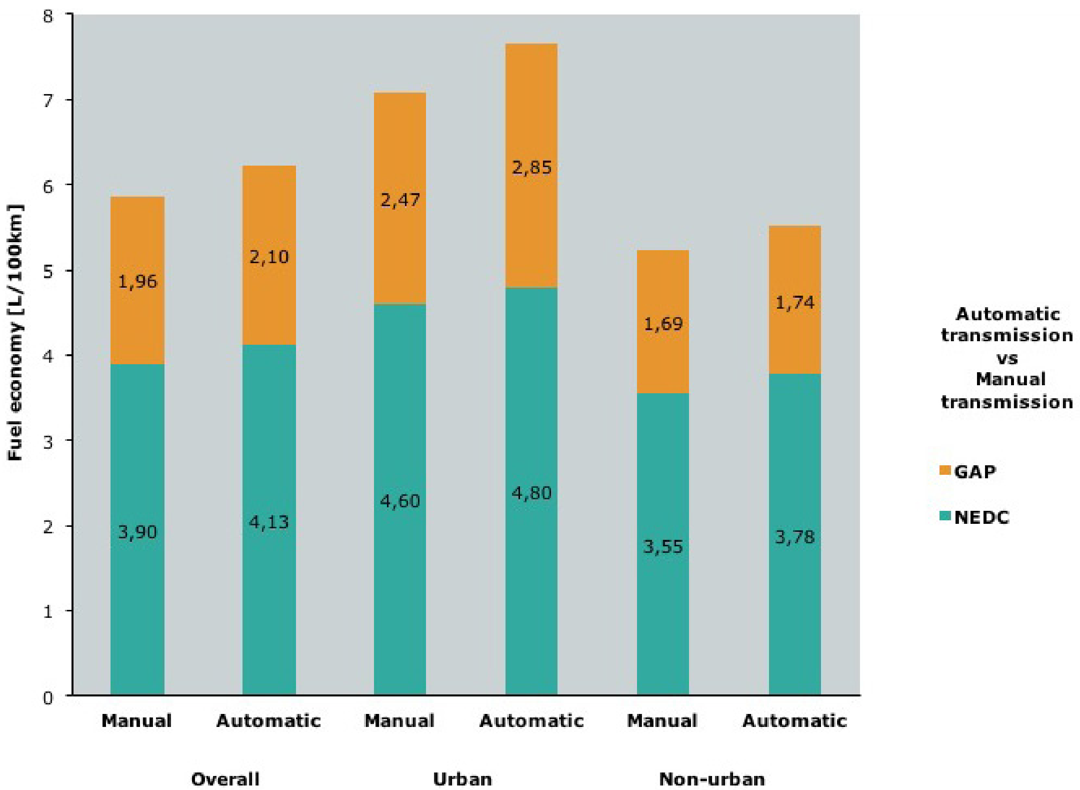

Figure 24: Transmission type customer approach

Impact of Stop & Start

Slightly over 50% of Groupe PSA sales in 2016 were fitted with a Stop & Start (S&S) system with 75% of the tested models using the technology because the device tends to be fitted on higher end vehicles, which are sold in lower volumes. The NEDC has long stop times, especially in the urban phase. This exaggerates the benefits of S&S compared with real-life conditions (Figure 25); although the technology brings additional benefits such as noise reduction, its cost-effectiveness will be reduced once the new WLTP is introduced, as it has fewer stops in the cycle.

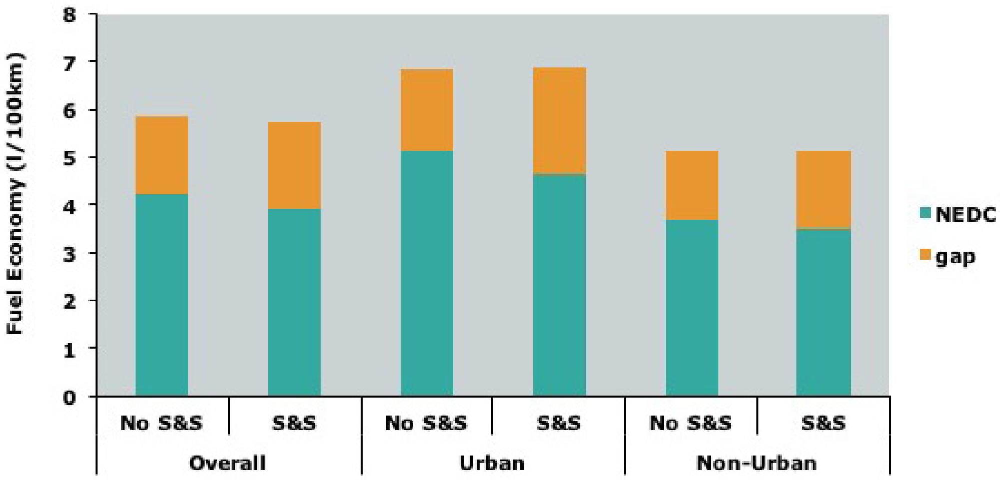

Figure 25 : Benefits of Stop & Start in urban driving is limited in real life.

The follow-on Figure 26 compares the fuel consumption for identical vehicles with and without S&S.

The S&S systems cuts the engine when the vehicle is stationary and therefore reduces fuel consumption in urban driving: 0.3 l/100km less fuel is used for S&S vehicles in real-life urban conditions. The gap between the Protocol and type approval fuel consumption values is higher for the versions with S&S: 0.2 l/100km in urban driving. This is explained by the fact that the vehicle is stationary for a longer time on the NEDC than in real driving conditions (see Table 2). The results are consistent with the market approach, except in the urban conditions, where the gap between certification and real life is significantly higher for the market approach, leading to no (or very limited) benefit of S&S systems in real urban conditions. This is probably because the average S&S vehicle is larger than the average non-S&S vehicle, leading to a higher average gap in urban conditions.

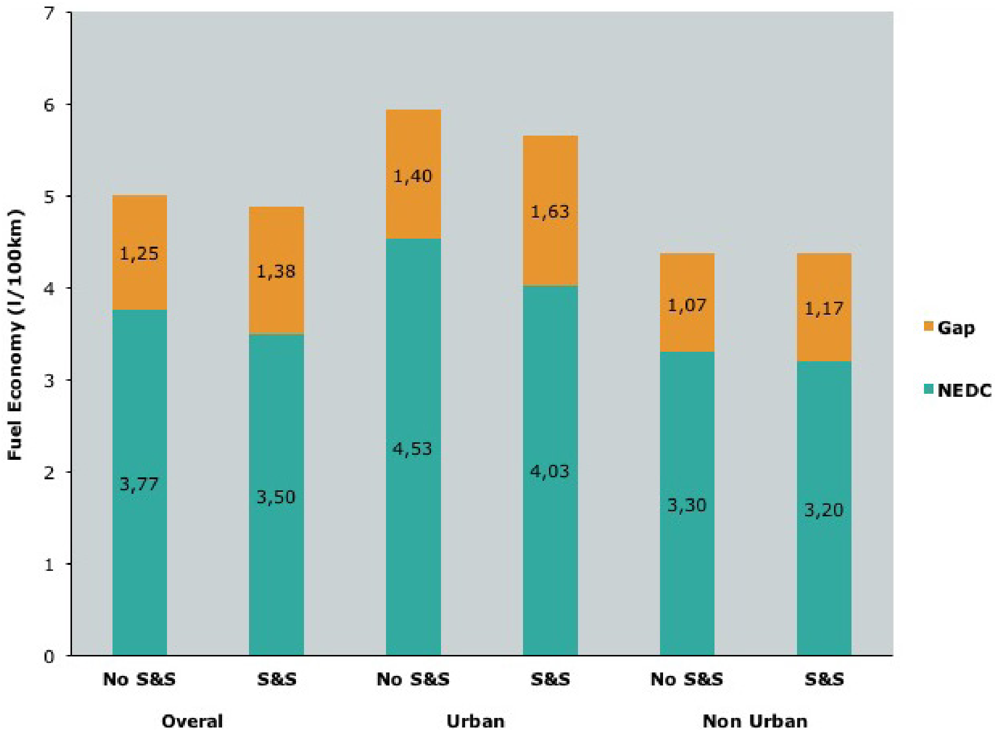

Figure 26: Stop & Start customer approach

4.2 CAN CERTIFICATION VALUES BE REACHED IN REAL-LIFE?

The Protocol data clearly show that it is not possible for an average driver to achieve the NEDC certification value measured under NEDC. At the 2017 Geneva Motor Show, a fuel economy simulator was launched to assist potential customers to better estimate their own fuel economy based on their own driving habits and their location[19]. The user provides information about vehicle occupancy and load, average trip characteristics, driving style and location to estimate a more accurate fuel economy for any vehicle contained in the database.

In the fuel economy simulator, test results have been used to estimate the fuel economy range depending on the conditions chosen, the centre point always being the value measured using the Protocol. The average value measured by the Protocol varies on a vehicle-by-vehicle basis, depending on the vehicle specifications. The best fuel economy values are reached when the driver is alone with no luggage, and drives smoothly over long trips in a temperate climate.

Ever under such favourable conditions, when one would expect to achieve the best fuel economy, only about 15% of the vehicles tested are able to reach the certification value. Furthermore, some patterns can be identified with respect to the vehicle specifications most likely to reach the certification fuel economy value in real life (Figure 27).

As highlighted in section 2.2, diesel engines, large vehicles and automatic transmission are more resilient to the effects of driving conditions. This means that most drivers will achieve results closer to the Protocol values. In other words, there is more to gain (and to lose) when driving gasoline cars in the most (and the least) favourable conditions than there is for a diesel car. Thus, an eco-driver is more likely to meet certification values if s/he owns a small gasoline car than if s/he owns a large automatic diesel vehicle.

19 http://media.groupe-psa.com/en/press-releases/group/psa-publishes-real-world-fuel-consumption-data

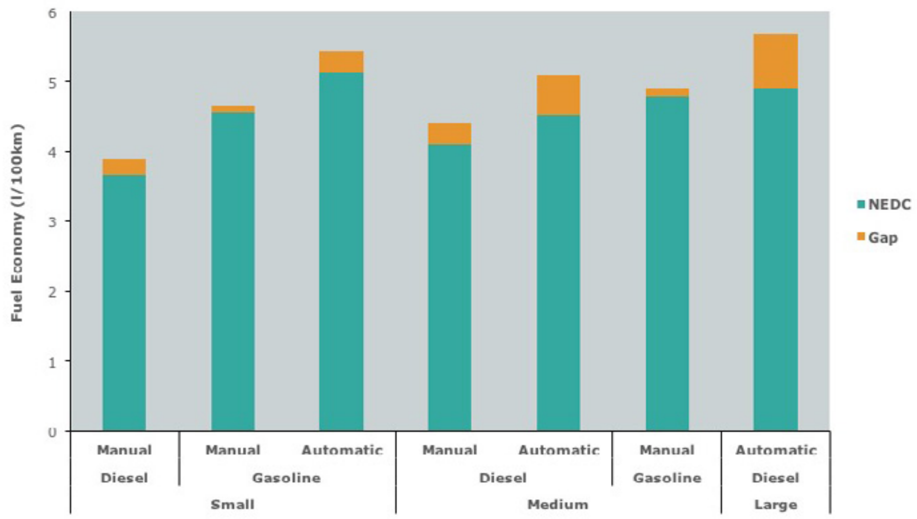

Figure 27 : Fuel economy gap to reach certification values in the most favourable conditions

4.3. REAL-LIFE DPF REGENERATION IMPACTS ON CO_2 EMISSIONS

All Original Equipment Manufacturers (OEMs) use Diesel Particulate Filters (DPFs) to lower particulate emissions and to certify their vehicles. Most DPFs need to be regenerated intermittently to burn stored particulates and to clean the filter for further particulate storage. This regeneration process has an impact on exhaust emissions with extra heat generated to burn the particulates stored in the DPF.

To take into account the impact of regeneration, regulation includes a Ki factor that depends upon the excess emissions during regeneration and also on the typical intervals between two successive regenerations. Type Approval Authorities in Europe are witnessing emissions tests during regenerations, but intervals between regeneration is a declared value by the OEMs. The Protocol can also be used to define real-life Ki factors, when two regenerations occur during the same test exercise. This has occurred only once for passenger cars, for a vehicle that was tested extensively as drivers were struggling to match average customer driving dynamics. Regenerations are detected by looking at exhaust gas temperature within the PEMS (Figure 28).

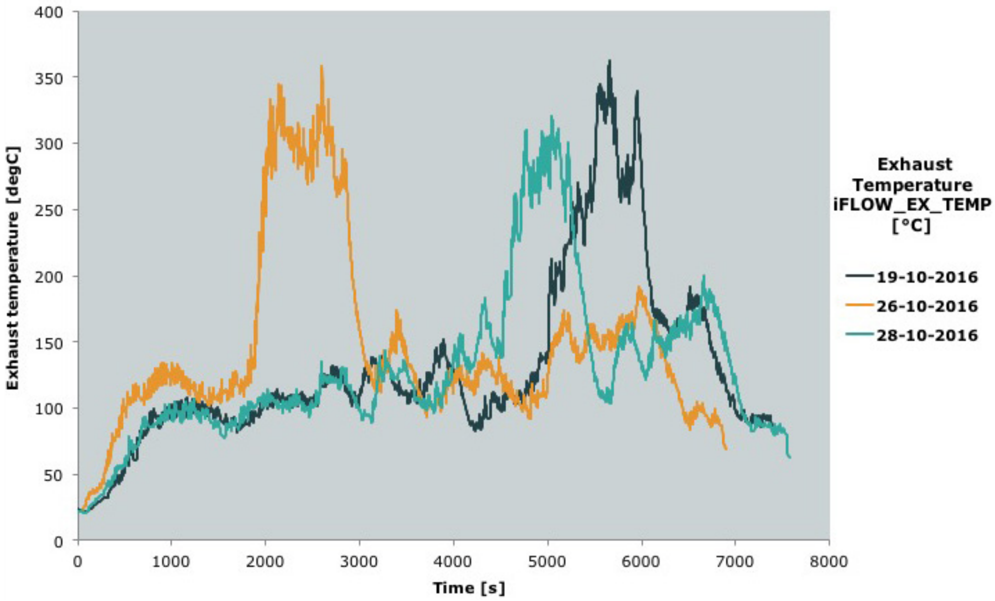

Figure 28 : Example of regenerations detected during various tests

When applying the formula specified in UNECE regulation 83, the real-life Ki factor can be determined as shown in Figure 29. In the one case for passenger cars when enough tests were made to have two regenerations, to thus obtain the interval between regenerations, a Ki factor was estimated at 0.5% for CO2, which was around twice as much as type approval Ki factors. The value of 0.5% has been used in the Protocol to take regeneration impacts into account.

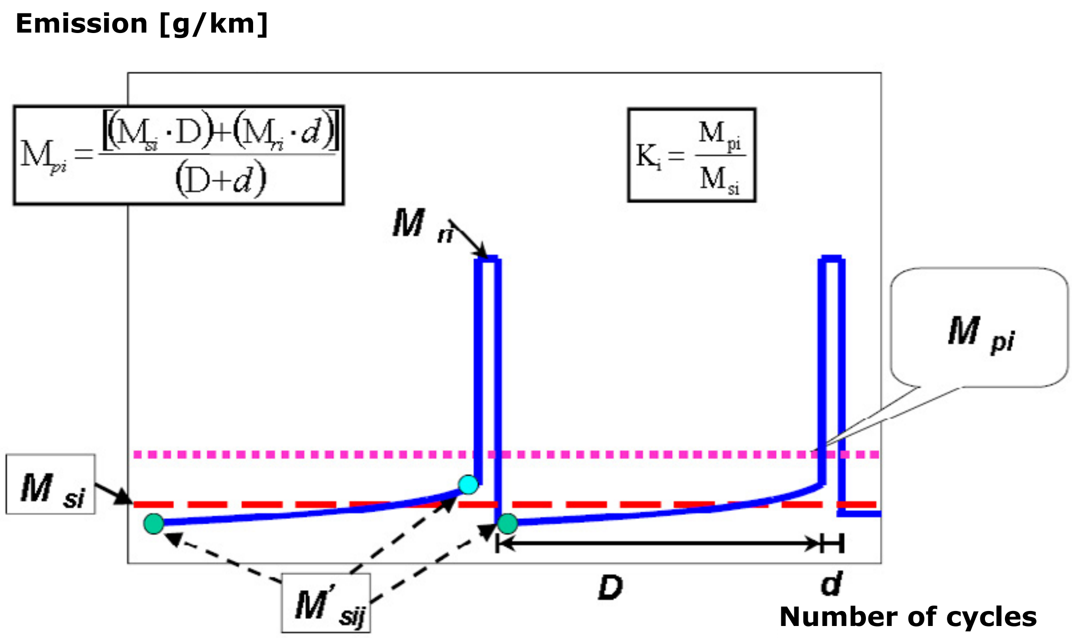

Figure 29 : Ki Factors calculation procedure as per UNECE regulation 83[20].

20 https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/R083r5e.pdf

5. CONCLUSION

Throughout this report, the partnership between Groupe PSA, T&E, FNE and Bureau Veritas has demonstrated that a technical collaboration between different stakeholders is possible and delivers concrete results and interesting insights.

Transparency was a key element of the partnership, and this report provides all the technical evidence gathered over the first 18 months using the Protocol for fuel economy measurements.

Real-life fuel economy measurements on open roads are possible, reliable, representative and repeatable. They are a valuable addition to laboratory tests and bring useful information to PSA customers concerned about fuel costs and energy efficiency. They also show good insights on which vehicle to choose to save fuel and which technologies are able to deliver fuel economy gains when used in real-world conditions.

With the development of RDE-compliant vehicles, the partnership is now looking at measuring regulated pollutant emissions at the exhaust pipe, using the Protocol. The test results will bring further transparency towards customers and civil society, both of whom are concerned about air quality and the contribution to regulated emissions from state-of-the-art vehicles.

The partnership will carry on working to minimise the environmental impact of vehicles and on making the information available in a transparent and robust way to the general public, as well as towards more specialised audiences.

ANNEX I: List of vehicle tested, with Protocol and type approval fuel economy results

Vehicle	Protocol (l/100km)	Homologation (gCO2/km)	Homologation (l/100km)	Gap (l/100km)
208 1.6L BlueHDi 100 MT5 Allure 16’’ tyre	4.7	90	3.5	1.2
208 1.6L BlueHDi 100 S&S MT5 Allure 16’’ tyre	4.7	79	3	1.7
308 1.6L BlueHDi 120 S&S MT6 Eco Model Allure 16’’ tyre	4.9	84	3.2	1.7
New C3 1.6L BlueHDi 75 S&S MT5 Live 15’’ tyre	4.9	83	3.2	1.7
C3 1.6L BlueHDi 75 S&S MT5 Confort Business 15’’ tyre	4.9	79	3	1.9
2008 1.6L BlueHDi 100 S&S MT5 Style 16’’ tyre	4.9	90	3.5	1.4
DS3 1.6L BlueHDi 120 S&S MT6 Sport Chic 17’’ tyre	5	94	3.6	1.4
DS3 cabrio 1.6L BlueHDi 100 STT MT5 So Chic 16’’ tyre	5	92	3.5	1.5
C4 Cactus 1.6L BlueHDi 100 MT5 Shine 16’’ tyre	5.1	95	3.6	1.5
2008 1.6L BlueHDi 100 MT5 Allure 16’’ tyre	5.1	97	3.7	1.4
C4 1.6L BlueHDi 100 MT5 Feel 16’’ tyre	5.1	95	3.6	1.5
308 1.6L BlueHDi 100 S&S MT5 Active 16’’ tyre	5.1	94	3.6	1.5
308 1.6L BlueHDi 120 S&S MT6 Standard Model Allure Pack 17’’ tyre	5.1	98	3.8	1.3
108 / C1 1.0L S&S MT5 Allure / Shine 15’’ tyre	5.1	88	3.8	1.3
2008 1.6L BlueHDi 120 S&S MT6 Allure 16’’ tyre	5.2	96	3.7	1.5
208 1.6L BlueHDi 120 S&S MT6 GT Line 17” tyre	5.3	94	3.6	1.7
308 1.6L BlueHDi 120 S&S AT6 Active 16’’ tyre	5.3	95	3.6	1.7
DS4 1.6L BlueHDi 120 S&S MT6 So Chic 17’’ tyre	5.4	100	3.8	1.6
C4 1.6L BlueHDi 120 S&S MT6 Feel 16” tyre	5.4	95	3.6	1.8
C4 Grand Picasso 5 seats 1.6L BlueHDi 120 S&S MT6 Seduction 16’’ tyre	5.7	106	4	1.7
C3 Picasso 1.6L BlueHDi 100 MT5 Confort 16’’ tyre	5.7	101	3.8	1.9
C4 Picasso 1.6L BlueHDi 100 S&S MT5 Seduction 17’’ tyre	5.7	100	3.8	1.9

Vehicle	Protocol (l/100km)	Homolo-gation (gCO2/km)	Homologa-tion (l/100km)	Gap (l/100km)
508 2.0L BlueHDi 150 S&S MT6 GT 18'' tyre	5.7	109	4.2	1.5
New 5008 1.6L BlueHDi 120 S&S MT6 Access 17'' tyre	5.8	108	4.2	1.6
108 /C1 1.0L MT5 Top Style / Feel 15'' tyre	5.9	95	4.1	1.8
DS5 1.6L BlueHDi 120 S&S AT6 Be Chic 16'' tyre	5.9	105	4	1.9
DS3 1.2L PureTech 110 S&S MT5 So Chic 16'' tyre	6	100	4.3	1.7
New C3 1.2L PureTech 82 MT5 Feel 15'' tyre	6	109	4.7	1.3
New 3008 1.6L BlueHDi 120 S&S MT6 Allure 18'' tyre	6	104	4	2
3008 1.6L BlueHDi 120 S&S MT6 Allure 17'' tyre	6.1	108	4.1	2
108 / C1 1.2L PureTech 82 MT5 Active / Feel 15'' tyre	6.1	99	4.3	1.8
Partner / Berlingo 1.6L BlueHDi 100 MT5 Active / Feel 15'' tyre	6.1	113	4.3	1.8
C4 Cactus 1.2L PureTech 110 S&S MT5 Shine 16'' tyre	6.1	100	4.3	1.8
C4 1.6L BlueHDi 120 S&S AT6 Shine 17'' tyre	6.1	104	4	2.1
308 SW 2.0L BlueHDi 180 S&S AT6 GT 18'' tyre	6.1	109	4.2	1.9
C4 Cactus 1.2L PureTech 82 MT5 Shine 16'' tyre	6.1	107	4.6	1.5
208 1.2L PureTech 110 S&S MT5 Allure 16'' tyre	6.2	99	4.3	1.9
508 2.0L BlueHDi 180 S&S AT6 Allure 17'' tyre	6.3	105	4	2.3
C3 1.2L PureTech 82 MT5 Shine 16'' tyre	6.3	107	4.6	1.7
308 1.2L PureTech 110 S&S MT6 Active 16'' tyre	6.3	95	4	2.3
C4 1.2L PureTech 110 MT5 Live 15'' tyre	6.3	112	4.8	1.5
2008 1.2L PureTech 82 MT5 Style 16'' tyre	6.4	114	4.9	1.5
208 1.2L PureTech 82 MT5 Allure 16'' tyre	6.4	104	4.5	1.9
C4 Grand Picasso 5 seats 2.0L BlueHDi 150 S&S AT6 Shine 17'' tyre	6.4	112	4.3	2.1
C4 Picasso 1.6L BlueHDi 120 S&S AT6 Exclusive 17'' tyre	6.5	106	4	2.5
308 1.2L PureTech 130 S&S MT6 Allure 16'' tyre	6.6	107	4.6	2
DS5 2.0L BlueHDi 180 S&S AT6 Sport Chic 18'' tyre	6.7	117	4.5	2.2

Vehicle	Protocol	Homologation	Homologation	Gap
	(l/100km)	(gCO2/km)	(l/100km)	(l/100km)
C5 Break 2.0L BlueHDi 180 S&S AT6 Exclusive 18’’ tyre	6.7	114	4.4	2.3
C4 1.2L PureTech 130 S&S MT6 Shine 17’’ tyre	6.7	110	4.8	1.9
DS4 1.2L PureTech 130 S&S MT6 So Chic 17’’ tyre	6.8	114	4.9	1.9
B618 1.2L PureTech 110 S&S AT6 Shine 17’’ tyre	6.8	110	4.9	1.9
C3 Picasso 1.2L PureTech 110 MT5 Confort 16’’ tyre	7	115	5	2
2008 1.2L PureTech 110 S&S AT6 Allure 16’’ tyre	7.1	110	4.8	2.3
308 1.2L PureTech 130 S&S AT6 Allure Pack 17’’ tyre	7.2	112	4.9	2.3
C4 Grand Picasso 7 seats 1.2L PureTech 130 S&S MT6 Exclusive 17’’ tyre	7.4	116	5	2.4
New 3008 1.2L PureTech 130 S&S MT6 Active 19’’ tyre	7.4	115	5	2.4
Traveller / Spacetourer PC L2H1 8pl 2.0L BlueHDi 150 S&S MT6 Business / Business 16” tyre	7.5	139	5.3	2.2
3008 1.2L PureTech 130 S&S MT6 Allure 17’’ tyre	7.6	115	4.9	2.7
508 1.6L THP 165 S&S AT6 Feline 17’’ tyre	8.2	130	5.6	2.6
308 GTI 1.6L THP 270 S&S MT6 19’’ tyre	8.6	139	6	2.6