Forschungsgesellschaft für Verbrennungskraftmaschinen und Thermodynamik mbH

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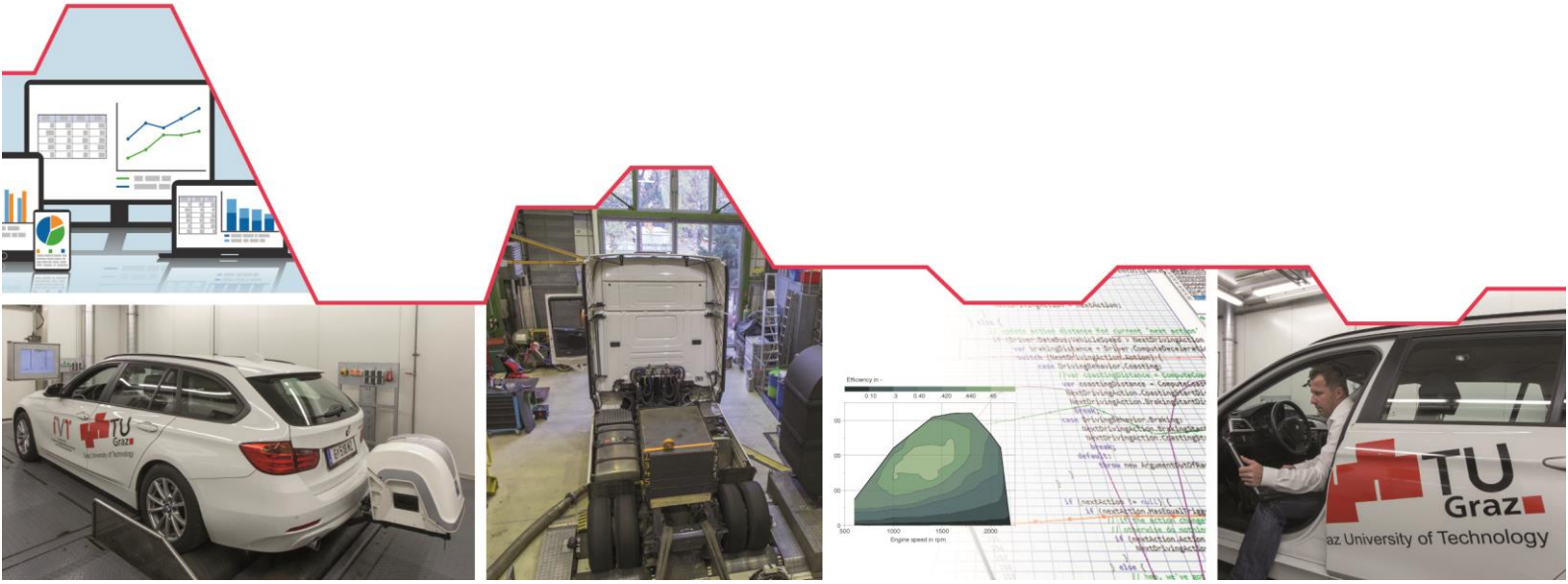
CO_2 and emissions performance of PHEV vehicles

18.01.2023



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CONTENT

Abbreviations

Avg.	……..	Average
AVL	……..	Anstalt für Verbrennungskraftmaschinen List
BMW	……..	Bayerische Motoren Werke
CO	……..	Carbon monoxide
CO_2	……..	Carbon dioxide
ERMES	……..	European Research group on Mobile Emission Sources
EU	……..	European Union
FVT	……..	Forschungsgesellschaft für Verbrennungskraftmaschinen und Thermodynamik m.b.H.
HVAC	……..	Heating, Ventilation and Air Conditioning
ICE	……..	Internal Combustion Engine
max.	……..	Maximum
n.a.	……..	Not available
NO	……..	Nitrogen monoxide
NO_2	……..	Nitrogen dioxide
NO_x	……..	Nitrogen oxides
NTE	……..	Not-To-Exceed
OBD	……..	On-Board-Diagnose
OBFCM	……..	On Board Fuel Consumption Monitoring
OVC-HEV	……..	Off-Vehicle Charging Hybrid Electric Vehicle
PEMS	……..	Portable Emissions Measurement System
perc.	……..	percentile
PHEV	……..	Plug-in Hybrid Electric Vehicle
PN	……..	Particle number
RDE	……..	Real Driving Emissions
REESS	……..	Rechargeable Electrical Energy Storage System
rpa	……..	Relative positive acceleration
sat.-nav.	……..	Satellite navigation
SoC	……..	State-of-Charge
SUV	……..	Sport Utility Vehicle
T&E	……..	Transport and Environment
VIN	……..	Vehicle Identification Number
VIN	……..	Vehicle Identification Number

1 Scope of the Work

The scope of the work was to investigate the real world performance of some current non-SUV PHEVs available on the EU market using a portable emission measurement system.
The objective for PHEV #1 was a Peugeot 308, for PHEV #2 a Renault Megane and for PHEV #3 a BMW 330e. FVT rented these three Euro 6d PHEVs from a manufacturer independent car rental company (Peugeot 308 and Renault Megane) and from a manufacturer independent car dealer (BMW 330e). The test program included four on-road tests for Peugeot 308 and Renault Megane and five on-road tests for BMW 330e. For Peugeot 308 and Renault Megane, FVT conducted the following on-road tests in detail:

- 1 trip using the zero emission mode to investigate the electric range
- 1 trip using the charge sustaining mode
- 1 trip using the charge mode
- 1 trip using the hybrid mode

For BMW 330e, the same tests were performed considering the vehicle's geo-fencing, which supports electric driving in cities that have been geo-fenced by BMW. An additional test was performed with the BMW 330e using the vehicle's smart hybrid mode.
For this project, the following data were recorded in 1 Hz:

- Emission masses (CO_2, CO, NO, NO_2, NO_x)
- Fuel mass flow calculated from the carbon balance based on the C/H ratio of the fuel
- Particle numbers > 23 nm (50 % cut-off)
- Exhaust mass flow
- Available OBD signals from vehicle supported by the OBD logger from PEMS
- OBFCM data before and after each test

The following chapters describe the measurement systems, vehicles and the tests in detail.

2 Measurement Systems and Evaluation Tool Used

The measurement system used at FVT is an AVL M.O.V.E. It consists of a so-called GAS-PEMS for the measurement of the gaseous components like CO_2, CO, NO and NO_2 and a PN-PEMS for PN_{23}. This portable emission measurement system (PEMS) can be installed in or on the vehicle. Figure 2.1 shows the installed PEMS in the PEUGEOT 308 as an example.

Figure 2.1: Installed PEMS in the Peugeot 308

In addition to the emissions, a variety of other parameters such as ambient temperature, humidity and pressure as well as OBD data via Dear-Born OBD Logger DPA5 can be recorded.

The AVL M.O.V.E system meets the requirements of the EU Regulation 2017/1151 of 01. June 2017, EU 2017/1154 of 07. June 2017 and EU 2018/1832 of 05. November 2018.

The OBFCM data were collected with the Hella Gutmann system before and after each performed test.

Table 2.1 shows the measurement systems with the respective serial number.

Table 2.1: Measurement systems

Measurement system	**Serial number**
AVL M.O.V.E Gas	171
AVL M.O.V.E PN_{23}	203
AVL M.O.V.E EFM 2,5"	140
Dear-Born OBD Logger DPA5	XOV13EAXOV

Panasonic Toughbook FZ-55	0FTCA39241
Hella Gutmann mega macs 56 (version 61)	4225

The evaluation of the RDE measurement data were carried out with the so-called ERMES tool. It calculates the mass emissions from the measured concentrations in volume percent and the measured mass flow, taking into account the gas running time from engine out to the emission sample point. The result file contains second-by-second data as well as a cycle average values in g/km and #/km.

Table 2.2: Evaluation tool

Evaluation tool	**Software version**
ERMES-Tool	2.3.2.1099

3 Test routes

For the tests, routes were required for the electric range, charge sustaining, charge increasing, the hybrid as well as for the smart hybrid test. The test routes were compiled according to the customer's requirements and are described below.

3.1 Route for electric range test

The electric range test was performed on a route through the city of Graz. The route started at the Inffeld campus of the Technical University in Graz. One lap was about 30 km. The vehicle was driven in electric mode for as long as possible until the ICE started for the first time due to empty REESS, therefore more than one lap on the same route was possible. The electric range test was stopped after the first start of the combustion engine. The same route was used for all test vehicles (minor variations due to road works and road closures). Figure 3.1 shows the route for the electric range test.

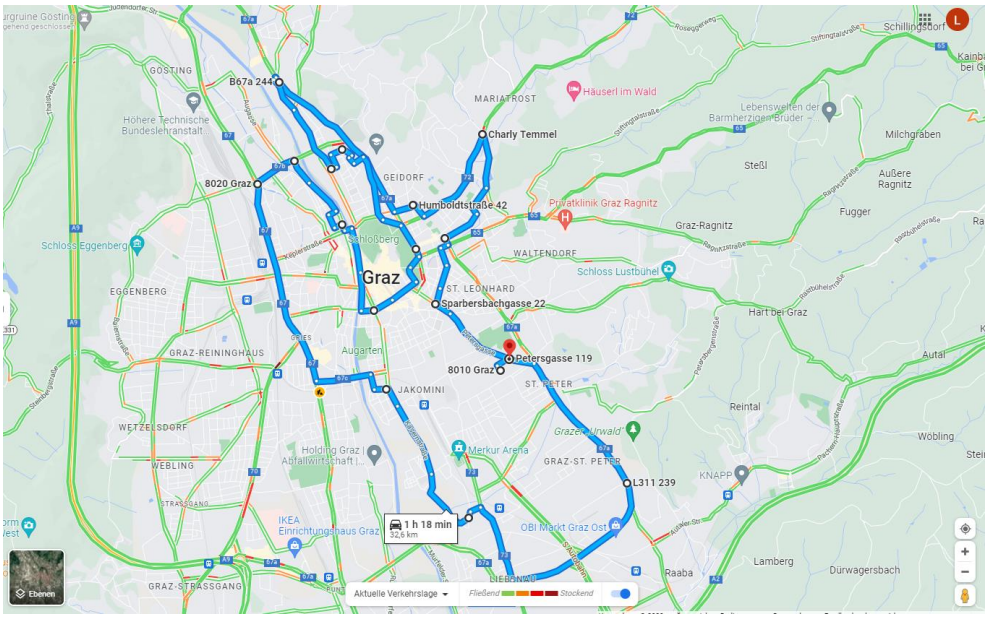

Figure 3.1: Route for electric range test, Source: Google maps

3.2 Route for charge sustaining test

The route for the charge sustaining test was similar to the route for the electric range test (see chapter 3.1). At the customer's request, two laps were driven on the route for each test vehicle. After the first lap, the batteries of the PEMS were changed, which took about 10 minutes.

3.3 Route for charge increasing test

This route started at the Inffeld campus of the University of Technology in Graz. The vehicle was driven directly to the A2 motorway and after reaching the city "Ilz" the entire route was driven back. The same route was used for all test vehicles (minor variations due to road works and road closures). Figure 3.2 shows the route for the charge increasing test.

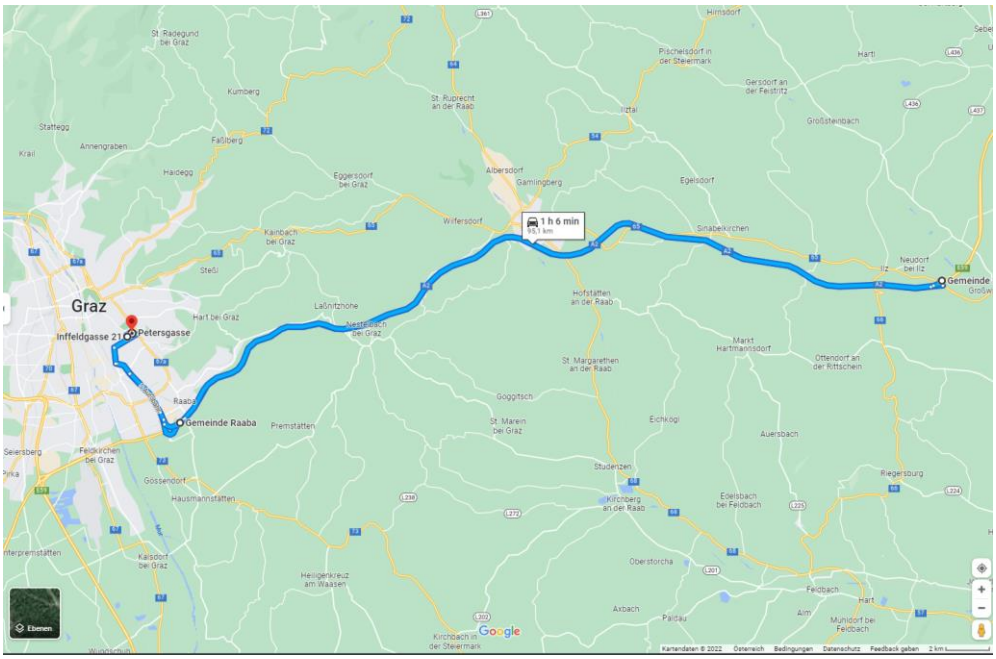

Figure 3.2: Route for charge increasing test, Source: Google maps

3.4 Route for hybrid and smart hybrid test

This route started in a city called "Gleisdorf", between Graz and “Ilz”. Therefore, the motorway part is a part of the motorway section from the charge increasing test. The vehicle was driven from “Gleisdorf” via the A2 motorway to the inner city of Graz. In the inner city of Graz, the test was paused at the old campus of the Graz University of Technology (Rechbauerstraße 12, 8010 Graz) for 20 minutes according to the costumer’s requirements. By choosing the old campus, it was ensured that the vehicle could always paused at the same place for all test vehicles. With the exception of some one-way streets, the same route was driven back to “Gleisdorf”. The same route was used for all test vehicles (minor variations due to road works and road closures). Figure 3.3 shows the route for the hybrid and smart hybrid test.

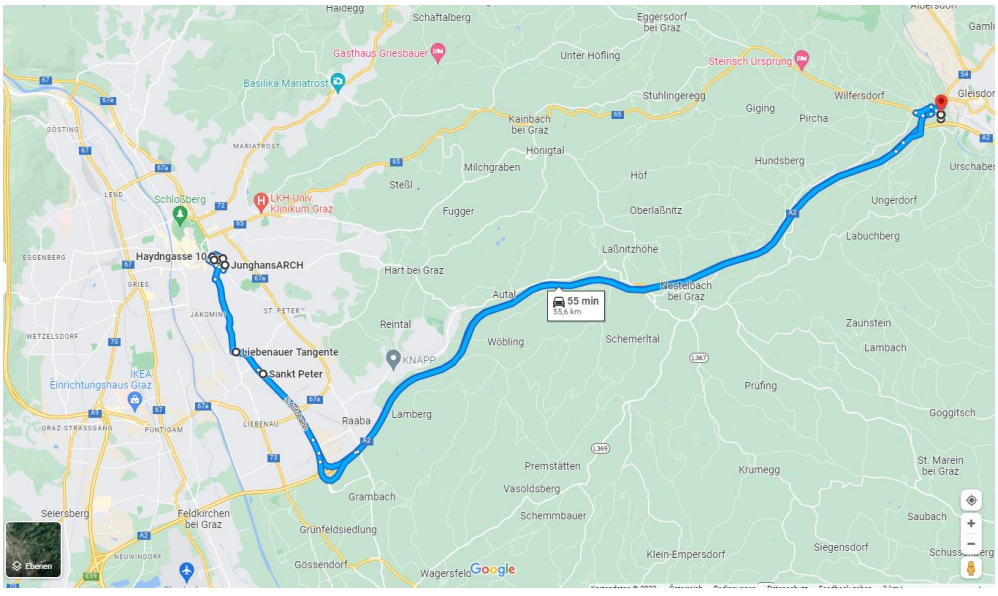

Figure 3.3: Route for hybrid and smart hybrid test, Source: Google maps

4 Tested vehicles

In total three PHEV vehicles were tested. PHEV #1 was a Peugeot 308, PHEV #2 a Renault Megane and PHEV #3 a BMW 330e xDrive, which are described in chapter 4.1. All test vehicles were checked prior to rental and before and after each test according to the customer's requirements. The checks performed for each vehicle are described in chapter 4.2. Chapter 4.3 gives an overview of the vehicle settings, chapter 4.4 presents the test results.

4.1 Vehicle data

4.1.1Peugeot 308

The first vehicle tested was a Peugeot 308 Hybrid 225 (Figure 4.1). The vehicle is equipped with a 132 kW gasoline engine, 81.2 kW electric motor and 8-speed automatic gearbox. The exhaust aftertreatment system consists of a three-way catalyst and a gasoline particulate filter. The mileage at the beginning of the tests was 3962 km. Table 4.1 shows the most important vehicle data.

Figure 4.1: Peugeot 308

Table 4.1: Vehicle data of the Peugeot 308

Vehicle manufacturer and model	**Peugeot 308 Hybrid 225**
VIN	VR3F3DGYTMY535046
Type of hybrid	OVC-HEV
Emission standard	Euro 6; AP
First registration	01.02.2022
Max. engine power ICE [kW]	132
Max. engine power E-motor [kW]	81.2
Mass in running order [kg]	1708

Max. permitted mass [kg]	2120
REESS capacity brutto/netto [kWh]	12.4 / n.a.
Gearbox	Automatic, 8-speed
Mileage at test start [km]	3962
Tyres	225/40 R18 Michelin primacy 4
Available Driving modes	Sport, Hybrid, Electric

4.1.2Renault Megane

The second test vehicle was a Renault Megane E-TECH Plug-in Hybrid 160 (Figure 4.2). The vehicle is equipped with a 69 kW gasoline engine, 74 kW electric motor and 6-speed automatic gearbox. The exhaust aftertreatment system consists of a three-way catalyst and a gasoline particulate filter. The mileage at the beginning of the tests was 9338 km. Table 4.2 shows the most important vehicle data.

Figure 4.2: Renault Megane

Table 4.2: Vehicle data of the Renault Megane

Vehicle manufacturer and model	**Renault Megane E-TECH Plug-in Hybrid 160**
VIN	VF1RFB00X67030168
Type of hybrid	OVC-HEV
Emission standard	Euro 6; AP
First registration	30.11.2021
Max. engine power ICE [kW]	69
Max. engine power E-motor [kW]	74

Mass in running order [kg]	1605
Max. permitted mass [kg]	2060
REESS capacity brutto/netto [kWh]	9.8/ n.a.
Gearbox	Automatic, 6-speed
Mileage at test start [km]	9338
Tyres	225/40 R18 Continental Premium Contact 6
Available Driving modes	Pure, My Sense, Sport

4.1.3BMW 330e xDrive

The third test vehicle was a BMW 330e xDrive (Figure 4.3). The vehicle is equipped with a 135 kW gasoline engine, 83 kW electric motor and 8-speed automatic gearbox. The exhaust aftertreatment system consists of a three-way catalyst and a gasoline particulate filter. The mileage at start of the tests was 7620 km. Table 4.3 shows the most important vehicle data.

Figure 4.3: BMW 330e xDrive

Table 4.3: Vehicle data of the BMW 330e xDrive

Vehicle manufacturer and model	**BMW 330e xDrive**
VIN	WBA6N710XMFK74552
Type of hybrid	OVC-HEV
Emission standard	Euro 6; AP
First registration	07.03.2022
Max. engine power ICE [kW]	135
Max. engine power E-motor [kW]	83

Mass in running order [kg]	1965
Max. permitted mass [kg]	2425
REESS capacity brutto/netto [kWh]	12/ 11.2
Gearbox	Automatic, 8-speed
Mileage at test start [km]	7620
Tyres	225/50 R17 Hankook Ventus S1 evo3
Available Driving modes	Sport, Hybrid Standard, Hybrid Eco Pro, Electric

4.2 Vehicle checks

For each test vehicle, the checks were divided into

- checks before start of the vehicle tests,
- checks before each vehicle test and
- checks before and after each vehicle test.

All tested vehicles passed the checks. The checks performed are described in the following subchapters.

4.2.1 Checks before start of the vehicle tests

For each vehicle, the following checks were carried out before start of the vehicle tests:

- Ensure that the vehicle has a full service and maintenance history
- Check that the vehicle has been properly maintained and no maintenance or repairs are needed
- Visual check and documentation of aftertreatment components
- Ensure that there is no damage or tampering to the vehicle
- Collect fuel sample from tank
- Check, that fitted tyres and tyre pressures follow manufacturer's recommendations

4.2.2 Checks before each vehicle test

The following checks were performed before each test:

- Check that there are no fault lights on the driver information display
- Check OBD fault codes
- Ensure that all fluid levels are within the min-max boundaries

4.2.3 Checks before and after each vehicle test

The following checks were performed and noted before and after each test:

- OBFCM
- REESS SoC from driver information display
- Odometer

4.3 Vehicle settings

4.3.1 Load settings

The same settings for load and additional equipment were used for each vehicle tested. The fixed load is about 275 kg. Table 4.4 provides details of the load settings, Table 4.5 the test mass for each test vehicle.

Table 4.4: Load settings

Fixed loading	Mass [kg]
AVL M.O.V.E	120
Driver	70-85 (depending on the driver)
Co-Driver	70-85 (depending on the co-driver)

Table 4.5: Vehicle test mass

Vehicle	Test mass [kg]
Peugeot 308	1949
Renault Megane	1848
BMW 330e xDrive	2176

4.3.2 Auxiliary settings

The HVAC, infotainment system and the lights have been activated in automatic mode. Table 4.6 provides details of the auxiliary settings.

Table 4.6: Auxiliary settings

Auxiliary	Setting
HVAC	Automatic mode with interior temperature set to 22 °C
Infotainment system	Activated with default mode selected by the vehicle at vehicle start
Lights	Automatic mode

4.3.3 Settings of start SoC, driving mode and satellite navigation

The following tables provides an overview of the settings for start SoC, driving mode and satellite navigation for the Peugeot 308, Renault Megane and BMW 330e xDrive.

Table 4.7: Settings for the Peugeot 308

Test number	Test	Start SoC level	Driving mode	Geo-fencing	Set destination in sat-nav.	Target SoC level (if it can be set)
1	Electric range test	100 %	Electric	Not available	No	Default set by vehicle
2	Charge sustaining test	0 %	Default hybrid mode activated by vehicle	Not available	No	Default set by vehicle
3	Charge increasing test	50 %	Default hybrid mode activated by vehicle	Not available	No	Default set by vehicle
4	Hybrid test	100 %	Default hybrid mode activated by vehicle	Not available	Yes	Default set by vehicle

Table 4.8: Settings for the Renault Megane

Test number	Test	Start SoC level	Driving mode	Geo-fencing	Set destination in sat-nav.	Target SoC level (if it can be set)
1	Electric range test	100 %	Electric	Not available	No	Default set by vehicle
2	Charge sustaining test	0 %	Default hybrid mode activated by vehicle	Not available	No	Default set by vehicle
3	Charge increasing test	50 %	Default hybrid mode activated by vehicle	Not available	No	Default set by vehicle
4	Hybrid test	100 %	Default hybrid mode activated by vehicle	Not available	Yes	Default set by vehicle

Table 4.9: Settings for the BMW 330e xDrive

Test number	Test	Start SoC level	Driving mode	Geo-fencing	Set destination in sat-nav.	Target SoC level (if it can be set)
1	Electric range test	100 %	Electric	activated	No	Default set by vehicle

2	Charge sustaining test	0 %	Default hybrid mode activated by vehicle	activated	No	Default set by vehicle
3	Charge increasing test	0 %	Default hybrid mode activated by vehicle	deactivated	No	100%
4	Hybrid test	100 %	Default hybrid mode activated by vehicle	activated	No	Default set by vehicle
5	Smart hybrid test	100 %	Default hybrid mode activated by vehicle	activated	Yes	Default set by vehicle

4.4 Vehicle test results

This chapter gives an overview of the vehicle behaviour in the different driving modes as well as results for electric range and CO_2, NO_x, CO and PN_{23} emissions. In the data provided to T&E, many other test data are included, such as OBFCM data, weather conditions and ambient temperatures.

4.4.1 Vehicle behaviour in the different driving modes

The following subchapters describe the behaviour of the test vehicles observed during the tests in the various driving modes.

4.4.1.1 Electric range test

All vehicles supported the electric driving mode. The driving mode was activated at the beginning of each electric range test. Each test was started with fully charged REESS. Since the test was carried out only in the city of Graz with low cycle power demand, the ICE was not started on any of the test vehicles to support the electric motor during the test. The ICE was only started when the REESS was empty, which also defined the end of the test for each test vehicle.

4.4.1.2 Charge sustaining test

The charge sustaining test was performed using the default hybrid mode that each test vehicle had activated at vehicle start. Each vehicle was started with an empty REESS and was driven 2 laps on the route described in chapter 3.2. At the end of each test, the vehicle's REESS remained empty.

4.4.1.3 Charge increasing test

The tests were mainly performed on the motorway, as described in chapter 3.3. No charge increasing mode was available for Peugeot 308 and Renault Megane, so the tests of these two vehicles were started with a start SoC level of 50 % and with the

default hybrid mode activated by the vehicle at the beginning of the test according to the costumer's request. The charge increasing mode was supported by the BMW 330e xDrive. Therefore, the charge increasing test of the BMW 330e xDrive was started with an empty REESS, the SoC target value was set to 100 % in the driver information system before start of the test.

At the end of the test, both the REESS of Peugeot 308 and Renault Megane were empty. Thus these tests were in reality no charge increasing tests since this function was not available for these two cars. For the BMW 330e xDrive, the SoC value was almost 100 % according to the driver information display.

4.4.1.4Hybrid and smart hybrid test

These tests were also performed with the default hybrid mode activated by each vehicle at the beginning of the test. For the BMW 330e xDrive, a smart hybrid test was additionally performed using the satellite navigation system. Each test was started with fully charged REESS. The REESS was empty at the end of the tests of Peugeot 308 and Renault Megane. The remaining SoC level of BMW 330e xDrive was between 50 and 75 % for the hybrid test and about 25 % for the smart hybrid test. Figure 4.4 shows the hybrid test, Figure 4.5 the smart hybrid test of the BMW 330e as an example. The red dots represent driving with internal combustion engine, the green dots pure electric driving.

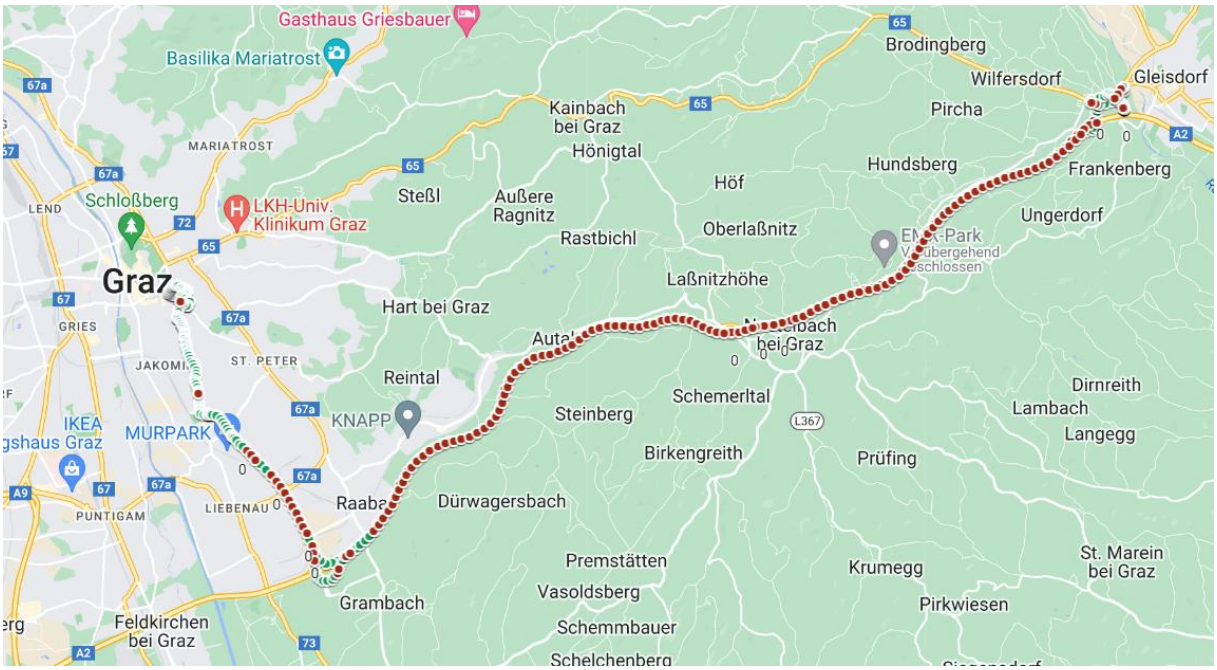

Figure 4.4: BMW 330e hybrid test with ICE (red dots) and pure electric operation (green dots), Source: Google My Maps

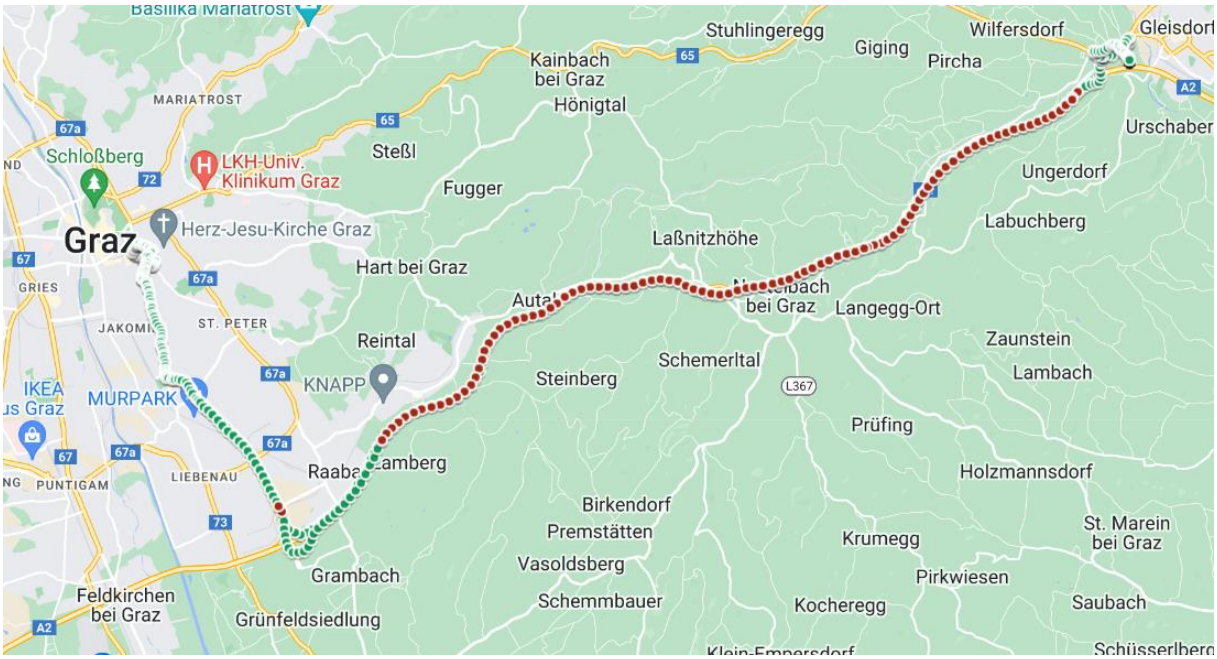

Figure 4.5: BMW 330e smart hybrid test with ICE (red dots) and pure electric operation (green dots), Source: Google My Maps

4.4.2Results of electric range

Figure 4.6 shows the electric ranges of the three PHEV test vehicles. The test to determine the electric range for each test vehicle was started with a fully charged REESS. The electric range test was stopped after the ICE started for the first time with an empty REESS. For all electric range tests, the driver information display showed 0 % or 0 km electric range of the test vehicles at the end of the test. The Peugeot 308 has an electric range of around 34 km, the Renault Megane around 49 km and the BMW 330e xDrive around 41 km.

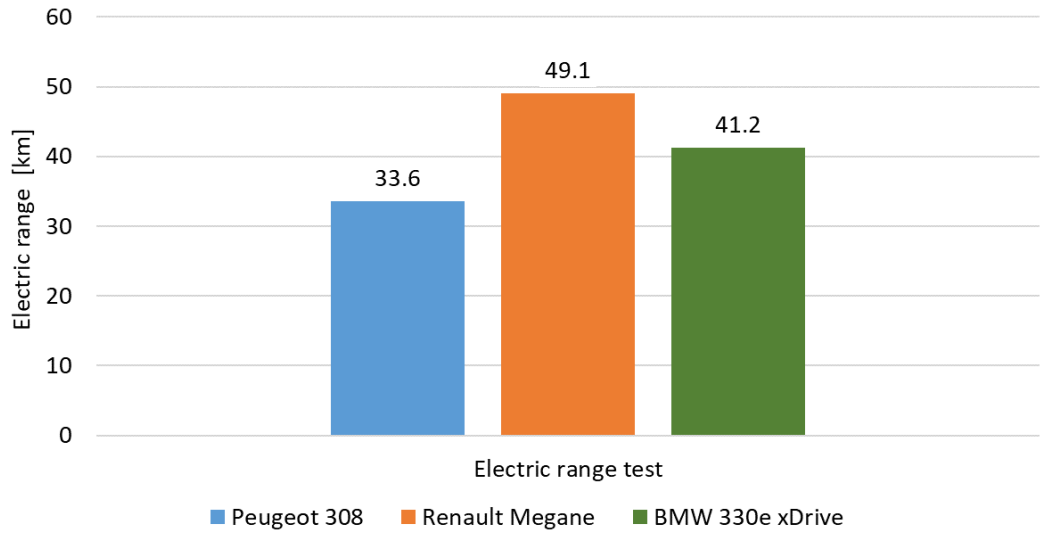

Figure 4.6: Results of electric range

4.4.3Results of CO_2, NO_x, CO and PN_{23} emissions

The CO_2 emissions for the different tests are shown in Figure 4.7. As mentioned earlier, only the BMW 330e xDrive supported the charge increasing mode, which can also be seen in the higher CO_2 emissions of the BMW 330e xDrive in the charge increasing test. In the hybrid test, the BMW 330e xDrive also had the highest CO_2 emissions, but as already mentioned, the remaining SoC level of the BMW was between 50 and 75 % for the hybrid test and about 25 % for the smart hybrid test, while the SoC level of the other test vehicles was 0 % at the end of the test. Comparing the hybrid test and the smart hybrid test of the BMW 330e xDrive, the smart hybrid test had 40 % lower CO_2 emissions. It should be mentioned, however, that for example different traffic volumes can also influence CO_2 emissions, as these were two separate tests. Nevertheless, the main reduction should come from the smart hybrid driving mode. The trend of fuel consumption in [l/100km] corresponds to the trend of CO_2 emissions. The fuel consumption was calculated from the carbon balance based on the C/H ratio of the fuel and is included in the data provided to the costumer.

In all tests, the NO_x emissions (= NO + NO_2) from the test vehicles were below 35 mg/km, which is also well below the Euro 6d NTE limit (Figure 4.8). The CO emissions of the tests are shown in Figure 4.9. The CO emissions were below 300 mg/km for all tests, with an average of 190 mg/km. The PN_{23} emissions are shown in Figure 4.10. All PN_{23} emissions were below 2E11 #/km, which is also below the Euro 6d NTE limit.

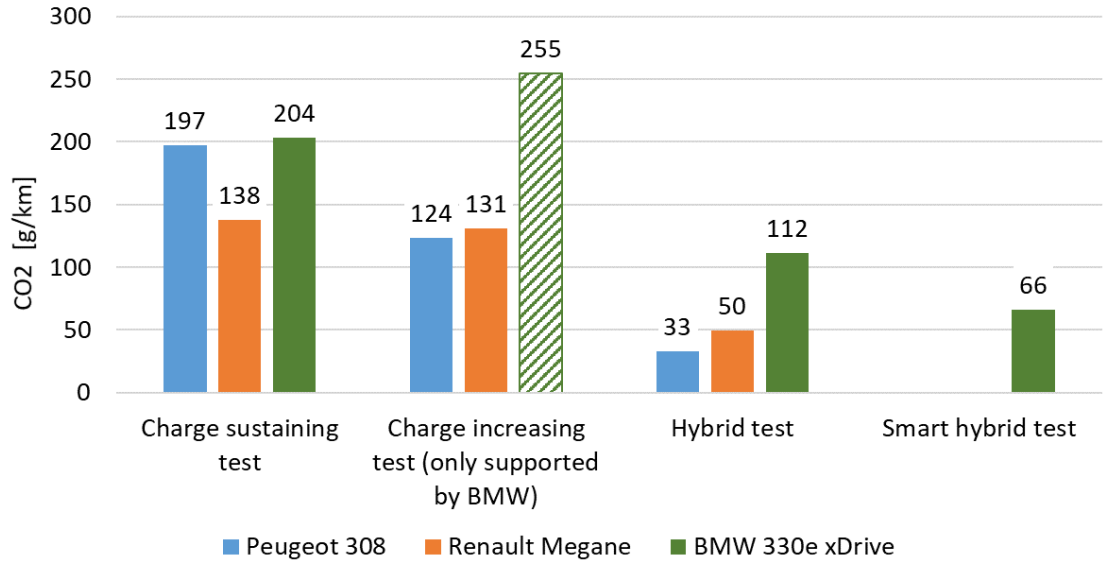

Figure 4.7: Results of CO_2 emissions (note: the Peugeot and Renault did not provide charge increasing driving modes)

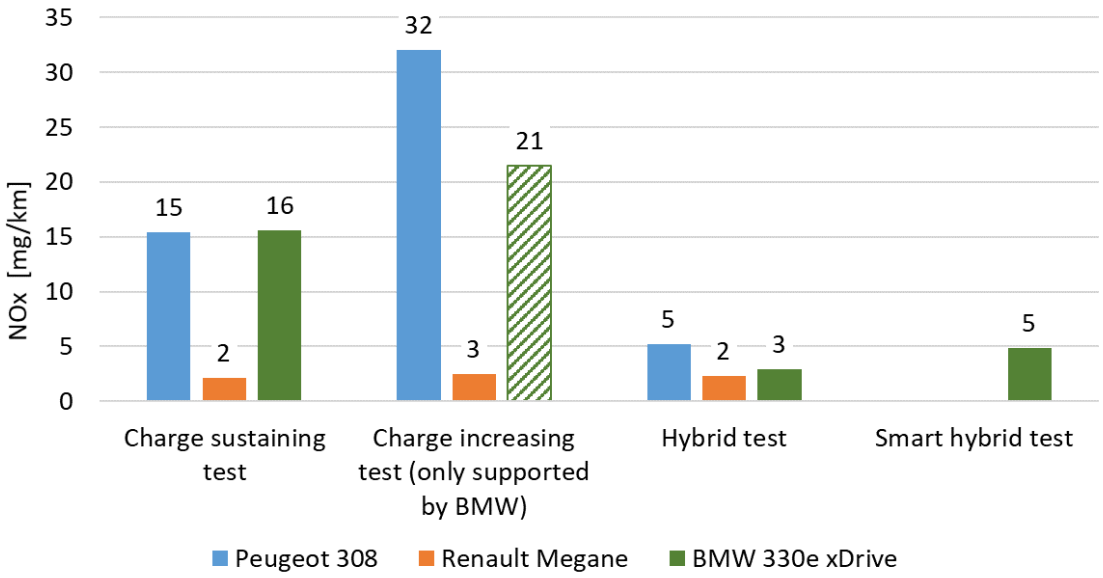

Figure 4.8: Results of NO_x emissions (note: the Peugeot and Renault did not provide charge increasing driving modes)

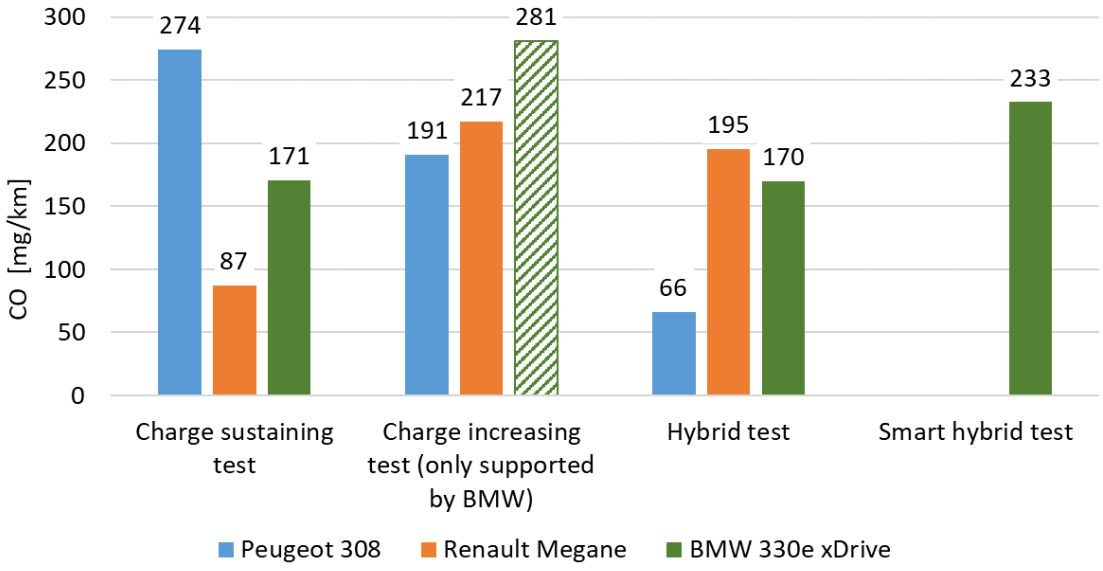

Figure 4.9: Results of CO emissions (note: the Peugeot and Renault did not provide charge increasing driving modes)

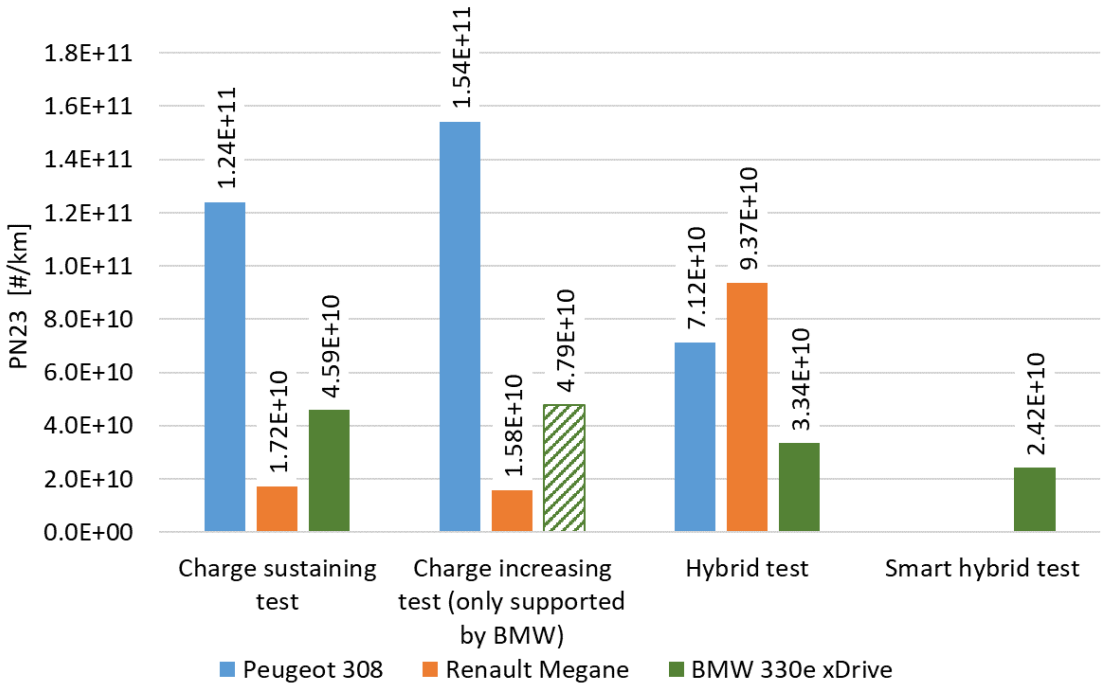

Figure 4.10: Results of PN_{23} emissions (note: the Peugeot and Renault did not provide charge increasing driving modes)

5 Data provided to the costumer

Following data were provided to the costumer T&E via password protected Cloud for each tested vehicle:

- Measurement data (evaluated and raw) in Microsoft Excel format
- Copy of the certificate of conformity
- Document of fuel analysis
- Photos of test vehicle and installed PEMS (also short videos of the BMW 330e xDrive)

Since all vehicles were tested before the first maintenance, no service history was available.

6 Conclusion

The scope of the work was to investigate the real world performance of current non-SUV PHEVs available on the EU market for the costumer T&E. In total three PHEV vehicles were investigated. PHEV #1 was a Peugeot 308, PHEV #2 a Renault Megane and PHEV #3 a BMW 330e xDrive. FVT rented the three PHEV of emissions standard Euro 6d from a manufacturer independent car rental company (Peugeot 308 and Renault Megane) and from a manufacturer independent car dealer (BMW 330e xDrive).

The tests were performed on different routes, which were compiled according to the customer's requirements. In total, the tests were performed on three different routes in the city, rural and on the motorway in and around Graz, where the tests for the electric range and charge sustaining were performed on the same route.

The AVL M.O.V.E was used as measurement system. The AVL M.O.V.E consists of a so-called GAS-PEMS for the measurement of the gaseous components CO_2, CO, NO and NO_2 and a PN-PEMS for PN_{23}. In addition to the emissions, a variety of other parameters such as ambient temperature, humidity and pressure as well as OBD data were recorded.

The test program included four on-road tests for Peugeot 308 and for Renault Megane with different driving modes. In the case of the BMW 330e xDrive, an additional test was performed using the vehicle's smart hybrid mode. For the electric, charge sustaining, hybrid and smart hybrid mode test, the BMW's geo-fencing was activated, which supports electric driving in cities that have been geo-fenced by BMW.

The electric ranges were around 34 km for the Peugeot 308, 41 km for the BMW 330e xDrive and 49 km for the Renault Megane. The test to determine the electric range for each vehicle was started with a fully charged REESS. The electric range test was stopped after the ICE started for the first time with an empty REESS.

Compared to the Peugeot 308 and Renault Megane only the BMW 330e xDrive supported the charge increasing mode, which can also be seen in the higher CO_2 emissions of the BMW 330e xDrive in the charge increasing test. In the hybrid test, the BMW 330e xDrive also had the highest CO_2 emissions, but as already mentioned, the remaining SoC level of the BMW was between 50 and 75 % for the hybrid test and about 25 % for the smart hybrid test, while the REESS of the other test vehicles was empty at the end of the test. Comparing the hybrid test and the smart hybrid test of the BMW 330e xDrive, the smart hybrid test had 40 % lower CO_2 emissions. The NO_x emissions in all tests were below 35 mg/km, the CO emissions were below 300 mg/km and the measured PN_{23} emissions were below 2E11 #/km.

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9 Appendix

This chapter presents the test results and trip parameters of each test.

9.1 Vehicle test results

Table 9.1: Test results Peugeot 308

	Electric range [km]	CO2 [g/km]	NOx [mg/km]	CO [mg/km]	PN23 [#/km]
Electric range test	33.6	-	-	-	-
Charge sustaining test	-	197.1	15	274	1.24E+11
Charge increasing test (only supported by BMW)	-	123.6	32	191	1.54E+11
Hybrid test	-	32.8	5	66	7.12E+10

Table 9.2: Test results Renault Megane

	Electric range [km]	CO2 [g/km]	NOx [mg/km]	CO [mg/km]	PN23 [#/km]
Electric range test	49.1	-	-	-	-
Charge sustaining test	-	138.1	2	87	1.72E+10
Charge increasing test (only supported by BMW)	-	131.2	3	217	1.58E+10
Hybrid test	-	49.8	2	195	9.37E+10

Table 9.3: Test results BMW 330e xDrive

	Electric range [km]	CO2 [g/km]	NOx [mg/km]	CO [mg/km]	PN23 [#/km]
Electric range test	41.2	-	-	-	-
Charge sustaining test	-	203.6	16	171	4.59E+10
Charge increasing test	-	254.8	21	281	4.79E+10
Hybrid test	-	111.5	3	170	3.34E+10
Smart hybrid test	-	66.5	5	233	2.42E+10

9.2 Trip parameters

Table 9.4: Trip parameters Peugeot 308

	Ambient temperature [°C]	Urban share [%]	Rural share [%]	Motorway share [%]	Avg. urban speed [km/h]	Avg. rural speed [km/h]	Avg. motorway speed [km/h]	Total 95% perc v*apos0.1 [m²/s³]	Total rpa [m/s²]	Total distance [km]
Electric range test	20.7	99.1	0.9	0.0	21.1	60.7	-	13.88	0.215	33.6
Charge sustaining test	30.7	97.2	2.8	0.0	22.7	64.1	-	13.53	0.212	65.1
Charge increasing test	30.6	7.7	6.5	85.8	27.9	77.4	123.5	24.10	0.101	95.8
Hybrid test	25.1	17.9	9.1	73.1	10.7	76.2	107.2	18.30	0.096	55.8

Table 9.5: Trip parameters Renault Megane

	Ambient temperature [°C]	Urban share [%]	Rural share [%]	Motorway share [%]	Avg. urban speed [km/h]	Avg. rural speed [km/h]	Avg. motorway speed [km/h]	Total 95% perc v*apos0.1 [m²/s³]	Total rpa [m/s²]	Total distance [km]
Electric range test	30.1	98.4	1.6	0.0	25.8	61.8	-	13.49	0.195	49.1
Charge sustaining test	33.9	97.9	2.1	0.0	24.5	61.9	-	13.30	0.198	65.8
Charge increasing test	33.7	8.0	8.2	83.8	28.2	82.1	124.6	22.38	0.100	95.9
Hybrid test	27.2	18.0	11.7	70.3	12.9	75.1	115.6	15.80	0.106	55.8

Table 9.6: Trip parameters BMW 330e xDrive

	Ambient temperature [°C]	Urban share [%]	Rural share [%]	Motorway share [%]	Avg. urban speed [km/h]	Avg. rural speed [km/h]	Avg. motorway speed [km/h]	Total 95% perc v*apos0.1 [m²/s³]	Total rpa [m/s²]	Total distance [km]
Electric range test	22.8	99.1	0.9	0.0	26.1	60.7	-	16.33	0.224	41.2
Charge sustaining test	30.2	97.2	2.8	0.0	25.4	61.9	-	13.33	0.204	65.8
Charge increasing test	23.1	8.1	4.4	87.5	28.7	76.3	122.4	24.52	0.093	97.1
Hybrid test	30.6	18.2	10.7	71.2	12.5	75.6	116.4	19.40	0.134	55.9
Smart hybrid test	25.5	20.2	7.2	72.6	13.4	75.6	114.3	22.57	0.138	56.0