Particle Reduced, Efficient Gasoline Engines

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Publishable Summary

The aim of this WP5 is the validation and assessment of the systems developed in the PaREGEn project through physical testing with the final objective of ensuring the correct operation of the subsystems developed (new engines and after-treatment technologies) and their optimal integration to the demonstrator vehicles. A Jaguar XE and a Mercedes E180 were chosen as a baseline vehicles by JLR and DAI, respectively. Throughout the project, a tracking and monitoring of this development will be performed in order to align the project results. At the end of the project, an evaluation of the complete system developed in two demonstrators (in terms of fuel consumption improvement and pollutant emissions reduction) will be performed. This evaluation will consist of the independent validation of the ≥ 15% CO_2 reduction potential of the two demonstrator vehicles and also compliance with Euro 6(d) RDE limits (including the ability of effectively reducing sub 23 nm particle emissions to at least 10 nm) to give an indication of the potential to reach possible future EU Super Low Emission Vehicle standards.
In parallell, a 2015 best-in-class vehicle equivalent with respect to the size and torque engine will be presented with the corresponding g CO2 value based on WLTC in order to have an additional reference of the demonstrator vehicle potential improvement to be based on in order to have an overall and more complete assessment at the end of the PaREGEn Project.

One of the first steps of the work defined in this deliverable is the identification of the targets that the two vehicle demonstrators have to fulfil at the end of the project. The defined targets will have to prove a reduction in WLTP CO_2 emissions compared with the values obtained from the baseline vehicle tests carried out at the beginning of the project. The WLTP CO_2 target was chosen because from September 2017, new vehicle types will be tested under WLTP to show more realistic CO2 emissions because many studies showed that NEDC did not reflect actual on-road pollutant emissions and fuel consumption. The targets definition has to be aligned with the testing schedule and independent testing programme. It is foreseen that the targets defined will be CO2, NOx and PN emissions, both in laboratory cycles and under real driving conditions.

This target definition was obtained by gathering information from different sources, such as the results obtained from the tests performed on the baseline vehicles, European Emissions standard limits of the Euro 6 (d), technical information about the baseline vehicles (Jaguar XE and Mercedes E180), vehicle databases from 2015 containing the different vehicle brands with the corresponding value of CO2 Emissions and also from information about the Vehicle Market Segmentation. The EEA Vehicle Database was one of the vehicle database selected to be used as a reference for this part of the project. The Vehicle Certification Agency Vehicle Database and other websites were used to confirm the data obtained from the EEA Vehicle Database. Due to the fact that the two baseline vehicles belong to a different Segment, one best in class for each baseline vehicle was searched for and obtained; the JLR vehicle (Jaguar XE) was classified as D-segment and the DAI vehicle (Mercedes E180) was classified as E-segment.

After the exhaust emission testing campaign performed on the JLR baseline vehicle, the obtained WLTC values in terms of CO2 Emissions were 171 and 181 g CO2/km, for WLTC Low and High, respectively. A reduction of a 15 % of these values of g CO2 are the targets that each vehicle demonstrator should fulfil at the end of the project. As a consequence, the obtained target setting for the JLR demonstrator vehicle in terms of CO2 Emissions is 145 and 154 g CO2/km, for WLTC Low and High, respectively. Regarding the DAI baseline vehicle, the obtained WLTC values in terms of CO2 Emissions were 160 and 190 g CO2/km, for WLTC Low and High, so the obtained target setting for the DAI demonstrator vehicle in terms of CO2 Emissions is 136 and 162 g CO2/km, for WLTC Low and High, respectively.

Additionally, in order to obtain an additional reference of the demonstrator vehicle improvement, a comparison of each vehicle with the best in class 2015 similar to each vehicle was performed. It is worth to mention that the value of the g CO2 emissions of the best-in-class vehicle was still monitored under NEDC so for most of the actual equivalent engines the information about the WLTP CO2 value was not available, so the VemSim (vehicle energy management simulator) was used as a simulation tool to estimate emissions g CO2 (WLTP) from emissions g CO2 (NEDC). VemSim is an internal IDIADA simulation software which is able to predict the fuel consumption of a vehicle in a specific test taking into account certain inputs of the specific vehicle such as Road Load Coefficients, vehicle weight, engine characteristics, etc. As a result of this work, additional references for the Jaguar XE and Mercedes E180 demonstrator vehicle in terms of CO2 Emissions were obtained.

In parallel to the target-setting task, the exhaust emission testing protocols, the equipment and the most suitable instrumentation to be used for both baseline vehicles and demonstrator vehicles were defined. It was intended to apply the same testing protocol throughout the whole project to enable comparison and analysis of the results obtained in a consistent way. Testing procedures were based on the standard ones for NEDC, WLTP and RDE, but with some adaptations to the project and also including some additional instrumentation and measurements in order to have additional information about non-regulated pollutants concentration emitted by vehicle tailpipe, second-by-second measurements during the exhaust emission tests and non-regulated particle number measurement, such as particle size distribution and sub 23 nm particle emissions to at least 10 nm. JRC supported IDIADA with the particle emissions techniques to measure sub 23 nm particle emissions down at least to 10 nm.

The RDE testing procedures are based on the latest amendment of Real Driving Emissions Regulations, the so-called 3rd RDE regulatory package which was published in the Official Journal of the European Union on 7 July 2017. A conformity factor of 1.5 for PN of gasoline direct injection (GDI) vehicles has been introduced, with effects from September 2017 for new type approvals and from September 2018 for all new vehicles. Furthermore, the Euro 6 PN emissions limit of 6.0×10^{11} pk/km for GDI vehicles is applicable as of the same dates.

These testing protocols for validation were carefully defined and agreed between all partners in order to obtain measurements on the vehicles as extensive and precise as possible taking into account the current available equipment and the regulations in force.

Other work included in this deliverable is the first phase of the testing campaign carried out on the Jaguar XE and Mercedes E180 baseline vehicles before adding all these developed subsystems. This testing was based on the exhaust emission test procedures defined at the beginning of the project. The tests on chassis dynamometer were performed in the exhaust emissions laboratory at IDIADA's facilities, and RDE tests on real road were carried out in the area around IDIADA.

Since road testing is not feasible during the early phases of powertrain development (new engines and after-treatment technologies), the demonstrator testing will be conducted only on chassis dynamometer facilities simulating a RDE previously done on real road on the baseline vehicles. In this sense, RDE testing on a real road is only executed during baseline vehicles testing phase. As a consequence, a RDE test was parametrized from the RDE test performed on each of the two baseline vehicles in a real road. Then, this parametrized RDE test was used for chassis dyno testing with the baseline vehicles and will also be used with both demonstrator vehicles at the end of the project.

Appendix A – Acknowledgement

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Project partners:

#	Partner	Partner Full Name
1	RIC	RICARDO UK LIMITED
2	DAI	DAIMLER AG
3	JLR	JAGUAR LAND ROVER LIMITED
4	BOSCH	ROBERT BOSCH GMBH
5	FEV	FEV EUROPE GMBH
6	JM	JOHNSON MATTHEY PLC
7	HON	HONEYWELL, SPOL. S.R.O
8	JRC	JOINT RESEARCH CENTRE – EUROPEAN COMMISSION
9	UNR	UNIRESEARCH BV
10	IDIADA	IDIADA AUTOMOTIVE TECHNOLOGY SA
11	SIEMENS	SIEMENS INDUSTRY SOFTWARE SAS
12	LOGE	LUND COMBUSTION ENGINEERING LOGE AB
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14	UDE	UNIVERSITAET DUISBURG-ESSEN
15	RWTH	RWTH AACHEN UNIVERSITY
16	UFI	UFI FILTERS SPA

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