



## JRC TECHNICAL REPORTS

# EU project GasOn (No 652816) - measurements of a Ford prototype vehicle by JRC

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## **Foreword**

As written into the Grant Agreement of EU project GasOn (Gas-Only Internal Combustion Engines) contract n.652816: "final assessment of the vehicles will be certified, as "independent testing", by JRC (Joint Research Centre) which will carry out additional measurements in their own testing facilities both on chassis dyno and by means of PEMS (Portable Emissions Measurement System)". For this reason, JRC has to test demo vehicles at the end of the activities performed on WP2, WP3 and WP4.

## **Acknowledgements**

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## ***Authors***

Barouch Giechaskiel, Giorgio Martini

## **Abstract**

The demo vehicle of Ford was measured at JRC in January 2019. In the laboratory the old type approval cycle NEDC and the new type approval cycle WLTC were tested. On the road RDE compliant routes were followed. The results showed that:

1. HC emissions were around half of the EU6 limit in NEDC and approximately 35% of the EU6 limit in the WLTC (not required for RDE).
2. NMHC emissions were in the range of 10% of the EU6 limit for both, the NEDC and the WLTC (not required for RDE).
3. CO emissions were about 20% of the EU6 limit in NEDC, approximately 50% of the EU6 limit in the WLTC and RDE and around 30% of the EU6d limit in RDE Urban.
4. NOx emissions were about 40% of the EU6 limit in NEDC, approximately 70% of the EU6 limit in the WLTC, around 85% of the EU6d limit in RDE and within the EU6d RDE Urban limit.
5. PN emissions were about 2% of the EU6 limit in NEDC, approximately 4% of the EU6 limit in the WLTC, below 20% of the EU6d limit in RDE and around 30% of the EU6d RDE Urban limit.

Conclusively, all pollutant emissions were below the respective 2020+ emissions limits in both, the laboratory tests (NEDC, WLTP) and on the road (RDE). Most are below 50% of the EU6d limit.

## **1 Introduction**

In order to exploit the main benefits of gas-powered engines, the aim of the GasOn project is to develop CNG-only, mono-fuel-engines able to comply with 2020+ emissions, CO<sub>2</sub> emissions targets and new homologation cycle and Real Driving conditions and simultaneously improving engine efficiency and vehicle performance also with regard to its CNG range capability.

According to the Grant Agreement the outcomes expected will be 3 different segment demonstrator vehicles, one per engine platform, able to prove emissions at least below half of upcoming Euro 6 limits in combination with new WLTC and a reduction of at least 20% in CO<sub>2</sub> emission levels (including CO<sub>2</sub> equivalent unburned methane and N<sub>2</sub>O) compared with the best in class related segment vehicles on the market in 2014. Real Driving emissions will be also part of the demonstration activities, according to the future regulation requirements and assessing the reliability of the different technologies proposed.

Within WP7 of GasOn the prototype vehicles are supposed to be finally assessed by JRC.

## **2 Experimental**

Regarding WP3, the vehicle tested was a Ford C max equipped with a 999 cm<sup>3</sup> TC CNG DI prototype engine and prototype CNG storage system (Power 110 kW).

The tests were conducted in VELA 2 (gas analysers MEXA series 7400) with 9 m<sup>3</sup>/min CVS flow rate. The coast down times were provided by Ford. The dyno was set to FWD (rear synch).

The test cycles were NEDC (with cold start) and WLTC (with cold start).

The on-road tests were RDE compliant. The PEMS used for RDE tests was the AVL MOVE. The results are integrated values, without any correction or post-processing.

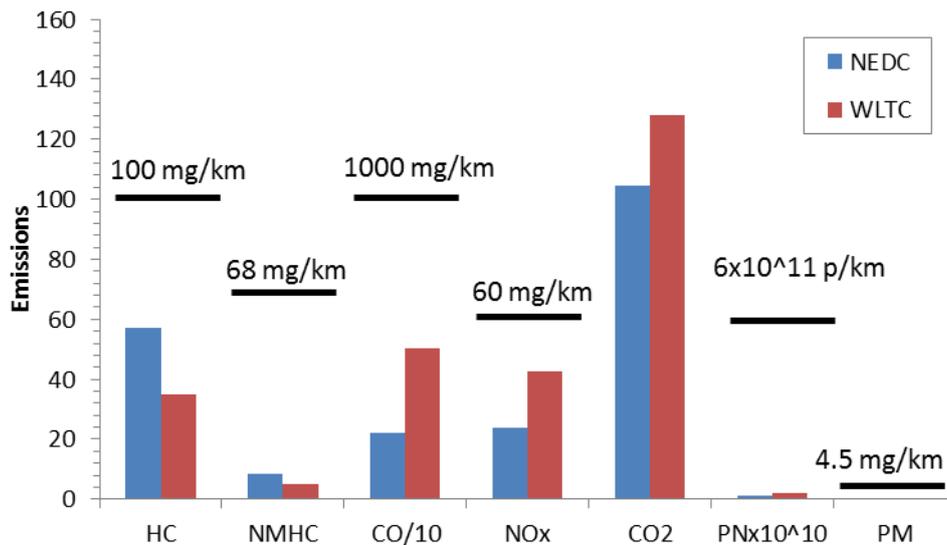
Two repetitions of each test were conducted.

### 3 results

#### 3.1 Laboratory results

The results of the cold start type approval cycles (NEDC until Sept. 2017 and WLTC from Sept 2017) are plotted in **Figure 1**.

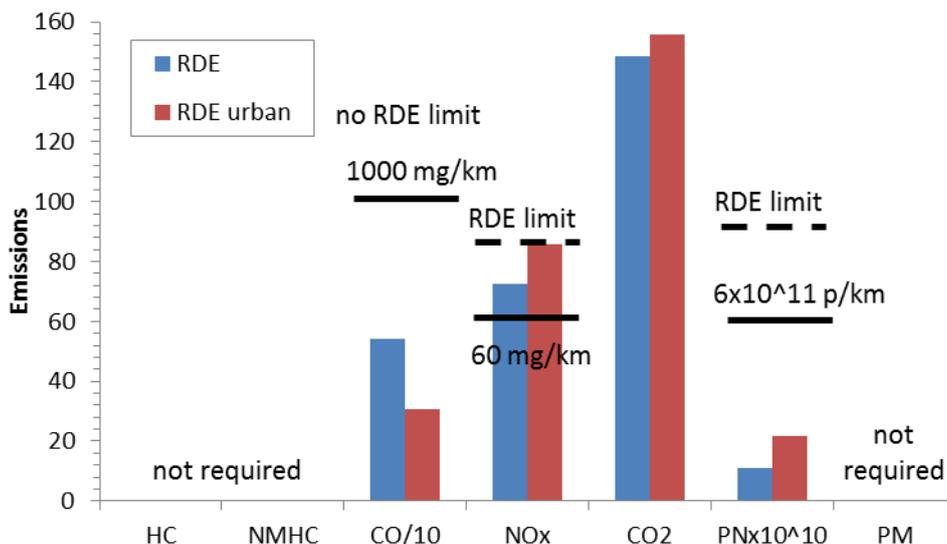
**Figure 1: Results for NEDC and WLTC. Lines show the Euro 6 limits for positive ignition vehicles.**



#### 3.2 On-road results

The on-road RDE results with PEMS are plotted in **Figure 2**.

**Figure 2: On-road results for RDE compliant route with PEMS. Lines give the laboratory Euro 6 limits. Dashed lines show the 2020 RDE limits, which are subject to annual revision.**



### 3.3 Results per pollutant

The following figures summarize the results per pollutant.

Figure 3: Total hydrocarbons. Line shows the laboratory Euro 6 limit.

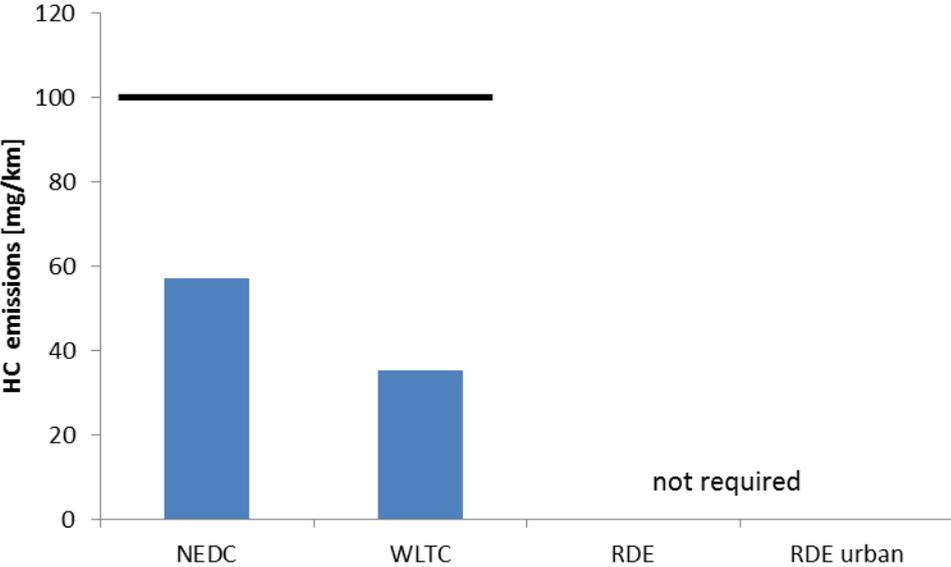


Figure 4: Non-methane hydrocarbons. Line shows the laboratory Euro 6 limit.

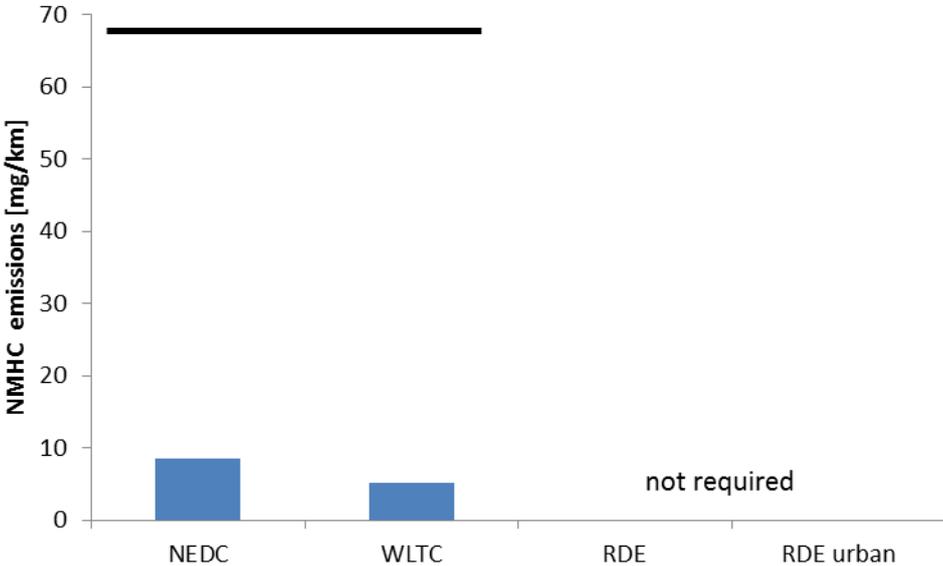


Figure 5: Carbon monoxide emissions. Line shows the laboratory Euro 6 limit.

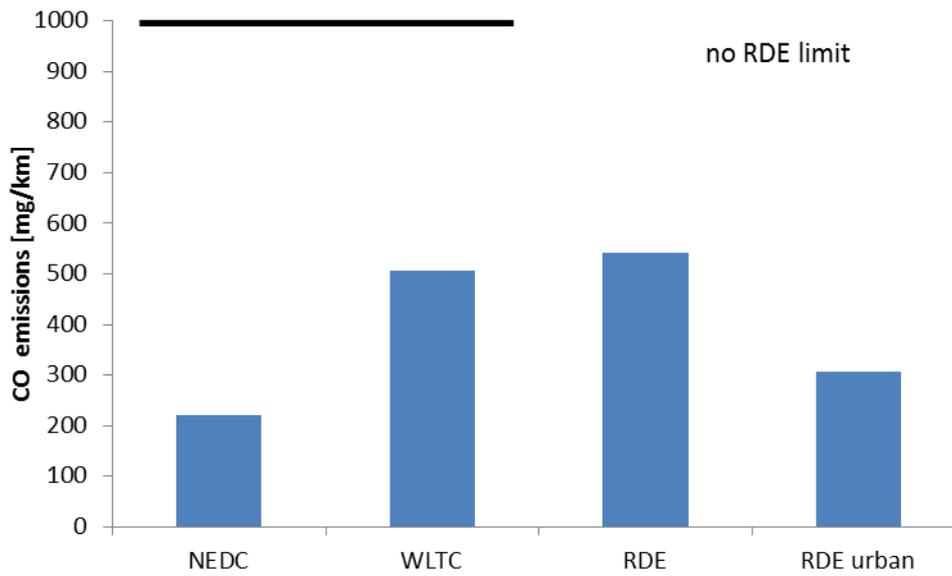
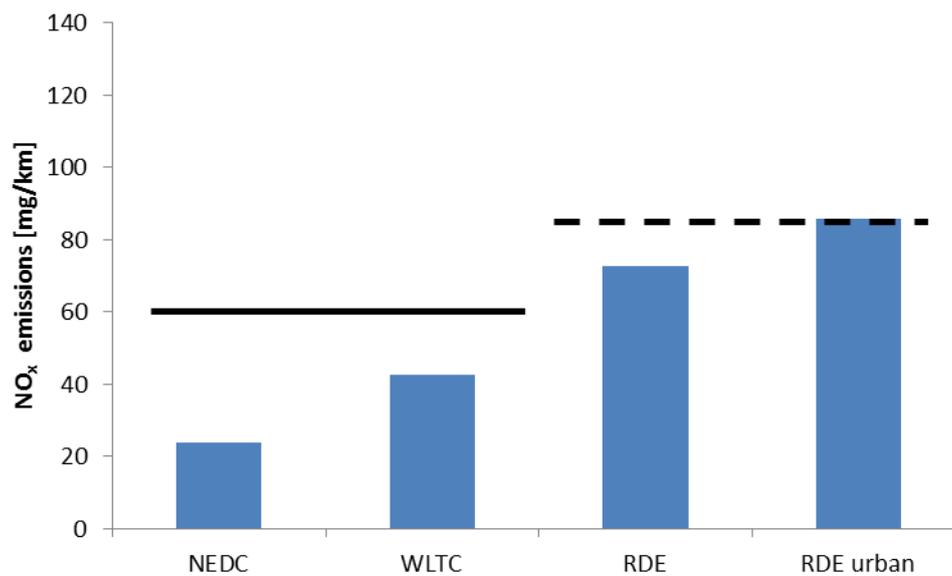
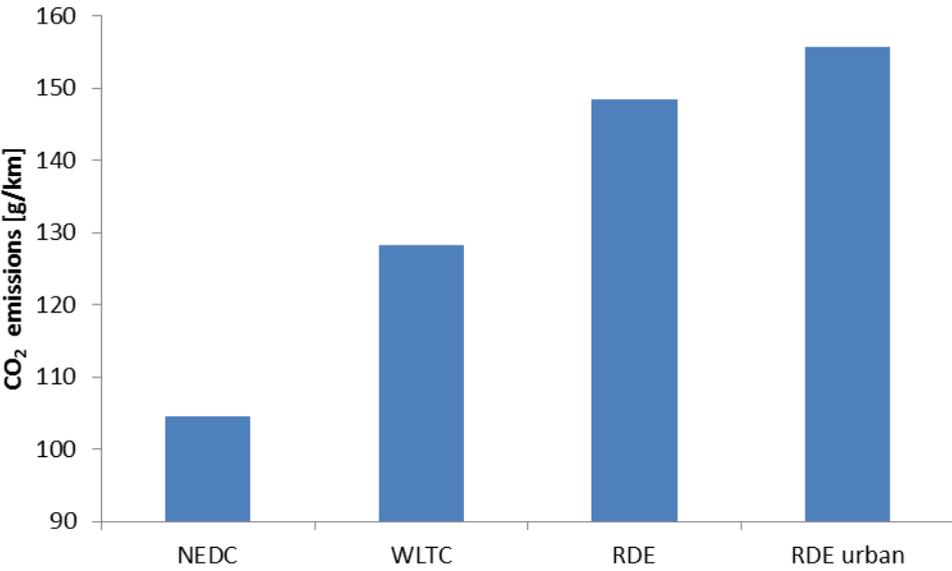


Figure 6: Nitrogen oxides emissions. Line shows the laboratory Euro 6 limit. Dashed line shows RDE limits that are under annual review (CF=1.43 at the time of writing).



**Figure 7: Carbon dioxide emissions.**



## **4 Conclusions and Outlook**

A demo vehicle from Ford was tested in the laboratory and on the road. All pollutants were below the respective emissions limits both in the laboratory and on the road.

According to the vehicle calibration team, due to the limited time and resources, the emission calibration could not be refined as much as a usual production state calibration (which is usually carried out by a considerably larger team of calibrators). Therefore, there is a significant emission reduction potential left in the calibration refinement.

Furthermore, the application of a 2nd underfloor catalyst, as already seen in some RDE gasoline applications, can further reduce the tailpipe emissions.

Therefore, the dedicated CNG engine concept can be evaluated as future emission capable.

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## **List of abbreviations and definitions**

CF	Conformity Factor
CNG	Compressed Natural Gas
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
CVS	Constant Volume Sampler
DI	Direct Injection
EU	European Union
FWD	Forward
HC	Hydrocarbons
JRC	Joint Research Centre
NEDC	New European Driving Cycle
NMHC	Non-methane hydrocarbons
NO <sub>x</sub>	Nitrogen oxides
PEMS	Portable Emissions Measurement System
PM	Particulate Matter
PN	Particle Number
RDE	Real-Driving Emissions
TC	Turbo charged
VELA	Vehicle Emissions Laboratory
WLTC	World Harmonised Light duty vehicle Test Cycle
WP	Work Package

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