FACT SHEET: EUROPE

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

GASOLINE VS. DIESEL

COMPARING CO_2 EMISSION LEVELS OF A MODERN MEDIUM SIZE CAR MODEL UNDER LABORATORY AND ON-ROAD TESTING CONDITIONS

BACKGROUND

In Europe, diesel engines were promoted as a clean and efficient vehicle technology that would play a key role in reducing carbon dioxide (CO_2) emissions in the transport sector. No other region in the world embraced diesel technology like Europe: in 2016, more than 60% of global diesel car sales were in the European Union (EU).

However, in the aftermath of the Dieselgate scandal, there has been a decrease in diesel car resale values and a significant drop in diesel market shares. Registrations of new diesel vehicles in the EU decreased from a peak of 55% in 2011 to 44% in 2017.

The release of a new generation of gasoline engines for Europe's most popular passenger car, the Volkswagen Golf, in late 2017 provided an opportunity to compare modern gasoline and diesel engines side by side, and to determine their respective CO_2 emission levels under laboratory and on-road driving conditions.

METHODOLOGY

Two VW Golfs were selected for testing, one diesel (TDI) and one gasoline (TSI) version. The key characteristics of both vehicles are summarized in Table 1. Both vehicles are rental cars that were type approved according to the Euro 6 emission standard and following the New European Driving Cycle (NEDC) procedure. Both vehicles came to the market prior to the introduction of the Worldwide harmonized Light vehicles Test Procedure (WLTP) and the EU's Real Driving Emissions (RDE) not-to-exceed limits for nitrogen oxide (NO_x).

Table 1. Key characteristics of the two test vehicles.

	 VW Golf TDI (diesel)	 VW Golf TSI (gasoline)
Model year	2016	2018
Emission standard	Euro 6b	Euro 6c
Engine	2.0l TDI Blue Motion Technology, 110 kW	1.5l TSI ACT Blue Motion, 96 kW
Transmission	Dual clutch, 6 gears	Dual clutch, 7 gears
Trim level	Comfortline	Comfortline
Mass of tested vehicle	1,420 kg	1,340 kg
0 – 80 km/h [s]	6.2	6.2
0 – 100 km/h [s]	8.6	9.1
Maximum speed [km/h]	214	210
CO_2 (in NEDC)	117 g/km	113 g/km
List price (in Dec 2017)	29,475 Euro	26,075 Euro

The TDI is of model year 2016, while the TSI is of model year 2018. However, key characteristics and, in particular, the type approval CO_2 emission level did not change significantly between model years 2016 and 2018, thereby allowing for a direct comparison between the two vehicles. Two versions of the new 1.5 liter gasoline engine are offered in the Golf TSI, one with 96 kW engine power and the other with 110 kW. Taking into account that both gasoline versions have virtually identical type approval CO_2 emission levels, we selected the 96 kW version as it offers a broader range of CO_2 reduction technologies which were of interest for this vehicle testing project. Both vehicles were tested under controlled laboratory conditions on a chassis dynamometer, as well as on-road using Portable Emissions Measurements System (PEMS) equipment.

KEY FINDINGS

The key findings of the tests are summarized in Figure 1 and described below.

Testing confirmed the gasoline TSI emitted lower CO_2 levels than the TDI, under laboratory conditions. The official NEDC type-approval CO_2 values are 117 g/km for the Golf TDI and 113 g/km for the Golf TSI. Following the NEDC test procedure, the values measured were 124 g/km (+6%) for the TDI and 109 g/km (-4%) for the TSI. Testing both vehicles according to the conditions of the new WLTP resulted in higher CO_2 emission levels, at 139 g/km for the TDI and 126 g/km for the TSI. As a result, the WLTP vs. NEDC ratio determined was 1.19 for the TDI and 1.12 for the TSI. Lower CO_2 emissions were observed for the TSI in cold and warm started test cycles despite the TSI's rapid catalyst heat-up strategy, which reduces air pollutant levels but at the same time increases fuel consumption and CO_2 emission levels.

During on-road testing, CO_2 levels of the gasoline TSI were found to be lower than of the TDI. Depending on the route composition, CO_2 values ranged from 148 g/km to 163 g/km (26-39% above NEDC type-approval) for the TDI and 140 g/km to 157 g/km (24-39% above NEDC type-approval) for the TSI. Even when taking into account the results of a driving dynamicity analysis, similar or lower CO_2 emissions are expected for the gasoline vehicle under real-world driving conditions.

Consumer experience confirms the gasoline TSI emits similar or lower CO_2 emissions as the diesel TDI. Comparing the real-world test results to consumer self-reported values, the CO_2 levels measured on Routes 1 and 2 are almost exactly in line with the average consumer's experience (-3% to zero deviation for the TDI, +1 to +5% deviation for the TSI). The consumer-reported values confirm the test results, with the gasoline version

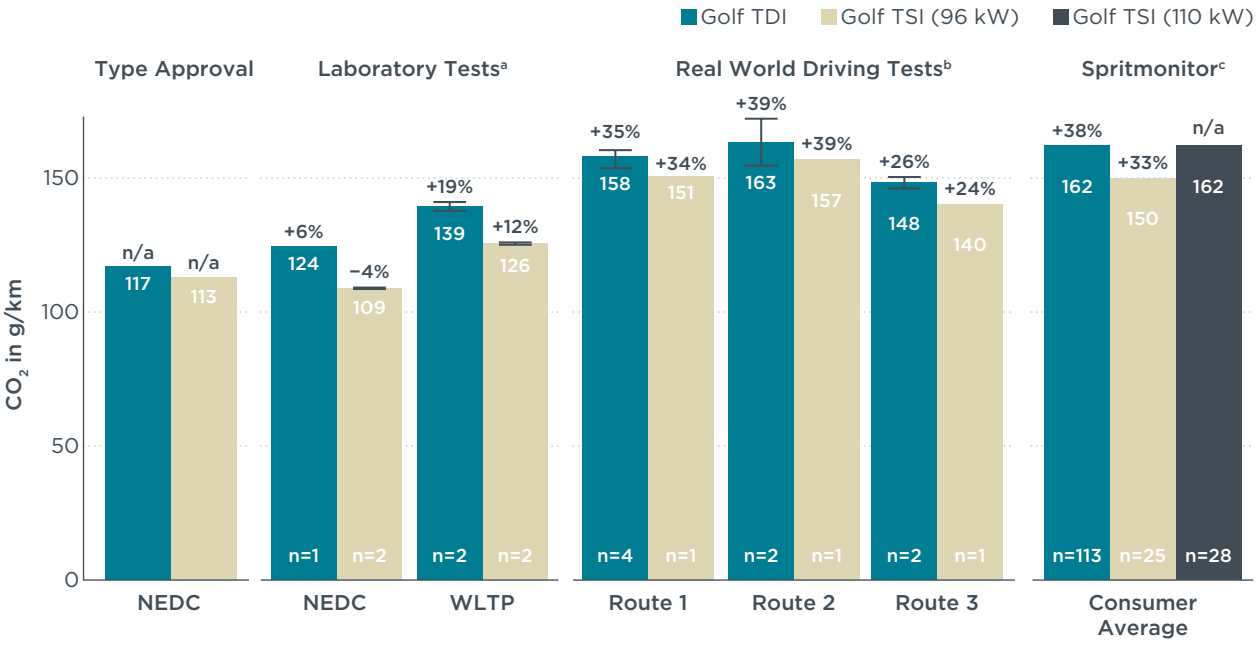

Figure 1: CO_2 levels of the Golf TDI (diesel) and Golf TSI (gasoline). Comparison of test results with declared type approval values (left-hand side) and Spritmonitor consumer reported numbers (right-hand side). The error bars show the minimum to maximum range of results if multiple tests were performed. The number of tests is shown at the bottom of each bar. The ratio of CO_2 emission level vs type approval value is shown above each bar.
[a]The tests shown were performed at 23 °C with cold engine at test start.
[b]The graph shows the real-world CO_2 emissions as measured, not corrected for effects of small differences in driving style or ambient temperature. When taking these effects into account, a similar relationship between the CO_2 levels of gasoline vs. diesel is expected.
[c]The bars reflect the average reported CO_2 emissions for 'n' different vehicles.

emitting less CO_2 than the diesel version of the VW Golf. Even for the 110 kW version of the Golf TSI, which has a higher driving performance than the Golf TDI and deploys less CO_2 saving technologies than the 96 kW gasoline vehicle, reported CO_2 emissions are at the same level as for the diesel version.

POLICY IMPLICATIONS

The results of this vehicle testing project clearly indicate that for the popular lower-medium segment and below, accounting for about 55% of EU market share, a modern gasoline vehicle can have the same or even lower CO_2 emissions than a comparable diesel version. This finding holds true not only for laboratory testing but also for on-road measurements under real-world driving conditions.

Diesel cars tend to have lower volumetric fuel consumption figures than comparable gasoline vehicles. However, the benefit in terms of CO_2 emissions is significantly lower, as the combustion of 1 liter of diesel fuel releases approximately 13% more CO_2 than for the same amount of gasoline fuel. Diesel engines require fuel-intensive NO_x reduction technologies and are heavier than their gasoline counterparts, which further reduces the alleged CO_2 benefit of diesel cars. Diesel cars also typically are equipped with more powerful engines and have a higher real-world CO_2 emissions gap than gasoline cars. Furthermore, Diesel engines are inherently more expensive to manufacture than gasoline engines. In the case of the two tested VW Golf versions, the December 2017 list price of the diesel vehicle was about 3,400 Euro higher than for the gasoline vehicle.

In many European countries, taxes on diesel fuel remain significantly lower than on gasoline. In Germany, for instance, excise duties are about 30% lower for diesel, costing the German government almost seven billion Euros in lost tax revenues per year. Given that modern diesel cars do not offer a notable CO_2 benefit over their gasoline counterparts, and in particular not when compared with hybrid-electric or full-electric vehicles, EU member states should re-assess preferential tax rates for diesel fuel and should join countries such as France, the United Kingdom and Switzerland, where diesel subsidies have already been or currently are being phased out.

FURTHER READING

Gasoline versus diesel: Comparing CO_2 emission levels of a modern medium size car model under laboratory and on-road testing conditions. https://www.theicct.org/publications/gasoline-vs-diesel-comparing-co2-emission-levels

Beyond NO_x: Emissions of unregulated pollutants from a modern gasoline car. https://www.theicct.org/publications/beyond-nox-emissions-unregulated-pollutants

Diesel car sales decline will have negligible impact on attainment of European CO_2 emission standards. https://www.theicct.org/publications/briefing-eu-diesel-sales-decline-impacts-20180318

Road tested: Comparative overview of real-world versus type-approval NO_x and CO_2 emissions from diesel cars in Europe. https://www.theicct.org/road-tested-sep2017

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