

BRIEFING

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Diesel car sales decline will have negligible impact on attainment of European CO₂ emission standards

Diesel engines used to be hailed as the key to meeting carbon dioxide (CO₂) standards for European passenger cars. No other region in the world embraced diesel technology like the European Union: the EU accounted for more than 60% of global diesel car sales in 2016.¹ However, in the aftermath of the Dieselgate scandal, diesel shares are falling in Europe. But the decline in diesel sales does not put EU CO₂ targets out of reach of automakers. In fact, other technologies—efficiency improvements in gasoline engines as well as the rollout of hybrid electric power trains—offer more compelling and cost-effective pathways to reducing CO₂ emissions from European passenger cars.²

BACKGROUND: DECLINING DIESEL SALES

The share of diesel vehicles among new car registrations in the EU decreased from a peak of 55% in 2011 to 49% in 2016.³ EU-wide statistics for 2017 were not available at the time of writing, but recent data indicate that diesel shares continued to fall in 2017 and early 2018. Figure 1 plots diesel shares of new car registrations in France, Germany, Italy, Spain, and the United Kingdom from January 2012 to December 2017. These five countries accounted for three-quarters of 2016 new car sales and are the largest diesel markets in the EU. In total, the diesel share fell from 56% in 2012 to 45% of passenger car sales in the five markets. In 2017 alone, the diesel share declined by 5 percentage points or more in all markets but Italy.

1 *European Vehicle Market Statistics—Pocketbook 2017/2018* (The International Council on Clean Transportation, 2017), <https://www.theicct.org/publications/european-vehicle-market-statistics-20172018>.

2 This briefing is adapted from another on the same topic published in German; see Peter Mock, “Diesel-Pkw: Rückgang des Marktanteils bleibt ohne negative Folgen für Klimaschutzziele” (International Council on Clean Transportation, 2018), <https://www.theicct.org/publications/diesel-pkw-rueckgang-des-marktanteils-20180130>.

3 *European Vehicle Market Statistics—Pocketbook 2017/2018*.

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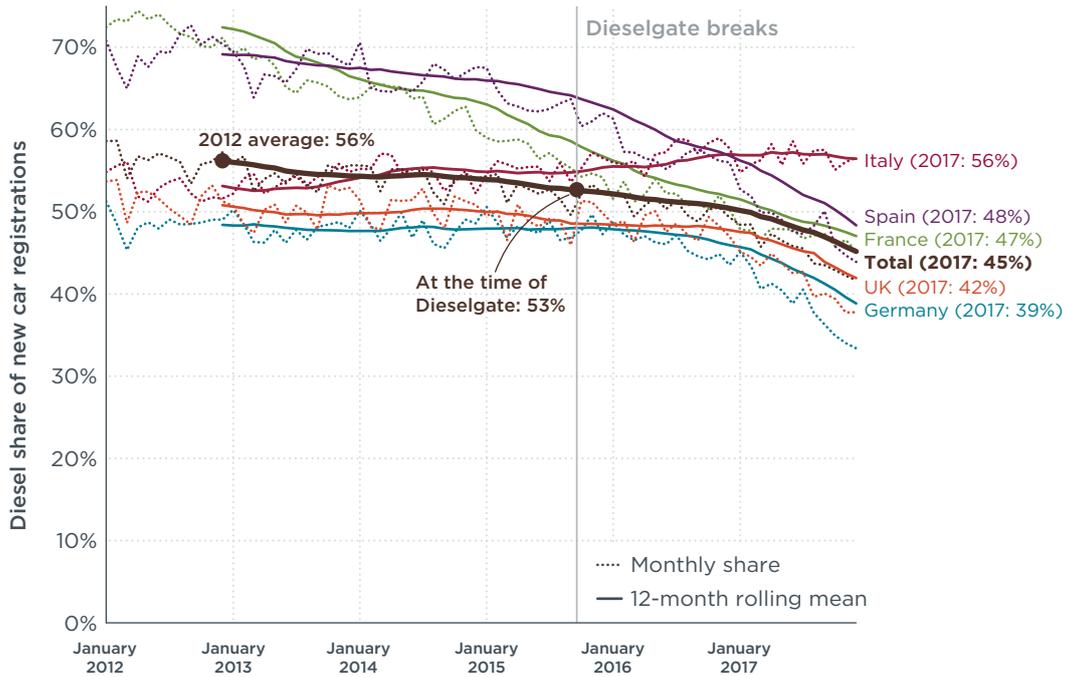


Figure 1. Monthly diesel shares of new car registrations in France, Germany, Italy, Spain, and the UK. Rolling means were added to smooth out monthly and seasonal variations.⁴

CO₂ EMISSIONS FROM GASOLINE AND DIESEL CARS

Diesel vehicles generally consume less fuel than comparable gasoline vehicles, but CO₂ emissions from diesel engines are not lower in the same proportion, for various reasons. The combustion of 1 liter of diesel fuel produces approximately 11% more energy than gasoline fuel, but the diesel fuel also releases approximately 11% more CO₂ due to its higher carbon content.⁵ As a result, fuel consumption figures are lower for diesel vehicles than for gasoline vehicles, but CO₂ emissions of the two fuels are comparable per unit of energy.

On top of the higher energy density of diesel fuel, diesel engines historically possessed a number of efficiency advantages over gasoline engines. But gasoline engines are gaining ground against diesel engines thanks to a suite of efficiency technologies, such as direct injection, turbocharging and downsizing, cooled EGR, and variable valve timing. Additional advances in gasoline-vehicle design, such as variable compression-ratio engines, will further erode the efficiency advantages of diesel.

Table 1 compares gasoline and diesel versions of the latest VW Golf, all with 110 kilowatt (kW) engines. The gasoline version has comparable CO₂ emission values—within ±5 grams per kilometer (g/km) of the diesel version—and costs €3,400 less.

4 Uwe Tietge, “2017 Year in Review: European Diesel down, Electric Vehicles on the Rise,” The International Council on Clean Transportation, January 24, 2018, <https://www.theicct.org/blog/staff/2017-year-review-european-diesel-down-electric-vehicles-rise>.

5 Robert Edwards et al., “Well-to-Wheels Analysis of Future Automotive Fuels and Powertrains in the European Context” (Joint Research Centre of the European Commission, 2014), https://iet.jrc.ec.europa.eu/about-jec/sites/iet.jrc.ec.europa.eu/about-jec/files/documents/wtw_report_v4a_march_2014_final_333_rev_140408.pdf.

Table 1. Comparison of select VW Golf model versions with Comfortline trim level. CO₂ values based on New European Driving Cycle. (Source: VW price list for Germany, model year 2018, accessed on December 27, 2017)

Model version	Fuel type	Transmission	Engine power (kW)	CO ₂ (g/km)	Price (euros)
VW Golf TDI	Diesel	Manual 6-gear transmission	110	109 to 111	27,450
VW Golf TSI ACT	Gasoline	Manual 6-gear transmission	110	114 to 116	24,050
Difference between diesel and gasoline version			0	-5	+3,400
VW Golf TDI	Diesel	7-gear dual-clutch transmission	110	111 to 117	29,475
VW Golf TSI ACT	Gasoline	7-gear dual-clutch transmission	110	112 to 114	26,075
Difference between diesel and gasoline version			0	-1 to +3	+3,400

While this one model may not be representative of the entire market, it clearly shows that gasoline vehicle can be as efficient as diesel vehicles and deliver comparable performance at a lower retail price.

On average, diesel vehicles registered in 2016 emitted 15% less CO₂ than a conventional gasoline vehicle in the same market segment. Across all segments, however, new diesel vehicles emit only 5% less CO₂ than gasoline vehicles, because diesel engines are primarily used in heavier, more powerful vehicles.

The discrepancy between CO₂ emissions in real-world operation and official CO₂ values obtained in type-approval testing is higher for diesel vehicles than gasoline vehicles.⁶ The real-world gap further erodes the CO₂ benefits of diesel vehicles, leaving them with a 2% advantage compared to gasoline vehicles in terms of on-road CO₂ emissions.

DIESEL TECHNOLOGY COSTS AND FUEL TAXES

Diesel engines are inherently more expensive to manufacture than gasoline engines because they have to withstand higher combustion pressures and require more advanced fuel injection systems. In addition to higher engine manufacturing costs, diesel vehicles require increasingly complex exhaust aftertreatment systems to reduce particulate and nitrogen oxide emissions. Compared with gasoline vehicles, additional manufacturing costs for diesel vehicles compliant with 2025 U.S. emission standards range from \$500 to \$1,300 for diesel engines and amount to approximately \$500 for exhaust aftertreatment systems.⁷ In the EU, additional manufacturing costs for exhaust aftertreatment systems were estimated at approximately €300–€500.⁸ As EU emission standards become more stringent and test procedures become more comprehensive, diesel technology will struggle to remain cost competitive in passenger cars.

Despite higher vehicle prices, approximately half of new cars in the EU are equipped with diesel engines, in large part thanks to lower fuel taxes on diesel than on gasoline in all but two EU member states.⁹ In Germany, for instance, excise duties are almost 30% lower for diesel than for gasoline, costing the German government almost €8 billion

6 Uwe Tietge et al., "From Laboratory to Road: A 2017 Update of Official and 'Real-World' Fuel Consumption and CO₂ Values for Passenger Cars in Europe" (The International Council on Clean Transportation, November 5, 2017), <http://theicct.org/publications/laboratory-road-2017-update>.

7 Aaron Isenstadt and John German, "Diesel Technology Developments" (International Council on Clean Transportation, 2017), <https://www.theicct.org/publications/diesel-technology-developments>.

8 David Blanco-Rodriguez, "2025 Passenger Car and Light Commercial Vehicle Powertrain Technology Analysis" (International Council on Clean Transportation, 2015), <https://www.theicct.org/publications/2025-passenger-car-and-light-commercial-vehicle-powertrain-technology-analysis>.

9 European Environment Agency, "Transport Fuel Prices and Taxes," Indicator Assessment, December 1, 2017, <https://www.eea.europa.eu/data-and-maps/indicators/fuel-prices-and-taxes/assessment-7>.

in lost tax revenues.¹⁰ Lower excise duties on diesel fuel is the primary factor driving demand for diesel cars, particularly in segments that typically see high annual vehicle mileage.

Voices calling for an end to preferential tax rates for diesel fuel are growing louder across Europe. The German Federal Environment Agency called for a gradual alignment of diesel and gasoline taxes by 2025.¹¹ Even automotive executives are questioning diesel subsidies.¹² France is already in the process of leveling taxes on diesel and gasoline fuel by 2021.

In addition to growing compliance costs and fuel taxes, cities threaten the viability of diesel technology by banning older diesel vehicles to improve air quality. Existing and proposed access restrictions directly curb demand for diesel vehicles in cities, but they also reduce market-wide resale values of diesel cars.¹³ By banning diesel cars, European cities lessen the value and appeal of buying and owning them.

THE FUTURE OF DIESEL AND COMPETING TECHNOLOGIES

To achieve compliance with the EU CO₂ standards, manufacturers can turn to a wide range of cost-effective alternatives to diesel, from improved gasoline engines to conventional hybrids to plug-in electric vehicles. Coming improvements to conventional gasoline engines will narrow the CO₂/km advantage of diesel engines and, due to the lower costs of gasoline engines and aftertreatment systems, gasoline cars will be able to add additional technology to match the CO₂/km of diesels and still cost less.

In addition, vehicle manufacturers increasingly use electric motors to complement conventional combustion engines in cars. Hybrid electric vehicles can provide efficiency gains over diesel power trains at lower CO₂ abatement costs. For instance, hybrid electric vehicles and diesel cars in the small (e.g., Renault Clio) and lower medium (e.g., VW Golf) market segments are, on average, similarly priced ($\pm 1\%$), but hybrid electric vehicles have approximately 20% lower CO₂ emissions.¹⁴ The cost advantage of hybrid electric vehicles is expected to grow as battery prices decline and diesel engines require increasingly complex exhaust aftertreatment technology. In contrast to diesel engines, hybrid electric vehicles also function as a logical stepping-stone toward fully electric power trains, which will ultimately be required to decarbonize road transportation.

More advanced electric vehicles (EVs)—plug-in hybrid electric vehicles and battery electric vehicles—have zero or low tailpipe CO₂ emissions and are gaining traction in the European market. EV sales increased by one-third in four large EU markets during 2017 and their sales are expected to continue growing.¹⁵ The very low CO₂ emissions of EVs can make them a lower-cost solution to help meet the CO₂ standards.

In summary, while demand for diesel passenger cars in Europe is waning, there are numerous lower-cost pathways to meet the EU CO₂ targets. This conclusion echoes the

10 German Federal Environment Agency, “Umweltschädliche Subventionen im Verkehrssektor auf Rekordniveau,” Text, Umweltbundesamt, October 12, 2016, <http://www.umweltbundesamt.de/presse/pressemittelungen/umweltschaedliche-subventionen-im-verkehrssektor>.

11 German Federal Environment Agency, “Umweltschädliche Subventionen im Verkehrssektor auf Rekordniveau.”

12 Sven Afhüppe and Stefan Menzel, “VW Boss Does a U-Turn on Diesel,” *Handelsblatt*, global edition, December 11, 2017, <https://global.handelsblatt.com/mobility/vw-boss-does-a-u-turn-on-diesel-matthias-mueller-muller-volkswagen-dieselgate-electric-cars-863483>.

13 Tietge, “2017 Year in Review: European Diesel down, Electric Vehicles on the Rise.”

14 *European Vehicle Market Statistics—Pocketbook 2017/2018*.

15 Tietge, “2017 Year in Review: European Diesel down, Electric Vehicles on the Rise.”

European Commission's findings.¹⁶ Our projections indicate that a decline in diesel shares down to 15% in 2025 would not interfere with meeting EU CO₂ standards and would actually decrease costs of meeting CO₂ standards.¹⁷

In light of these conclusions, preferential tax rates for diesel fuel resemble a high-stakes bet on a technology that is less cost-effective, less future-proof, and more polluting than competing power trains. Some member states have recognized that lower taxes on diesel fuel are unwarranted. The UK, for instance, already levies the same tax on gasoline and diesel fuel. Taxing fuels based on their energy and carbon content would avoid special treatment of diesel fuel and send a clear signal about the scarcity and climate impact of fossil fuels. EU member states would benefit from considering such best practices instead of propping up diesel technology with preferential fuel taxes.

16 European Commission, "Impact Assessment Accompanying the Document Proposal for a Regulation of the European Parliament and of the Council Setting Emission Performance Standards for New Passenger Cars and for New Light Commercial Vehicles as Part of the Union's Integrated Approach to Reduce CO₂ Emissions from Light-duty Vehicles and Amending Regulation (EC) No 715/2007 — Part 1/2" (Brussels: European Commission, November 8, 2017), https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/swd_2017_650_p1_en.pdf.

17 Sonsoles Díaz et al., "Shifting Gears: The Effects of a Future Decline in Diesel Market Share on Tailpipe CO₂ and NO_x Emissions in Europe" (International Council on Clean Transportation, 2017), <http://www.theicct.org/effects-of-future-EU-diesel-mkt-share-decline>.