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Emissions testing for cars and environmental regulations

Key points

- Despite the tightening of requirements for the regulatory approval of new vehicles, air quality remains a problem in many cities.
- The information provided by existing tests did not capture real-world driving conditions, thus undermining the effective enforcement of standards and weakening incentives for innovation to reduce car emissions.
- Quick implementation of the new Worldwide Harmonized Light Vehicle Test Procedure would contribute to more robust action against emissions and encourage innovation.

Summary

Car emissions, including carbon dioxide and a number of pollutants, have negative consequences for climate change and health. Regulatory standards for the approval of new vehicles have become increasingly tighter. However, air quality remains a problem in many cities. Long-term exposure to nitrogen dioxide is estimated to result in 75,000 premature deaths in 40 European countries. There is a clear discrepancy between expected emission values on the basis of the tests carried out for regulatory approval and different studies aiming to better capture real-world driving conditions. The discrepancy is particularly large for emissions of nitrogen dioxides by diesel cars. On-road emissions from diesel passenger cars exceed Euro 3 standards by up to 350 per cent and Euro 6 standards by up to 125 per cent. Diesel cars are particularly important in Europe, where they have been promoted to support climate mitigation policies as they emit less CO_2 than petrol-fuelled cars. UNECE has developed a Worldwide Harmonized Light Vehicle Test Procedure (WLTP) that addresses some of the shortcomings of existing tests. Quick implementation of the WLTP would contribute to increasing consumer trust in test procedures and enhancing incentives for innovation to reduce emissions.

Climate and health

Cars are a significant source of carbon dioxide, which is the main greenhouse gas. In the European Union, for example, they account for around 12 per cent of total CO_2 emissions[i]. Reducing these emissions is therefore an important goal in climate policies. Higher fuel efficiency has been seen as way to diminish the contribution of vehicles to climate change. Cars also generate a number of pollutants that are harmful for health, including NO_x (a collective term including nitrogen oxide and nitrogen dioxide) and fine particulate matter ($PM_{2.5}$). Car emissions also lead to the formation of ground level ozone. Black carbon is a component of fine particulate matter that is formed by the incomplete combustion of fossil fuels. It has also strong light absorbing properties, thus contributing to climate change as well.

The impact of air pollution on health and the associated costs in terms of loss of life and illness has been increasingly recognized as a major policy challenge. Against this background, environmental regulations determining acceptable levels of emissions by cars of CO_2 and different pollutants have become increasingly tighter. However, despite the introduction of stricter standards, reducing the maximum authorized levels of emissions for new vehicles in given test cycles, target values for key pollutants are exceeded under real world driving conditions in many countries of the UNECE region and beyond.

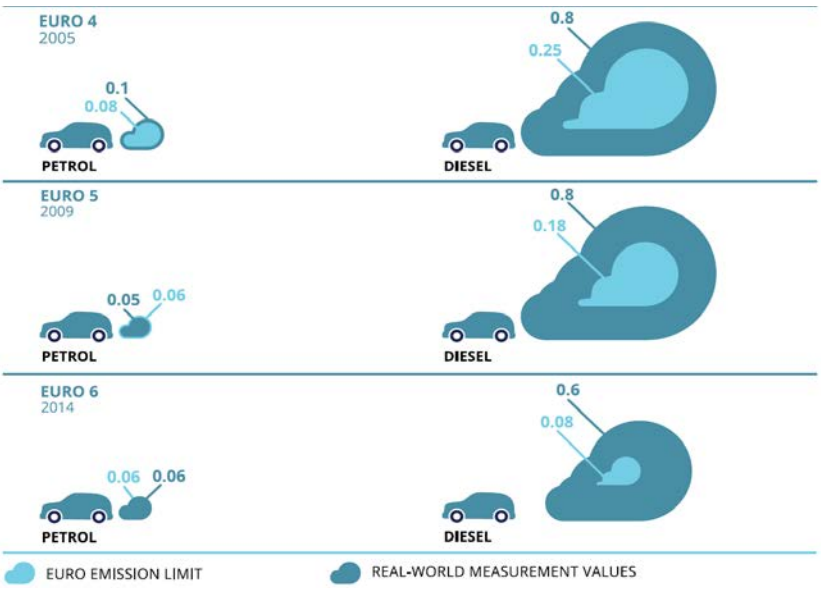
While other pollutants come from a variety of sources, the transport sector is the main driver for NO_x emissions in Europe, accounting for 46 per cent of the total in the EU in 2013. Around 80 per cent of the NO_x from vehicles comes from diesel powered vehicles. Insufficient progress in reducing nitrogen oxides from road transport has been one of the factors undermining the observance of air quality standards in many urban areas. The EEA estimated that the impact of long term exposure to NO_2 in 40 European countries resulted in 75,000 premature deaths. The health gain from compliance with NO_2 air concentration limit value of 40 µg/m3 at all locations would be equivalent to 205 000 life years, taking 2012 as the reference year.

Tests limitations

In order to determine compliance with environmental regulations, it is necessary to perform appropriate tests. In the last decades, vehicles have been tested in controlled laboratory environments to establish official emissions values according to pre-established driving cycles. However, there has been mounting evidence of the divergence between real life emissions and what could be expected according to these laboratory tests.

This unsatisfactory situation has partly been linked to the shortcomings of the standardized tests used for type approval (the New European Driving Cycle adopted in most countries in the world, as well as other tests such as the FTP 75 in the United States or the JS-08) and the in-service conformity testing. The Volkswagen scandal has increased awareness and created a sense of urgency regarding the need to have appropriate tests that ensure that environmental regulations are effectively enforced and consumer confidence restored.

Figure 1. Comparison of NO_x emissions and standards for different Euro classes



Note: Nitrogen dioxide emissions in g/km
Source: European Environmental Agency (2016), Explaining road transport emissions. A non-technical guide.

Existing procedures failed on different accounts when trying to determine real emissions [ii]. Tests were not representative of real-world driving patterns and modern engine loads. Some technologies for fuel-saving and emission reduction are more efficient under laboratory conditions. In addition, there were a number of flexibilities allowed by legislation to manufacturers which were used to optimise testing conditions. Auxiliary devices, such as air conditioning, were not considered in the tests for approval.

The gap between the results derived in laboratory tests and real-driving conditions is far from new. Comparisons of fuel economy tests noticed that fuel use was understated by 15-25 per cent more than two decades ago[iii]. This implies that emissions of carbon dioxide were also underestimated.

According to the International Council on Clean Transportation (ICCT)[iv], the gap between CO_2 emissions in test approvals and in real conditions has been increasing, reaching 38 per cent in 2014, up from 8 per cent in 2001. Official emission approval values for CO_2 emissions decreased by 27 per cent since 2001 in the EU, but this does not provide an accurate picture, given the inability of existing tests to identify real emissions.

The European Environmental Agency has also pointed out that the increased divergence between official carbon dioxide emissions, as measured by laboratory-based official tests, and real fuel consumption has been a major concern undermining policies to reduce the environmental impact of transport by establishing increasingly stringent targets for average emissions. The discrepancy between laboratory tests and real-world values was initially the same for both diesel and petrol cars but since 2010 the gap was higher for diesel vehicles, being around 5 per cent greater than for petrol vehicles[v].

Why diesel cars matter

Passenger cars remain an important – but not the only- source of pollution in cities, with significant negative health consequences. For example, a recent study[vi] of London estimated that the health impact of $PM_{2.5}$ and NO_x was equivalent to 3,537-9,416 deaths in 2010, depending on the range of effects considered. The estimated economic costs, including also hospital admissions, totalled £1.4-3.7 billion (0.1-0-2 per cent of overall United Kingdom GDP).

Emissions in real-life conditions are higher than those measured during the tests but problems seem to concentrate on emissions of nitrogen oxides by diesel vehicles[vii]. This is a critical issue for Europe, as more than half of the passenger fleet is diesel powered. By contrast, in the United States only 1.5 per cent of all light duty vehicles on the

UNECE work

UNECE services the World Forum for Harmonization of Vehicle Regulations (WP.29), which provides a unique framework for globally harmonized vehicles regulations.

The Working Party on Pollution and Energy is a subsidiary body that prepares regulatory proposals on pollution and energy efficiency to WP.29. Its work includes technical provisions for pollutant emissions standards and measurement emissions.

UNECE hosts the Convention on Long-range Transboundary Air Pollution, which has been extended by eight protocols that identify specific measures to cut emissions of air pollutants, including nitrogen oxides. The Gothenburg Protocol is the first binding agreement to include emission reduction commitments for fine particulate matter, including black carbon.

road in 2014 ran on diesel[viii]. Diesel cars are more efficient that petrol engines. This higher efficiency and therefore lower fuel consumption was seen as a way to reduce carbon emissions.

The first comprehensive test[ix] of emissions of road vehicles using Portable Emission Measurement Systems (PEMS) found that emissions of nitrogen oxides by petrol vehicles as well as hydrocarbon emissions of both diesel and petrol vehicles were in general below emission limits. By contrast, nitrogen oxides emissions of diesel vehicles exceed emission limits by 90-320 per cent. In addition, on-road carbon dioxide emissions also exceeded emission levels by 9-21 per cent (median values).

The analysis contained in the impact assessment[x] of the EU Clean Air Policy Package established that diesel emissions have been driving NO_x compliance problems. Countries' challenges to comply with emission targets for NO_x under protocols of the UNECE Convention on Long-range Transboundary Air Pollution have also been documented. The lack of progress, in particular regarding light-duty vehicles, is in contrast with the advances in reducing vehicle emissions of other regulated pollutants. Between 1993 and 2009, emission limit values of NO_x for diesel passenger cars were tightened by a factor of four but the estimated average emissions under real driving condition only slightly increased. Other studies have pointed in a similar direction. For example, the EU Joint Research Centre[xi] found that the on-road NO_x emissions of diesel vehicles exceeded Euro 3 standards by up to 350 and Euro 6 standards by up to 125 per cent.

The ICCT carried out a comprehensive study[xii] of the road performance of diesel cars in Europe and the US using portable emissions measurement systems (PEMS). This study led to the uncovering of the of the Volkswagen scandal. Average on-road emission levels were estimated at 7 times the certified emission limit for Euro 6 vehicles. However, the study also found large differences across cars, which confirmed the availability of technologies that can meet these standards. More stringent emissions standards under Euro 6 can be a solution to address existing problems if they are complemented by effective emission tests for light vehicles.

While nitrogen oxides are a key problem, concerns also extend to other pollutants. Hydrocarbons, as nitrogen oxides, are key precursors of ozone and particulate matter. A study[xiii] of emissions of diesel hydrocarbons in the UK and the US showed that regulatory inventories of diesel related hydrocarbons underestimate actual levels in urban areas by 4-9 times, depending on the type of hydrocarbon.

The economics of diesel

Diesel has been promoted because diesel vehicles are more efficient than petrol vehicles. Hence less fuel is necessary to travel a given distance, which means less CO_2 emissions. But this is a benefit that is captured by the owners of the vehicles, which may encourage buying larger vehicles or travelling more, thus offsetting the impact of higher fuel efficiency[xiv].

In addition, diesel is taxed in many countries at rates lower than gasoline. Taking into account the higher energy and carbon content of diesel, taxation is lighter in practically all OECD countries per unit of carbon – the notable exception being the United States. Fuel taxation affects patterns of use for the whole fleet, including older vehicles that do not meet the latest emission standards. Fuel prices in the United States are much lower than in Europe for both diesel and gasoline, thus encouraging higher fuel consumption. On a relative basis, which is what matters for purchase decisions, diesel is cheaper than petrol in Europe as a result of lower tax rates. This, together with the higher performance of these vehicles, has contributed to the growing share of diesel vehicles in the passenger fleet in in the European Union. The gap between diesel and petrol prices has been slowly narrowing but diesel is still around 30 per cent cheaper than petrol per unit of energy or ton of CO_2[xv]. In addition, diesel cars often benefit from lower registration and road taxes in many countries in Europe, which are increasingly CO_2-based.

Moreover, encouraging its use through lower taxation and therefore lower fuel prices increases demand. This impact has been highlighted by a number of studies[xvi] that relate the intensity of car use to the cost of fuel. Lower costs per distance leads to a "rebound effect", which may require complementary demand management policies to mitigate the impact of lower prices on demand.

The difference in CO_2 emissions per kilometre between diesel and petrol new cars has shrunk from 17 g CO_2/km in 2004 to only 2.5 g CO_2/km in 2014. This has been the result of the increased weight and size of diesel cars, thus reducing the fuel economy benefits of diesel cars[xvii]. It would seem that the cost advantage of diesel has been used to some extent to purchase larger models.

The benefits of diesel cars in climate change mitigation may have been overrated as diesel vehicles prior to Euro 5 perform worse than petrol cars regarding black carbon. In older models, subject to less stringent standards in Europe on particulate matter emissions, the relative advantage of diesel cars regarding climate change mitigation may have been inexistent[xviii]. Overall, experience shows that a taxation strategy to enhance fuel efficiency that focuses too narrowly on CO_2

emissions may hamper efforts to reduce air pollution.

New tests

The persistent discrepancy between expected results on the basis of emission limits checked through laboratory tests and real outcomes, as determined in a variety of studies, has stressed the need for new test procedures that appropriately represent the existing situation. The inaccurate picture that results from the shortcomings of existing tests does not offer a solid basis for policy decisions.

A new Worldwide Harmonized Light Vehicle Test Procedure[xix] has been developed under the World Forum for Harmonization of Vehicle Regulations (WP.29) of UNECE through the Working Party on Pollution and Energy (GRPE). The aim of this project was to develop a test-cycle that would represent more faithfully driving characteristics around the world and would provide the basis for the worldwide harmonization of type tests. The ICCT has estimated[xx] the impact of switching from the existing New European Driving Cycle (NEDC) to WLTP for a 2020 vehicle fleet, which would result in an increase of 5.7-7.7 per cent on measured CO_2 emissions, depending on the temperature at which the test is performed.

Complementing this initiative, EU Member States agreed that as of September 2017, the new Real Driving Emissions - Light Duty Vehicles Test (RDE) will be used to approve new car models. However, a gradual, two-phase transition period will be introduced to facilitate the adaptation of car manufactures to the new conditions. This is done through the application of conformity factors, which increase the emission limits by a multiple. Compliance with standards will be gradually phased in, so until 2020 new diesel cars will be still allowed emissions 2.1 times the current standards[xxi].

Given the need to increase consumer confidence in existing tests and to create better conditions for the effective enforcement of environmental regulations, there is a strong rationale for quick implementation of the WLTP test. The implementation of these internationally harmonized testing procedures would benefit consumers, the car industry and policymakers by increasing trust and transparency.

Regulations and innovation

There is ample evidence that environmental regulations encourage innovation, both at the sector and the firm level[xxii], in particular when the country is a regulatory leader. The absence of tests that allowed obtaining a truthful picture of emissions has had negative implications for the pace of environmental innovations.

The lack of effective enforcement of environmental standards distorted incentives and did not encourage sufficiently the development of non-polluting alternatives. While less polluting diesel technologies existed, some manufacturers chose not to face the extra costs required to deploy them in the absence of more stringent tests procedures. The new tests will demand stronger research efforts, as manufacturers adjust to meet de facto stricter standards while keeping costs down.

The more demanding WLTP test will solve part of the problem, but real life testing would be a more robust approach to capture the wide range of operation each vehicle is faced with, for both local pollutants and greenhouse gas emissions.

The debates regarding diesel are a powerful reminder of the complexity of policymaking and the need to consider multiple dimensions. An integrated policy assessment of costs and benefits is required to craft policy packages that often include regulatory initiatives, effective enforcement and market-based mechanisms. While diesel appeared to make a contribution to climate change mitigation through fuel efficiency, it had negative implications for air pollution which were not properly addressed because of the existence of weak incentives. On the other hand, the relative advantage of diesel cars on CO_2 emissions has been eroded through time, as petrol engines have become more efficient.

REFERENCES

[i] http://ec.europa.eu/clima/policies/transport/vehicles/cars/index_en.htm
[ii] European Environmental Agency (2016), Explaining road transport emissions. A non-technical guide.
[iii] Shichpper, L. and Tax, W. (1994), New car tests and actual fuel economy: Yet another gap? Transport Policy, Vol 1, No. 4.
[iv] Tietge, U. et al (2015), From laboratory to the road: A 2015 update, The International Council on Clean Transportation.
[v] European Environment Agency (2015), Evaluating 15 years of transport and environmental policy integration — TERM 2015: Transport indicators tracking progress towards environmental targets in Europe.
[vi] Walton, H. et al (2015), Understanding the Health Impacts of Air Pollution in London, Transport for London and the Greater London Authority.
[vii] Weiss, M. et al (2011), On-road emissions of light-duty vehicles in Europe, Environmental Science Technologies, Vol 45, No.19
[viii] Chambers, M. and Schmitt, R. (2015), Diesel Powered Passenger Cars and Light Trucks, Factsheet, Bureau of Transportation Statistics, US Department of Transport.
[ix] Weiss, M. et al (2011), On-road emissions of light-duty vehicles in Europe, Environmental Science Technologies, Vol 45, No.19
[x] European Commission (2013), The Clean Air Policy Package. Impact assessment. Commission Staff Working Document, SWD(2013)531.
[xi] Weiss, M. et al (2013), A complimentary emissions test for light-duty vehicles: Assessing the technical feasibility of candidate procedures, JRC Scientific and Policy Reports.
[xii] Franco, V. (2014), Real-world exhaust emissions from modern diesel cars. A meta-analysis of PEMS emission data from EU (Euro 6) and US (tier 2 BIN/Ulev II) diesel passenger car. Part 1: aggregated results, White Paper, The International Council on Clean Transportation.
[xiii]Dunmore,R. et al (2015), Diesel-related hydrocarbons can dominate gas phase reactive carbon in megacities, Atmospheric Chemistry and Physics, Vol. 15.
[xiv] Harding, M. (2014), "The Diesel Differential: Differences in the Tax Treatment of Gasoline and Diesel for Road Use", OECD Taxation Working Papers, No. 21 OECD Publishing.
[xv] Transport and Environment (2015), Europe's tax deals for diesel, October.
[xvi] A. Marques, J. Fuinhas and B. Gonçalves, "Dieselization and Road Transport CO2 Emissions: Evidence from Europe," Low Carbon Economy, Vol. 3 No. 3, 2012, pp. 54-62
[xvii] European Environment Agency (2015), Evaluating 15 years of transport and environmental policy integration — TERM 2015: Transport indicators tracking progress towards environmental targets in Europe.
[xviii] Cames, M. and Helmers, E. (2013), Critical evaluation of the European diesel car boom – global comparison, environmental effects and various national strategies, Environmental Sciences Europe, Vol. 25, No. 15.
[xix] UNECE(2013), Development of a worldwide harmonized light duty driving test cycle. Technical report, UN/ECE/WP.29/GRPE/WLTP-IG.
[xx] Mock, P. et al. (2014), The WLTP : How a new test procedure for cars will affect fuel consumption values in the EU, Working Paper No. 9, The International Council on Clean Transportation.
[xxi] European Commission Press Release, Commission welcomes Member States' agreement on robust testing of air pollution emissions by cars, Brussels 28 October 2015. Available http://europa.eu/rapid/press-release_IP-15-5945_en.htm
[xxii] Dechezleprêtre A. and Sato, M. (2014), The impact on environmental regulations on competitiveness, Policy Brief, Grantham Research Institute on Climate Change and the Environment, Global Green Growth Institute.

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