

3 April 2013

Reducing exhaust emissions of nitrogen oxides (and particles) from diesel vehicles

1. Summary

The UK is failing to meet legally binding, health based standards ('limit values') for nitrogen dioxide (NO₂) that were agreed by all Member States at the European Union (EU) level and introduced into legislation in 1999. These standards were required to be met by 2010 across the whole of the UK (and Europe) but they are still regularly exceeded in many UK towns and cities. London has the highest levels of NO₂ of any capital city in Europe.

In submissions to the European Commission, the Government admitted it does not expect to comply with NO₂ limit values across the UK until 2025. This means that hundreds of thousands of people in the UK will spend up to 15 years breathing air that fails to meet minimum health and legal standards. It also brings a threat of legal enforcement action by the European Commission and/or UK Courts.

These standards are important for the protection of public health. A report titled 'Something in the Air: The forgotten crisis of Britain's poor air quality' by Policy Exchange dated 19 July 2012 found that diesel vehicles were responsible for 91% of dangerous airborne particles (PM_{2.5}) and 95% of NO₂ exhaust emissions in Londonⁱ. 'Emissions' come from tailpipes whereas 'concentrations' are measured in ambient or outdoor air to assess compliance with legal and health standards. Other vehicle emissions arise from tyre and brakewear. In June 2012, the World Health Organisation classified diesel exhaust as carcinogenic for humansⁱⁱ.

The Government has argued that it has not been able to meet the NO₂ standards due largely to the alleged failure of European vehicle emission standards ('Euro standards') to reduce emissions of oxides of nitrogen (NO_x comprising nitrogen monoxide (NO) and NO₂) from road vehicles. Euro standards for new cars were agreed by all Member States at the EU level before entering into force in 1992 and being progressively tightened to the present 'Euro 5' phase.

Recent research has shown real world NO_x emissions for later Euro standards performing less well than earlier standards for NO_x. The Euro 4 standard however for diesel vehicles seems to have reduced NO_x over earlier (and perhaps later) standards but not NO₂ emissions. The main reasons though behind the UK's NO₂ failings are deliberate policy decisions by successive Governments that have increased sharply the number of diesel vehicles on the UK's roads. In this paper, Clean Air in London (CAL) shows that:

- the shift from petrol to diesel cars since 2000, for which Governments have been responsible, has resulted in actual primary NO₂ emissions in 2010 being more than twice the level they would have been under the 2000 car fleet mix scenario (107%) – even after allowing for NO₂ emissions as a fraction of NO_x emissions increasing from around 5% to 20% or more in the real world;
- UK tax policy has created a substantial shift in the new car market from petrol to diesel fuelled vehicles. These tax advantages have been maintained even though the Government knew they would have a detrimental impact on air quality in cities. Specifically, the Government knew that:
 - diesel cars and light vans were always expected to have significantly higher emissions of NO_x than petrol equivalents. The Euro standards never set specific limits for NO₂ emissions other

- than the need to keep within the much higher NO_x 'cap'. This 'emissions gap' was implicit in the Euro standards;
- the proportion of NO_x emitted directly as NO₂ from diesel cars has increased sharply over the past 20 years from around 5% to 20% or more. This trend has been apparent for nearly a decade and was flagged up in 2007 by the Government's own expert advisory group;
 - there may be many reasons for diesel vehicles underperforming the Euro engine emissions standards in the real world e.g. vehicle manufacturers might have complied with a narrow engine test standard but paid less attention to real world emissions, diesel vehicles have been turbo-charged in recent years, the retrofitting of DPFs may have increased NO₂ or emissions control equipment may have been removed or tampered with;
 - the US, where 'technology neutral' standards were set and diesel cars are relatively rare, has been far more successful in managing vehicle emissions and reducing ambient NO₂ concentrations; and
 - the current MOT emissions test fails to comply with Directive 2010/48/EU. It fails to ensure that all engine and emission control equipment is present, has not been modified or tampered with and is functioning correctly.

Successive Governments failed to agree 'technology neutral' standards for emissions, failed to act when the failings of diesel vehicles were identified and are knowingly allowing the vehicle testing regime to permit the continued use of diesel vehicles that have had their emissions control equipment removed or tampered with.

It is disingenuous or worse of the current Government to blame Euro engine standards for its failure to control emissions from all forms of combustion and comply with NO₂ limit values.

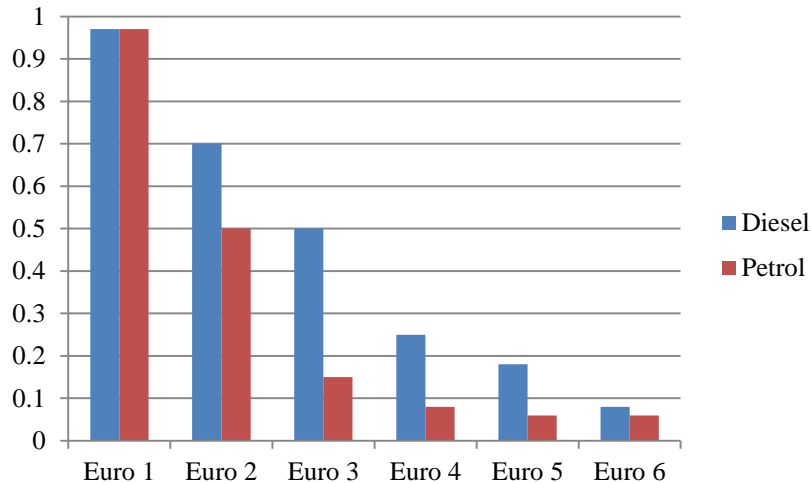
2. What was expected from engine emission standards?

2.1 European vehicle emission standards (Euro standards)

European standards for emissions from all new cars first came into effect in 1992 with the Euro 1 standardⁱⁱⁱ. Progressively more demanding standards have followed: cars and light vans manufactured at the present time are required to meet the Euro 5 standard, with the tighter Euro 6 standard due for introduction for cars in 2014. NO_x limits for cars and light vans are shown in Graph 1 below.

Separate standards apply to diesel and petrol vehicles with diesel vehicles subject to 'laxer' emission standards for NO_x and particulate matter than petrol vehicles. The dispensation for diesel vehicles may (wrongly) have been permitted to allow the higher manufacturing cost for diesel vehicles to control harmful emissions. It is important to note that separate diesel and petrol emission standards are not universal in emissions standard regimes outside of Europe. The US, for example, sets a single emission standard that all cars are required to meet regardless of the fuel used (see section 2.2 below) i.e. it is 'technology neutral'.

Graph 1 - Euro standard NO_x limits for cars (g/km)



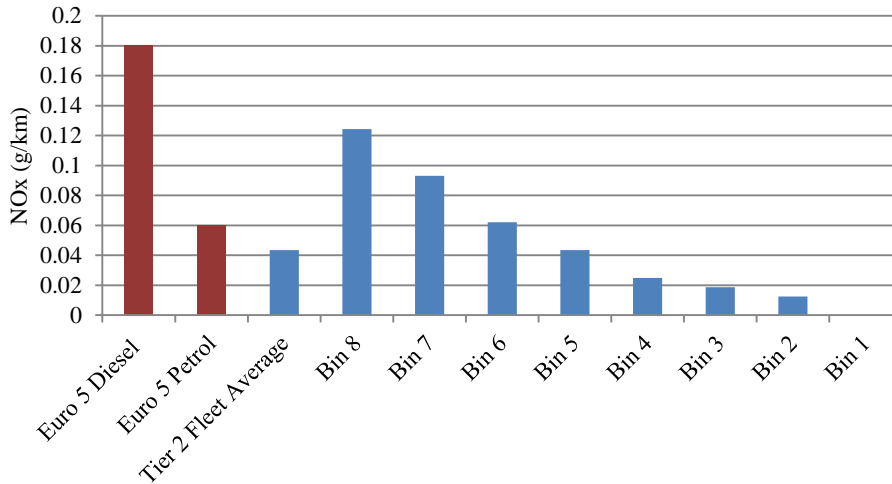
2.2 US vehicle emission standards, emissions control and air quality

Diesel cars are comparatively rare in the US: diesel vehicles comprised only 0.6% of the total car fleet^{iv} in 2010, with petrol fuelled vehicles overwhelmingly dominant. Diesel is unpopular in the US for several reasons including: negative public opinion (it is seen as ‘dirty’); poor infrastructure; and the low cost of road fuels (compared to the UK).

However, a key factor holding down diesel market share is that US emissions standards for light vehicles are ‘technology neutral’: both diesel and petrol vehicles have to meet the same emissions standard. Historically, the cost of manufacturing diesel vehicles to meet US emission standards has been relatively high.

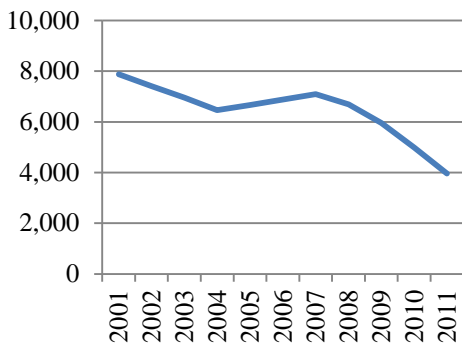
Emissions standards in the US are significantly different to those in Europe. Since 2009 vehicles have been manufactured to meet ‘Tier 2’ emissions standards which set maximum emission rates for similar air pollutants to the Euro standards. Tier 2 sets a number of certification ‘bins’ that vehicles may meet and a fleet average NO_x standard. This system allows flexibility for manufacturers whilst guaranteeing fleet average emissions. It also improves customer choice and means that the State Governments can set higher standards if they choose to do so. The eight bins and fleet average NO_x standard are shown in Graph 2 below, compared to the Euro 5 NO_x standard^v.

Graph 2 - US Tier 2 emission standards for light vehicles

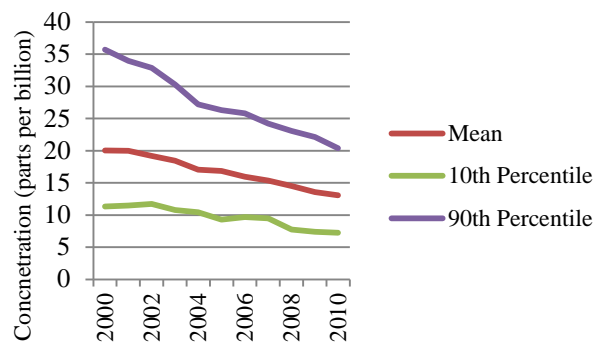


Graphs 3 and 4 below show the results of measures to reduce US vehicle NO_x emissions. Graph 3 shows NO_x emissions from highway vehicles between 2001 and 2011 - these are theoretical figures similar to those from the UK's National Atmospheric Emissions Inventory. However, unlike the UK, the planned reduction in NO_x emissions in the US has achieved results as shown by the downward trend in measured concentrations shown in Graph 4. This graph shows the mathematical average of annual average NO_x emissions measured at 81 sites across the US.

Graph 3 - US NO_x emissions from highway vehicles (000s of tonnes)



Graph 4 - Monitored NO₂ annual average concentrations at 81 sites



There is a firm downward trend in NO₂ concentrations at nearly all US monitoring sites^{vi}, which contrasts sharply with the static or rising trend at many UK monitoring sites.

3. What happened to air quality in the UK?

3.1 Trends in UK nitrogen dioxide concentrations

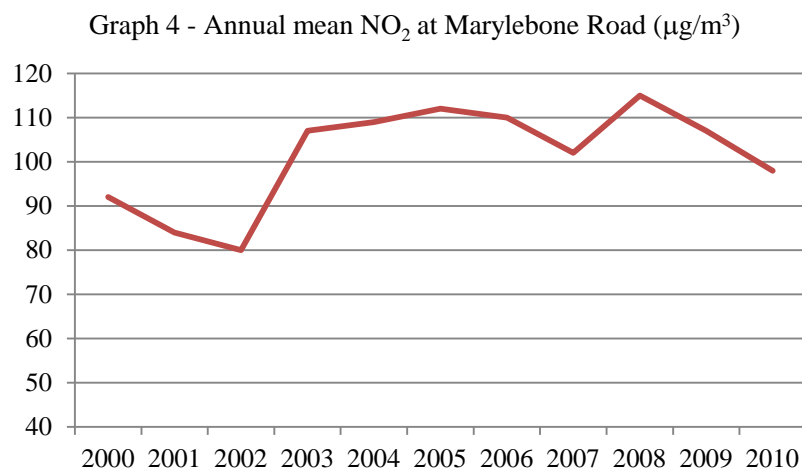
Emissions of NO_x from vehicles are thought to account for roughly a third of total UK NO_x emissions. However, in terms of exceedances of European NO₂ standards, vehicle emissions are by far the most important source as vehicle emissions take place at street level directly into busy urban areas. The

advancing Euro standards shown in Graph 1 were expected to be followed by declining NO₂ concentrations in the ambient air. This, however, has not been the case and over the past decade monitoring carried out by both the Government and local authorities has shown NO₂ concentrations that are static or even rising in many locations. This trend has been particularly pronounced in urban locations.

Research for the Department for Environment, Food and Rural Affairs (Defra) in 2011 attempted to understand the mismatch between predicted and measured NO₂ concentrations. The findings^{vii} stated that:

'Trends in ambient concentrations of NO_x and NO₂ in the UK have generally shown two characteristics: a decrease in concentration from ~1996 to 2002–2004, followed by a period of more stable concentrations from 2002/2004–2009. Concentrations of NO_x and NO₂ from 2004–2009 overall, are best described as having been weakly downward, although there is of course a distribution of trends depending on the site in question.'

This static trend has been particularly pronounced at some of London's most polluted roadside locations. Graph 4 below shows annual mean NO₂ at Marylebone Road in Westminster^{viii} (the EU limit value is 40 µg/m³).



Note that this is not a new trend: the static/ rising trend has been apparent since 2004 or earlier. However, the Government did not publish research examining the reasons behind this trend until 2011. The retrofitting of DPF to older buses may have contributed to this problem.

In a report titled 'Something in the Air: The forgotten crisis of Britain's poor air quality' by Policy Exchange dated 19 July 2012 found that diesel vehicles were responsible for 91% of PM_{2.5} and 95% of NO₂ exhaust emissions in London.

In June 2012, the World Health Organisation raised the status of diesel exhaust from 'probably carcinogenic to humans' to 'carcinogenic to humans' reflecting growing certainty that exposure causes increased risks of lung cancer.

4. Why have concentrations of NO₂ not fallen in the UK?

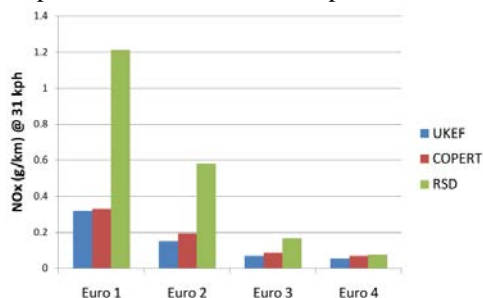
4.1 Did Euro emission standards fail?

Emissions standards in themselves do not provide a complete picture of a vehicle's emissions performance in real world driving. Emissions from new cars are tested over a standardised drive cycle i.e. a car is tested on a rolling road in a laboratory over a cycle designed to replicate both urban and high speed driving. Fuel efficiency figures are produced in a similar fashion and, just as most drivers struggle to match a car's official fuel economy figures in their everyday driving, emissions of air pollutants in real world driving conditions may differ from those required by the vehicle's Euro standard.

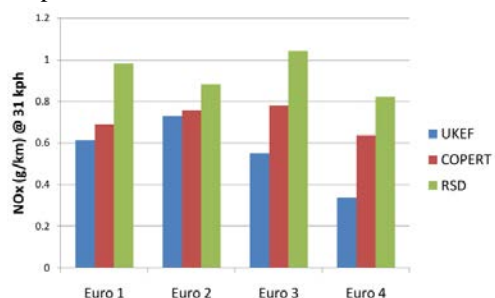
The aforementioned Defra paper, 'Trends in NO_x and NO₂ emissions and ambient measurements in the UK' explored the differences between test cycle and real world emissions. It described the results of a large scale monitoring programme using remote sensing techniques to measure actual emissions from vehicles in everyday use.

The research found that emissions of NO_x from road vehicles were significantly higher than previously thought, however the problem was predominantly one of diesel vehicles. This is shown in the Graphs 5 and 6 below which show emission factors estimated using remote sensing data (RSD, in green) compared to the emissions factors currently used by the UK Government (UKEF, in blue).

Graph 5 - Emission factors for petrol vehicles



Graph 6 - Emission factors for diesel vehicles



The higher than expected figures for Euro 1 and 2 petrol cars is thought to be due to catalyst degradation on older vehicles, however newer petrol cars perform largely as expected. The report concluded that:

'The data suggest that NO_x emissions from new Euro 5 petrol vehicles have reduced by ~96% since pre-Euro (non-catalyst) vehicles.'

For diesel vehicles, emissions of NO_x are higher than previously expected, with the report concluding that:

'We find that diesel cars and LGV (light good vehicles) emissions of NO_x have not decreased for the past 15–20 years; even for Euro 5 vehicles.'

The Euro 4 standard seems to have reduced NO_x for diesel vehicles in real world driving conditions compared to earlier (and perhaps later) standards but not NO₂ (see Graph 7). Please note Euro standards never set specific limits for NO₂ emissions other than the need to keep within the much higher NO_x 'cap'.

The previous Government was fully aware of the problems of diesel vehicles by June 2007. A Parliamentary answer from Stephen Ladyman admitted that diesel passenger cars emitted 16.9 times the PM₁₀ in g/km and 1.84 times the NO_x in g/km that petrol passenger cars in 2005 (based on emission factors from 2000)^{ix}. These estimates were broadly confirmed in 2010, 2011 and 2012.

4.2 Did manufacturers ‘game’ the test cycle?

CAL understands that type approval for vehicles and the related tests have taken place at a Member State level (agreed on a ‘mutual recognition basis’). Engine manufacturers were given freedom to decide how to meet the Euro 3, 4, 5 etc emissions standards in tests.

There have long been suggestions that vehicle manufacturers may have sought to meet type approval emissions standards during the ‘test cycle’ but made less effort to reduce real world emissions. With testing occurring at a national level, Member States were best placed to detect any problems at an early stage, if necessary ordering a ‘call back’. Even one example of a poorly performing vehicle should have been enough to make manufacturers take another look at vehicles already on the market. Apparently this has occurred in the US but, as far as CAL is aware, not in Europe.

More positively, presumably, any engine management system programmed to operate more ‘efficiently’ during the test cycle, whilst being less ‘ambitious’ in other conditions, could simply be ‘retuned’ by changing the chip. This is worth investigating further.

4.3 Was it something else e.g. increasing ‘direct’ NO₂ emissions from diesel vehicles?

Another important factor affecting NO₂ concentrations is the relationship between NO_x and NO₂ emissions from vehicles. Diesel and petrol vehicles emit both NO (nitrogen monoxide) and NO₂ (nitrogen dioxide), which together are known as ‘NO_x’. European air quality standards have been set for the concentration of NO₂ in the air, not NO_x. For compliance purposes we are only interested in the concentration of NO₂ in the air i.e. not emissions from tail pipes.

NO₂ emitted directly from vehicle exhaust is known as ‘primary NO₂’. NO emissions can also be converted to NO₂ via chemical reactions in the air; NO₂ produced in this way is known as ‘secondary NO₂’. These chemical reactions take some time to occur, therefore the relative importance of primary and secondary NO₂ will change depending on the location where concentrations are measured:

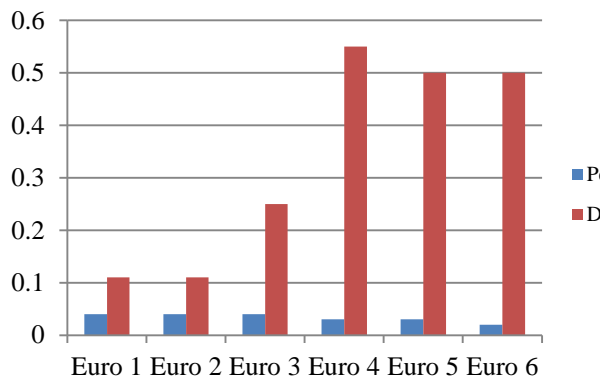
- in locations close to busy roads *primary* NO₂ tends to have the most significant influence on NO₂ concentrations; and
- in quieter locations both *primary AND secondary* NO₂ have significant influence on NO₂ concentrations

There is a considerable difference in primary NO₂ emissions between petrol and diesel cars, with the proportion of NO_x emitted as primary NO₂ being far higher for modern diesel cars than equivalent petrol cars. The Euro emission standards set limits for emissions of total NO_x, not separate standards for NO₂ and NO. This has meant that vehicle manufacturers could use technologies that increase the proportion of NO_x emitted as primary NO₂, providing they meet the overall standards for NO_x emissions.

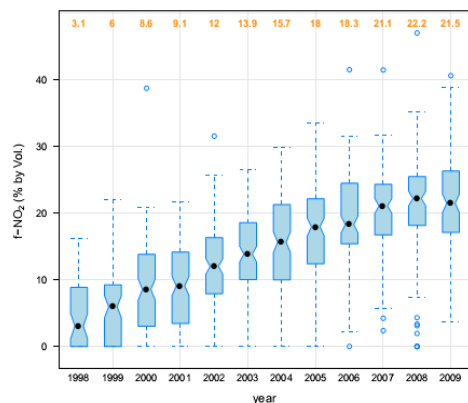
Emission control technology used in diesel cars is understood to increase the proportion of primary NO₂ emissions, when compared to both older diesel cars and equivalent modern petrol cars. This increase has been apparent for nearly a decade, and was explicitly highlighted by the Government's own expert advisory body (the Air Quality Experts Group) in their 2007 report 'Trends in Primary Nitrogen Dioxide in the UK'^x.

The trends in primary NO₂ emissions are shown in Graphs 7 and 8 below. Graph 7 shows the change in direct NO₂ emissions from cars depending on the emission class and fuel^{xi}, whilst Graph 8 shows the measured change in NO_x emitted as NO₂ in London^{xii}.

Graph 7 - Proportion of NO_x emitted as NO₂ by new cars



Graph 8 – Measured trends in percentage of NO_x emitted as NO₂ in London



4.4 Have other changes affected the performance of diesel vehicles e.g. the use of cerium oxide?

CAL found, through a Freedom of Information request to Transport for London (TfL), that Stagecoach is using cerium oxide (CeO₂) in its fleet across the UK, including London, as an additive in diesel fuel. Stagecoach may have reduced fuel consumption by 4-7% by using fuel additive as an oxidant or booster. The response from TfL confirmed that Metroline was the only other bus operator in London using fuel additive.

A leading scientist, Professor Vyvian Howard of Ulster University was reported by the Daily Mail on 24 August 2009 to be 'looking specifically at nanoparticles present in chemicals found in sunscreens and an additive in some diesel fuels – titanium dioxide and cerium oxide – and their connection to Alzheimer's and Parkinson's diseases'. Professor Howard was quoted as saying^{xiii}:

"It has recently been discovered that nanoparticles can have highly significant impacts on the rate of misfolding of key proteins associated with neurodegenerative diseases like Alzheimer's and Parkinson's disease.

"The brain itself is a very special organ. It cannot repair by replacing nerve cells, the ones you get at birth have to last all your life, which makes them peculiarly vulnerable to long term low dose toxicity."

TfL says there is no evidence to suggest there might be health impacts associated with the use of cerium oxide. CAL has not been able to discover whether fuel additives have other impacts e.g. altering the mix of vehicle exhaust emissions.

5. Did successive Governments respond to the evidence?

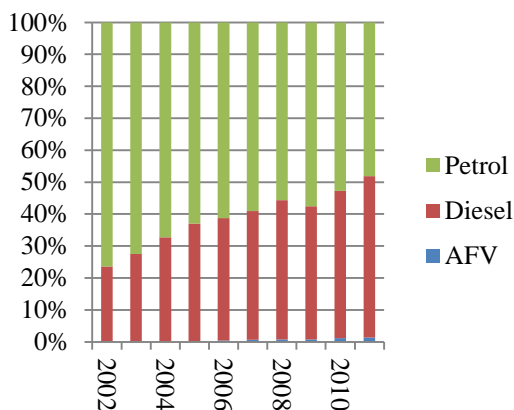
5.1 UK light vehicle (cars and vans) taxation policy

Since 2001, UK light vehicle taxation has moved to a system based on the carbon dioxide (CO₂) emissions of the vehicle. The three main taxes are:

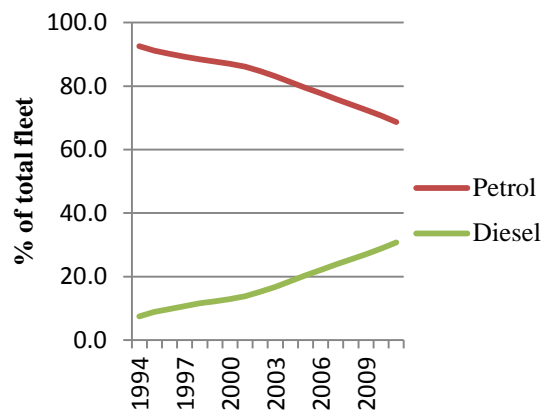
- vehicle excise duty (road tax) has been linked to CO₂ emissions since 2001, with the difference in tax rate between the lowest and highest emitters increasing in more recent years. The lowest band (less than 100g/km) now pay no tax, whilst the highest band (more than 225 g/km) pay a first year rate of £1,030 followed by £465 for subsequent years;
- company car tax has been linked to CO₂ emission since 2002, and is now calculated from three factors:
 - i. the CO₂ band the vehicle sits in and whether the vehicle is diesel fuelled (diesel vehicles are assigned a small penalty compared to petrol vehicles with the same CO₂ emissions)
 - ii. the list price of the vehicle
 - iii. the income tax rate paid by the driver
- fuel duty has been progressively increased over the past decade. Higher fuel duty penalises vehicles with low fuel economy and high CO₂ emissions. Fuel duty is now levied at the same rate on diesel and petrol fuels: there is no diesel ‘penalty’ in the fuel duty system.

Diesel cars have tended to have slightly lower CO₂ emissions than equivalent petrol models, so these policies encouraged a substantial shift in the new car market from petrol to diesel fuel. In 2011 more diesel than petrol cars were sold in the UK for the first time^{xiv}. As a result, the UK car fleet is moving from one dominated by petrol vehicles to one with similar numbers of petrol and diesel vehicles^{xv}.

Graph 9 – New car sales by fuel



Graph 10 - UK car fleet by fuel



5.2 In-service emissions testing

In order to ensure good emissions performance throughout their lifetime it is essential that vehicles are regularly and appropriately tested and not tampered with. In CAL’s opinion, the current UK in-service testing regime is inadequate, not least with respect to controlling harmful emissions.

CAL understands that the fitting of a catalytic converter to petrol engine vehicles is mandatory for vehicles of specified age and type e.g. passenger car, goods vehicles etc. Diesel vehicles are required to meet certain emissions limits for type approval, though, as mentioned earlier, the method of doing so is not specified.

CAL understands that in-service vehicle testing takes place through two main pathways. The first is testing by manufacturers (and Member States), with a small number of vehicles tested at various points through a model's lifespan to check that they are functioning as anticipated. These tests include emissions testing. The second pathway is mandatory emissions testing as part of the annual vehicle test, still commonly referred to as the 'MOT', which takes place annually for all vehicles over three years old.

The MOT emissions test is based upon the age of the vehicle and the fuel (diesel or petrol) it runs upon. However, the pollutants tested are not those of current concern (i.e. not NO_x, NO₂ and particulate matter). Petrol vehicles are tested for carbon monoxide and hydrocarbons, whilst diesel vehicle are tested only for smoke density. The emissions limits used are relatively high compared to the expected emissions from the vehicle. In short, the MOT emissions test may filter out some polluters, but does not pick up vehicles that are significantly under-performing in terms of NO_x and/or particulate matter emissions.

This situation would be concerning in itself, but CAL further understands that there is a burgeoning market in vehicle modifications that could impact adversely on vehicle emissions and public health. Two 'services' offered for diesel vehicles are:

- engine remapping which changes the settings in the vehicle's engine control unit. This may improve power output and/or fuel economy, while increasing pollutant emissions; and
- diesel particulate filter (DPF) removal, where the DPF is taken off the vehicle and the engine control unit remapped for the vehicle to 'accept' the filter removal.

Without Government intervention to stop it, the situation is likely to deteriorate as vehicles fitted with increasingly sophisticated emissions control systems age and the removal of these systems presents a more cost effective 'option' than repair or replacement. DPFs have only recently become mandatory for light duty diesel vehicles under the Euro 5 standard so their numbers are now growing rapidly and so too may the number of failures associated with them.

Directive 2010/48/EU^{xvi} requires visual inspection of petrol and diesel engines to ensure roadworthiness. Reasons for failure include: the control unit has been illegally modified and/or there has been illegal engine modification (6.1.9); and that emission control equipment fitted by the manufacturer is absent, modified or obviously defective (8.2.1.1 and 8.2.2.1). Where the method of inspection is given as visual, it means that in addition to looking at the items, the inspector should, if appropriate, also handle them, evaluate noise or use any other appropriate means of inspection without the use of equipment. Where the vehicle is found to be defective with regard to the test items listed, the competent authorities in the Member States must adopt a procedure for setting the conditions under which the vehicle may be used before passing another roadworthiness test.

CAL understands that petrol vehicles that 'qualify for a full catalyst emissions test' are now checked during their MOT to see that the catalyst is present. However a similar check is not performed for

diesel vehicles fitted with a particulate filter. CAL understands that the Vehicle & Operator Services Agency (VOSA) claims^{xvii} that “testers would be unable to readily determine which diesel vehicles were originally fitted with a Diesel Oxidation Catalyst (DOC), Diesel Particulate Filter (DPF) or Selective Catalytic Reduction (SCR) system”. Further, “it was considered that the introduction of a Reason for Rejection for a missing diesel catalyst or filter at this stage, whilst complying with the Directive, was likely to lead to many incorrect failures which was considered unacceptable”. VOSA stated that the matter is under review and may therefore change in the future.

In February 2013 the Government confirmed (via a written answer to a parliamentary question) that, ‘there is no statutory requirement in MOT testing procedures to ensure that particulate filters or other emission control equipment fitted to a vehicle at manufacture are functioning correctly. The MOT test does however, include an exhaust gas opacity test against measurements laid down in Directive 2010/48/EU, providing these limits are met, the vehicle is considered to have passed that part of the test’^{xviii}.

The MOT test does not comply with the requirements of Directive 2010/48/EU. It does not ensure that modern vehicles maintain acceptable emissions performance throughout their lifetime especially when it comes to NO_x and/or particulates, the pollutants of greatest concern for public health.

6. How much has it mattered?

6.1 The impact of the UK’s shift to diesel fuelled cars in the light vehicle market

CAL has investigated the impacts on NO₂ emissions and concentrations of the large shift to diesel cars seen over the past 10 years. In this section we have used two techniques to do this:

- adjusting official 2010 figures for UK light vehicle NO_x emissions to a 2002 fleet mix (diesel and petrol); and
- examining the success of the US in managing NO₂ emissions and concentrations. The US has a relatively small and stable proportion of diesel compared to petrol cars.

6.2 Estimating oxides of nitrogen (NO_x) emissions under a 2000 light vehicle fleet mix

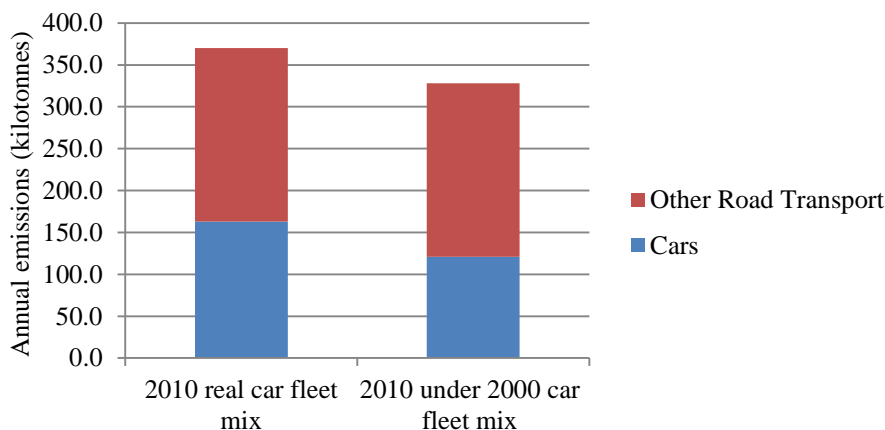
Emission estimates for several pollutants, broken down by sector, are produced by the Government as part of the National Atmospheric Emissions Inventory. For road vehicles, emission estimates are given by vehicle type (e.g. cars, HGVs, buses, etc), fuel and mode of driving. CAL has used figures released by the Department for Transport^{xix} to adjust the 2010 emissions figures to the petrol/diesel car fleet mix of 2000:

2000 – petrol 87.1%, diesel 12.9%

2010 – petrol 71.1%, diesel 28.9%

No adjustments were made to emissions from other (larger) vehicles, as it is assumed that the overwhelming majority of vans, HGVs and buses were, and continue to be, fuelled by diesel. The results are shown in Appendix 1 and Graph 11 below.

Graph 11 – Estimated emissions of NO_x in 2010, using 2010 and 2000 petrol/diesel car fleet mixes



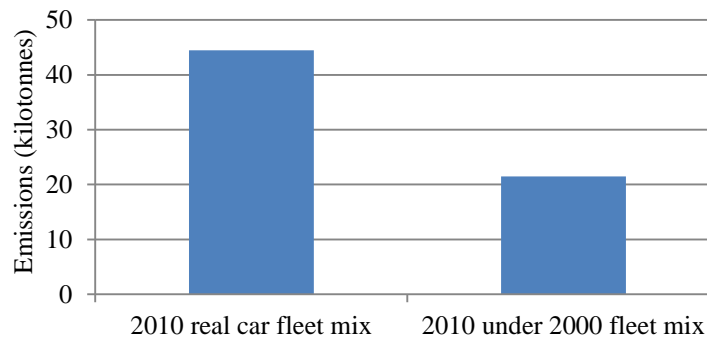
This analysis suggests that the shift to diesel has increased NO_x emissions by 11.4% for all road vehicles, and by 25.8% for the car sector alone, over a business as usual scenario. These figures are based upon emission factors that pre-date research into the poor real world NO_x performance of diesel vehicles, and so, in reality, the difference in emissions between the two scenarios is likely to be far larger. CAL does not have the resources to model the impacts that this difference in emissions would have on ambient NO₂ concentrations, but clearly there would be a significant impact.

Note that this is a relatively simple analysis that may ignore some factors that have an impact on emissions. For example, as diesel car sales have increased year upon year the average age of the UK diesel car fleet is likely to be younger, and therefore have a higher average Euro emission standard, than the petrol fleet. This would not be the case if the petrol/ diesel sales split had stayed the same as it was in 2000. On the other hand, diesel cars tend to be driven farther on average each year than petrol cars so may contribute disproportionately to total traffic and hence emissions.

6.3 Estimating nitrogen dioxide (NO₂) emissions under a 2000 light vehicle fleet mix

We can also use this technique to estimate 2010 primary NO₂ emissions from the car sector under 2000 and 2010 fleet mixes. The results are shown in Graph 12 below. This calculation uses fleet composition mixes produced for the National Atmospheric Emission Inventory^{xx}, and the figures for the percentage of direct NO₂ emissions shown in Graph 7, to produce a ‘fleet average’ figure for the percentage of direct NO₂ emissions.

Graph 12 - Estimated primary NO₂ emissions from the car sector



This analysis suggests the impacts of the shift to diesel cars on primary NO₂ emissions has been much greater than for NO_x emissions as a whole, with actual 2010 primary NO₂ emissions 107% higher than under the 2000 car fleet mix scenario.

7. Where next?

This report has demonstrated that the Government is wrong to blame failure in the diesel vehicle Euro emission standards for the UK's NO₂ problems.

Government policy deliberately encouraged people to purchase diesel fuelled cars despite it being known from the outset that these vehicles would have higher emissions of NO_x and PM₁₀ than their petrol equivalents. Evidence has pointed for many years towards NO_x emissions from diesel vehicles being higher in the real world than expected. Successive Governments did little to investigate the problem and continued with tax policies that encouraged the adoption of diesel cars. Worse, Governments have failed even to establish a testing regime that ensures that basic engine and emission control equipment is operating effectively.

The Government must address urgently the problem of high levels of pollutants from light vehicles. Action is needed in three areas simultaneously: first, measures to reduce emissions of diesel exhaust in the most polluted areas; second, tax policy that is truly technology neutral; and third, Euro 6 standards that deliver on their expectations of achieving sharp reductions in harmful emissions.

First, the following measures are needed:

- information online and at point of sale about real world emissions of CO₂, NO_x, NO₂, PM_{2.5} and PM₁₀ for all new and used cars;
- a national framework for low emission zones with local authorities actively encouraged to set up low emission zones in the most polluted areas. Separate standards for diesel and petrol vehicles should be encouraged and the zones themselves should cover larger vehicles and cars (as they do in Germany^{xxi});
- scrappage grants should be introduced to speed the exit of the oldest and most polluting diesel vehicles from the fleet;
- emissions related charging schemes (such as congestion charging and variable parking charges) should be used to encourage non-diesel, ultra-low emission technology. Please see CAL's

response to Transport for London's 2013 consultation on the Congestion Charge Greener Vehicle Discount^{xxii}; and

- Directive 2010/48/EU must be implemented fully to ensure that manufacturer fitted engine and emissions control equipment is working effectively and that the vehicle has not been modified or tampered with.

Second, the following policies are needed:

- 'technology neutral' taxation based on the absolute levels of CO₂, PM₁₀, NO_x and NO₂ emissions i.e. stop treating diesel and petrol as two completely different technologies. This should be introduced for new vehicles and phased in for older vehicles; and
- maintain the above penalties for diesel vehicles in the vehicle taxation system until Euro 6 becomes a mandatory standard and is proven to work effectively^{xxiii}.

Third, the following actions are needed:

- the European Commission should investigate whether engine management systems could be 'retuned' (positively) for real world driving conditions simply by changing the chip; and
- the European Commission should ensure that a new 'world test cycle' (the World Light Duty Test Protocol), that is still under development, will achieve substantial improvements over the current test cycle in reflecting real world NO_x emissions from diesel vehicles. Until it does so, there remains a real danger that Euro 6 emissions standards will repeat the deficiencies of Euro 5 in reflecting real world emissions^{xxiv}.

After nearly 20 years of policy failure, the current public health crisis makes the above actions urgent.

Appendix 1

Estimated emissions of NO_x in 2010, using 2010 and 2000 petrol/diesel car fleet mixes

Emissions	Fuel	Emissions ('000s of tonnes)	
		2010 (actual car fleet mix)	2010 (2000 car fleet mix)
Road transport - cars - cold start	DERV	6.2	2.8
Road transport - cars - cold start	Petrol	9.7	11.9
Road transport - cars - motorway driving	DERV	22	9.8
Road transport - cars - motorway driving	Petrol	9.1	11.1
Road transport - cars - rural driving	DERV	37	16.6
Road transport - cars - rural driving	Petrol	22	26.9
Road transport - cars - urban driving	DERV	36	16.1
Road transport - cars - urban driving	Petrol	21	25.7
Total cars		163	120.9
% difference in NO_x (cars)			-25.8%
Total other road transport		207.2	207.2
Total all road transport		370.2	328.1
% difference in NO_x (all road transport)			-11.4%

Appendix 2

Roadworthiness testing of vehicles under European law

1. Directive 2010/48/EU adapting to technical progress Directive 2009/40/EC of the European Parliament and of the Council on roadworthiness tests for motor vehicles and their trailers

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:173:0047:0072:EN:PDF>

8.2.2.1 on page 68 requires for diesel vehicles: the visual inspection of ‘Exhaust emission control equipment’ and should lead to a fail in the roadworthiness test if (a) ‘Emission control equipment fitted by the manufacturer absent or obviously defective’ or (b) ‘Leaks which would affect emission measurement’.

<http://www.theyworkforyou.com/wrans/?id=2013-02-01b.140569.h>

2. Motor vehicles testing: parliamentary answer from Stephen Hammond MP to Andrew Smith MP on 1 March 2013

<http://www.theyworkforyou.com/wrans/?id=2013-03-01a.144827.h>

3. Motor vehicle testing: Parliamentary answer from Stephen Hammond MP to Andrew Smith MP on 1 February 2013

<http://www.theyworkforyou.com/wrans/?id=2013-02-01b.140569.h>

4. ‘Common Sense has prevailed over the EU’s MOT proposals’ by Stephen Hammond MP on Conservative Home on 23 December 2012

<http://conservativehome.blogs.com/platform/2012/12/stephen-hammond-mp-common-sense-has-prevalled-over-eu-mot-proposals-one-of-the-great-things-about-serving-as-a-minister-i.html>

“One of the great things about serving as a minister in the Department for Transport is that you can help millions of people in a number of simple but important everyday matters. Rarely have I been as keenly aware of this fact than during a meeting I attended at the European Council last week.

“On the agenda were proposals that, when originally mooted in the Autumn, would have meant British caravan and trailer owners were forced to put their vehicles through MoT tests, while classic and historic vehicle owners faced having their vehicles taken off the road if they had been modified – even if only slightly, for example with a new indicator.

“Aside from the fact that these plans were unnecessary, it also quickly became clear that they were going to be extremely expensive – hitting the British Taxpayer with a £1billion bill over five years in test fees and lost time.

“Happily, I am able to record a positive outcome from the meeting. Following months of close working with like-minded countries and meetings with concerned vehicle owners, we’ve been able to persuade EU Transport Ministers to agree a number of changes to the original proposals which mean small businesses and other motorists will not be forced to have their trailers and caravans subjected to mandatory MoT testing.

“Equally, we have secured consensus on a far less prescriptive approach for historic and modified vehicles. UK testers and regulators will be able to continue using their expert judgement in allowing vehicles with higher spec modifications to pass MoTs as long as they are safe. And historic vehicles will continue to be exempt from MoT testing if they were registered before 1960.”

5. Roadworthiness statements

<http://www.theyworkforyou.com/wms/?id=2012-12-18a.96WS.6>

6. Statements about the MOT

<http://conservativehome.blogs.com/platform/2012/12/stephen-hammond-mp-common-sense-has-prevailed-over-eu-mot-proposals-one-of-the-great-things-about-serving-as-a-minister-i.html>

<http://www.theyworkforyou.com/wrans/?id=2013-02-01b.140569.h>

<http://www.theyworkforyou.com/wrans/?id=2012-12-11a.132344.h>

<http://www.theyworkforyou.com/wms/?id=2012-11-21a.34WS.1>

<http://www.theyworkforyou.com/wrans/?id=2013-02-11a.142484.h&s=speaker%3A11927#g142484.r0>

7. New guidance from the Vehicle & Operator Services Agency, 20 March 2013

<http://www.dft.gov.uk/vosa/repository/SN%2001%202013%20V1.0.pdf>

Introduction: Where a vehicle has been extensively modified or converted, certain Reasons for Rejection, such as for components ‘missing where fitted as standard’ should not be applied, for example:

- *a car converted for rally use (i.e. rear seats removed and fitted with a roll cage and full harness seat belts etc.) may have been converted so as not to require a brake servo, power steering or airbags*
- *a car converted to a stretch limousine may no longer be fitted with curtain airbags or functional Electronic Stability Control*

Section 7.1: Method of Inspection amended for purpose of clarity, to:

On petrol engine vehicles that qualify for a full catalyst emissions test, check the presence of the catalytic converter.

Note: To ascertain whether a vehicle qualifies for a full catalyst test, use the flow charts in Section 7.3.C disregarding the result of the Basic Emissions Test.

Notes

ⁱ ‘Something in the Air: The forgotten crisis of Britain’s poor air quality’ by Policy Exchange dated 19 July 2012 <http://www.policyexchange.org.uk/publications/category/item/something-in-the-air-the-forgotten-crisis-of-britain-s-poor-air-quality>

ⁱⁱ ‘Diesel engine exhaust carcinogenic’ publication by International Agency for Research on Cancer dated 12 June 2012 http://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf

ⁱⁱⁱ Separate standards exist for light vehicles (cars and vans) and heavy duty engines used in heavy goods vehicles and buses. This paper focuses on the light vehicle standards

^{iv} Source, US Energy Information Administration, www.eia.gov/forecasts/aeo/pdf/0383%282012%29.pdf

^v For information only - Tier 2 and Euro standards are not tested over same drive cycle

^{vi} See <http://www.epa.gov/airtrends/nitrogen.html>

^{vii} ‘Trends in NO_x and NO₂ emissions and ambient measurements in the UK’, see http://uk-air.defra.gov.uk/reports/cat05/1103041401_110303_Draft_NOx_NO2_trends_report.pdf

^{viii} Source, London Air Quality Network website (<http://www.londonair.org.uk>)

^{ix} Motor vehicles - exhaust emissions: Parliamentary answer from Stephen Ladyman MP, Minister of State in the Department of Transport, to James Arbuthnot MP on 25 June 2007

<http://www.theyworkforyou.com/wrans/?id=2007-06-25e.145736.h>

^x See <http://archive.defra.gov.uk/environment/quality/air/airquality/publications/primaryno2-trends/documents/primary-no-trends.pdf>

^{xi} Source, Imperial College – see

<http://www.niam.scarp.se/download/18.71afa2f11269da2a40580007431/1273578332622/Tim+Oxley+1.pdf>

^{xii} Source, ‘Trends in NO_x and NO₂ emissions and ambient measurements in the UK’, see http://uk-air.defra.gov.uk/reports/cat05/1103041401_110303_Draft_NOx_NO2_trends_report.pdf

^{xiii} ‘Suncream may be linked to Alzheimer’s disease, say experts’ in the Daily Mail on 24 August 2009:

<http://www.dailymail.co.uk/health/article-1208720/Suncream-linked-Alzheimers-disease-say-experts.html>

^{xiv} Source, SMMT ‘Motor Industry Facts 2011’ www.smmt.co.uk/wp-content/uploads/SMMT_FACTS_2012_WEBv.pdf

^{xv} Source, Department for Transport

^{xvi} <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:173:0047:0072:EN:PDF>

^{xvii} <http://www.honestjohn.co.uk/forum/post/index.htm?t=71579>

^{xviii} www.theyworkforyou.com/wrans/?id=2013-02-01b.140569.h&s=mot+section%3Awrans+section%3Awms#g140569.q0

^{xix} Source, ‘Licensed cars by propulsion / fuel type, Great Britain, annually from 1994’
<http://www.dft.gov.uk/statistics/tables/veh0203/>. We have assumed hybrid vehicles have the same emissions as petrol vehicles.

^{xx} See http://naei.defra.gov.uk/other/uk_fleet_composition_projections_v2.xls

^{xxi} See <http://lowemissionzones.eu/DE-ammap>

^{xxii} <http://cleanairinlondon.org/sources/mayor-must-stop-financial-incentives-for-diesel-vehicles/>

^{xxiii} The new Euro VI standard (for heavy vehicles) now includes a slow speed driving simulation as part of the emissions test cycle, which is intended to simulate urban driving conditions. Tests on some early vehicles suggest that this may be effective in reducing real world NO_x emissions

^{xxiv} See for example Hausberger S. November ‘Fuel Consumption and Emissions of Modern Passenger Cars’, TU Graz, Austria