Would a diesel car scrappage scheme improve air quality?

In response to the news in September 2015 that VW cheated emissions tests on their diesel cars in the United States, and concerns about the difference between real world emissions compared to those recorded in the lab, there have been various calls for the consideration of a scrappage scheme for diesel cars, including by the former Labour science minister Lord Drayson:

"We have a much better understanding than we did just a few years ago of the health effects of the products of diesel, and they are literally killing people. It is clear that in retrospect that it was the wrong policy ... we have got to take action really quite quickly.

"I think we should have things like a car scrappage scheme where people who want to trade in their diesel get an electrical car or hybrid. I think that's something the government should support."

A scrappage scheme would not be a new phenomenon. From May 2009 UK consumers were offered £2,000 to scrap pre-August 1999 cars: £1,000 coming from government and £1,000 coming from the industry. The scheme was unambiguously aimed at supporting the automotive sector. The Chancellor said: "To give a boost to the car industry during the current downturn, the Government announces the introduction of a vehicle scrappage scheme."

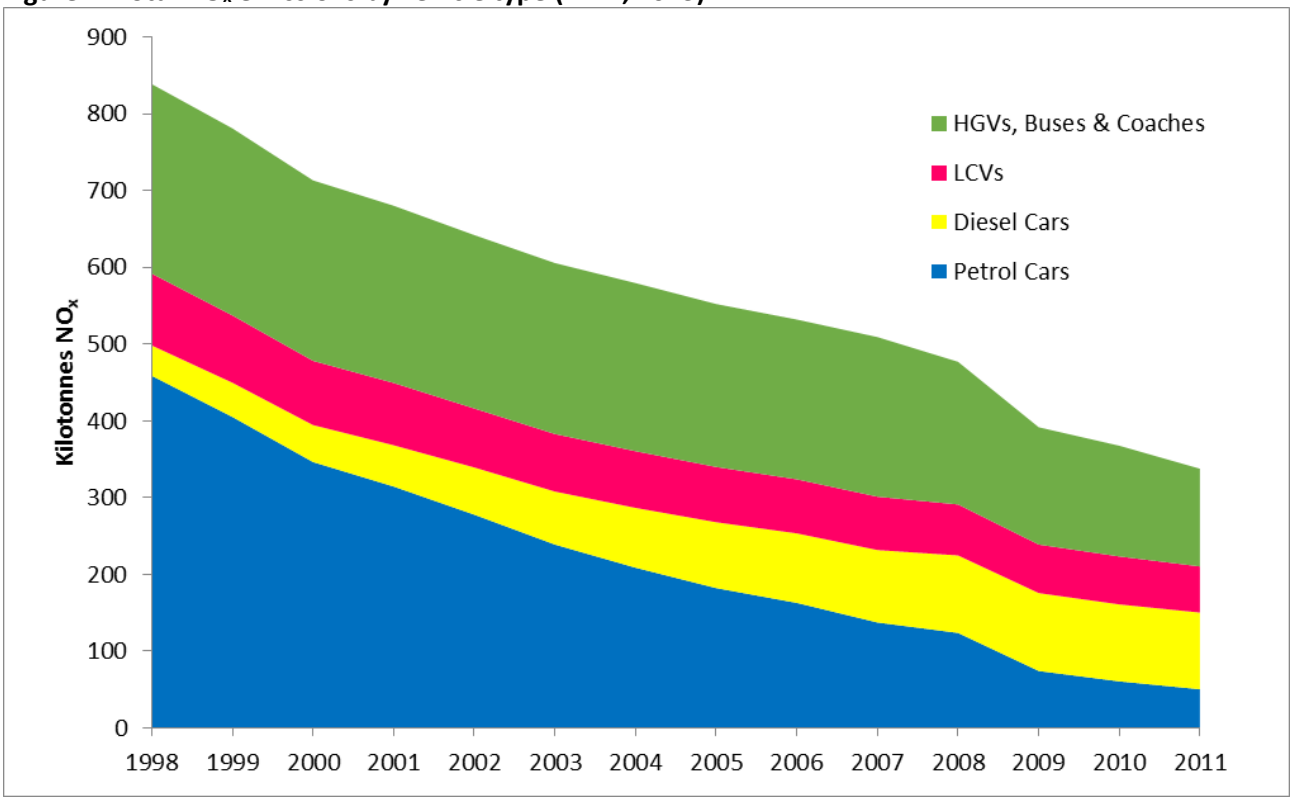
When the scheme was announced in Budget 2009 the Institute for Fiscal Studies warned of its minimal environmental benefits:

"While new cars have lower emissions per mile, they may be driven more and there are environmental costs associated with their production. As fiscal stimulus, this measure benefits one industry. Many new cars are not produced in Britain though some foreign made vehicles will contain British components. A significant fraction of cars of this age are scrapped each year, so there is scope for a large part of the subsidy to go to replacements that would have occurred anyway. The measure should cause some households to bring forward a vehicle replacement. This will mean fewer sales later. The government hopes that this will occur after the economy has picked up."

What Car? magazine claimed the scheme did not make much financial sense for consumers as manufacturers used the scheme to hide behind and put up retail prices. By the time the scheme finished in March 2010, 400,000 cars had been scrapped.

In a report for the RAC Foundation– *Air Quality and Road Transport: Understanding the problem* (June 2014) – Ricardo AEA present National Atmospheric Emissions Inventory (NAEI) data which suggests that total NO_x emissions from road transport roughly halved in the 15 years to 2011 (Figure 1).

Figure 1. Total NO_x emissions by vehicle type (NAEI, 2013).



While the volume of NO_x emitted by petrol cars has fallen markedly, it has not been the same story for diesels. According to the Ricardo AEA report:

"Looking at road transport's contribution to these emissions nationally, and focusing on NO_x, PM10 and PM2.5, it is seen that road vehicles are responsible for 33%, 15% and 18% of the totals, respectively (NAEI, 2013). The figure for NO_x is significant, and… these emissions are concentrated on the road networks in the UK's towns and cities, where pollution levels peak, and are therefore a major contributor to breaches of the NO_2 limit values…

"However, the change in emissions does vary between the vehicle types. NO_x emissions from petrol cars have reduced by some 90% over this period, whereas emissions from diesel cars have actually risen by 250%... This dramatic difference is a result of a rapid growth in the number of diesel cars in the parc, and relatively higher NO_x emissions of diesel vehicles compared to petrol vehicles.

"Estimated NO_x emissions for light commercial vehicles (LCVs) and heavy goods vehicles (HGVs), buses and coaches have gone down by 36% and 49% respectively. By 2011, the main source of NO_x emissions from road transport was the heavy-duty vehicles, contributing 38%, followed by diesel cars, which contributed 29%."

Today there are roughly 11 million diesel cars on the road in the UK, up from 1.9 million in 1995. They are broken down by Euro standard categories in Table 1. Table 1 also contains the NO_x emission limits for each of these Euro standards, as well as the estimates of real-world NO_x emissions used by the International Council for Clean Transport (ICCT). These estimates are based on the analyses of data from remote sensing and portable emissions measurement systems (PEMS) studies.

Table 1. Diesel cars in the UK by Euro standard (based on a snapshot of UK vehicle parc as of August 2015).

	Number of cars	Euro standard NO_x limit (gNO_x/km)	Real-world NO_x emission estimates (gNO_x/km)
Euro 1, 2 & 3	1.9 million	0.5 (Euro 3)	1.0 (Euro 3)
Euro 4	3.7 million	0.25	0.8
Euro 5	4.8 million	0.18	0.8
Euro 6	0.7 million	0.08	0.6
TOTAL	**11.2 million**		

Note: Due to the rounding of values, calculations may not sum-up exactly.

Two approximations have been made of the absolute NO_x emissions per kilometre being emitted from the current diesel parc.

First, in Table 2, it is assumed all cars emit NO_x at the limit set by the particular Euro standard they should be conforming to. Because no separate NO_x limits were set for Euro 1 and 2 (they were included in an overall figure with hydrocarbons) vehicles in these groups have been assigned the same limit as the later Euro 3 standard.

Table 2. NO_x emissions from UK diesel cars per kilometre based on emissions at Euro standard limits.

	Number of cars (millions)	These cars as % of the diesel parc	Absolute weight of NO_x emissions per kilometre in tonnes	Weight as % of total NO_x emissions per kilometre
Euro 1, 2 & 3	1.9	17.4	0.97	34.4
Euro 4	3.7	33.0	0.92	32.7
Euro 5	4.8	43.1	0.87	30.8
Euro 6	0.7	6.6	0.06	2.1
TOTAL	**11.2**	**100%**	**2.83**	**100%**

Note: Due to the rounding of values, calculations may not equate exactly.

Second, in Table 3, it is assumed all cars emit NO_x at the real-world estimate levels in Table 1 (similar to Table 2, Euro 1 and 2 vehicles are assumed to emit at the NO_x emissions estimate for Euro 3 cars).

Table 3. NO_x emissions from UK diesel cars by kilometre based on emissions at real-world estimates.

	Number of cars (millions)	These cars as % of the diesel parc	Absolute weight of NO_x emissions per kilometre in tonnes	Weight as % of total NO_x emissions per kilometre
Euro 1, 2 & 3	1.9	17.4	1.95	21.1
Euro 4	3.7	33.0	2.96	32.1
Euro 5	4.8	43.1	3.87	42.0
Euro 6	0.7	6.6	0.44	4.8
TOTAL	**11.2**	**100%**	**9.21**	**100%**

Note: Due to the rounding of values, calculations may not equate exactly.

A calculation was also made as to the annual NO_x emissions based on estimated mileages for diesel cars in each standard, at both the Euro standard and estimated real-world emission levels (Tables 4 & 5). The mileages were derived from official MOT test data.

Table 4. NO_x emissions from UK diesel cars by annual mileage based on emissions at Euro standard limits.

	Average annual mileage per car (miles)	Total annual mileage all cars (billion miles)	Absolute weight of NO_x emissions (tonnes)	% weight of NO_x emissions
Euro 1, 2 & 3	7,600	14.8	11,900	27.0
Euro 4	9,400	34.8	14,000	31.6
Euro 5	12,200	58.9	17,000	38.5
Euro 6	13,500	9.9	1,300	2.9
TOTAL	**10,600**	**118.3**	**44,200**	**100%**

Note: Due to the rounding of values, calculations may not equate exactly.

Table 5. NO_x emissions from UK diesel cars by annual mileage based on emissions at real-world estimates.

	Average annual mileage per car (miles)	Total annual mileage all cars (billion miles)	Absolute weight of NO_x emissions (tonnes)	% weight of NO_x emissions
Euro 1, 2 & 3	7,600	14.8	23,900	15.5
Euro 4	9,400	34.8	44,800	29.1
Euro 5	12,200	58.9	75,700	49.2
Euro 6	13,500	9.9	9,600	6.2
TOTAL	**10,600**	**118.3**	**154,000**	**100%**

Note: Due to the rounding of values, calculations may not equate exactly.

By taking the oldest 1.9 million diesel cars off the road (those falling into the Euro 1, 2 and 3 standards and accounting for 17.4% of the UK diesel fleet) there could be a reduction in NO_x emissions from diesel cars of 27% if they emitted at Euro standard limits. But based on estimates of real-world NO_x emissions, the reduction is lower at 15.5%.

If 400,000 of the oldest diesel cars were taken off the road – in line with the number of vehicles scrapped under the 2009/10 scheme – then NO_x emissions from diesel cars would be cut by 5.5%, based on NO_x emissions at the relevant Euro standard limit, or 3.2% when NO_x emissions are considered to be at estimated real-world levels (Table 6). If funded on the same basis as 2009/10 it would cost the government and industry £400 million each: £800 million in total.

However to achieve these reductions in NO_x the scrapped cars would have to be replaced with zero-emission equivalents. If the scrapped vehicles were replaced with new Euro 6 standard diesel vehicles the already relatively-small benefits would be smaller still; more so if the replacement cars did the same mileage as other new Euro 6 diesels rather than the same mileage as those they replaced (also Table 6).

Table 6. Annual NO_x emission reductions under a 400,000 car scrappage scheme, by type of replacement vehicle and miles driven.

	Assumes cars bought under the scrappage scheme are all zero emission		Assumes cars bought under the scrappage scheme are diesel and do same mileage as the older models they replaced		Assumes cars bought under the scrappage scheme are diesel and do same mileage as other new Euro 6 cars	
	Euro standard	ICCT real-world estimate	Euro standard	ICCT real-world estimate	Euro standard	ICCT real-world estimate
% change in annual NO_x emissions	-5.5%	-3.2%	-4.7%	-1.3%	-4%	0.2%
Absolute change in weight of NO_x emissions (tonnes)	-2,500	-4,900	-2,100	-2,000	-1,800	300

Note: Due to the rounding of values, calculations may not equate exactly.

Discussion

Areas for continued discussion/research:

1) Few doubt discrepancies exist between Euro standard limits and real-world emissions. But accurately judging the size of those gaps is critical when making calculations that influence policy, could lead to huge taxpayer contributions and affect people's health.
2) All other things being equal, you would expect the natural scrappage cycle of cars to reduce NO_x emissions. A formal scrappage scheme would accelerate the process. But by how much and at what cost?
3) At what rate does a car's performance degrade? I.e. if a car returned 40 mpg as new in 2000, what would it return today? What has happened to associated emissions levels?
4) Where are diesel cars driving? Are they mostly on inter-urban routes where NO_x emissions might be less of an issue than in more congested and densely populated towns and cities? Is there a difference in travel patterns between older and newer vehicles?
5) Could the £400 million of government money be better spent improving air quality by another method? Perhaps by retrofitting buses, taxis and HGVs all of which contribute significantly to NO_x emissions?
6) Is there a level at which the benefits of a scrappage scheme would outweigh the costs and if so would it be an affordable level for the government?
7) Where do concerns about NO_x emissions sit alongside worries about CO_2 and particulates?
8) With understanding of the air quality problem being updated and improved all the time are government policies keeping up with the science?
9) Would current infrastructure be able to support the sudden growth in the number of electric vehicles that could result from the introduction of a scrappage scheme?

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