The Social Costs of Air Pollution from Cars in the UK

By Neil Lock

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Back in April the mayor of London, Sadiq Khan, introduced from the coming October a £10 a day "toxicity charge" for pre 2006 cars, both petrol and diesel, entering the current London congestion charge zone. He also set out plans for a London "Ultra Low Emissions Zone" (ULEZ) [[1]]. From April 2019 (brought forward from September 2020), it will cost £12.50 per day to drive in this zone a diesel car first registered before September 2015, or a petrol car built before 2006. Furthermore, he plans to extend this zone to the area inside the North and South Circular roads by 2021.

It was also mooted that drivers of diesel cars first registered before September 2015 should be charged to enter any of up to 35 cities around the UK. In some cases, there would also be bans on diesel cars driving into cities at certain times of day. This raised the spectre of greedy, activist, anti-car councils all over the UK imposing arbitrary bans and heavy charges on diesel drivers who enter, or drive within, their areas.

More recently, as reported by the *Daily Mail* [[2]], the government has said such measures are intended only as a last resort, only for the dirtiest cars and only when they are actually using the few dozen roads which have been identified as the worst polluted. However, it still isn't clear what other punitive taxes they are planning in an effort to force people out of diesel cars.

I myself drive a 2011 diesel car. When my previous (petrol) car failed in early 2014, I was looking for a car to keep running at least until 2023 (when I will be 70), and hopefully many years longer. I didn't intend to or want to buy a diesel. But I couldn't find a petrol example of the model I wanted. I later found out this was because the manufacturer had made 40 diesel cars of that model for every petrol one. So, as I approach retirement, I'm likely to be stuck with a car I can't afford to replace, and taxes and charges I can't afford to pay.

Social cost

My immediate reaction to the proposed schemes was that the charges seemed outrageously high. So, having long ago been trained as a mathematician, I decided to try to calculate the "social cost" of the pollution from cars in the UK, so I could compare it with the proposed charges.

Social cost is the total expense, to all those affected, of the effects of an activity. In the context of pollution, the term is used to mean the total cost of the "externalities" (that is, secondary or unintended consequences) caused by the pollution, and specifically by its effects on health.

In making these calculations, I uncovered some interesting backstory on the issue, some of which may be new to many people. So, my purpose today is twofold. One, to tell the backstory as best I can. And two, to come up with some rough figures of how much people *ought to* have to pay for the health effects on others of driving their diesel or petrol cars. So, what I'm going to do is work out this social cost, as best I can, as a number of pounds per car per year. And then I'm going to break it down among cars of various ages, according to the emissions standards which were in force at the time they were built.

The players

As in almost any governmental activity, there's an alphabet soup of agencies involved. Here is a list of the major players in the case.

- **WHO** (World Health Organization). This is a United Nations agency, concerned with public health on an international level. It issues "guidelines" which, in matters of air quality, offer global guidance on thresholds and limits for key air pollutants that pose health risks.
- **COMEAP** (Committee on the Medical Effects of Air Pollution). It provides independent advice to UK government departments and agencies on how air pollution impacts on health.
- **DEFRA** (Department for Energy, Food and Rural Affairs). Its involvement in the case includes: Reporting on emissions of air pollutants in the UK as a whole. Making calculations on the social costs of pollutants as an input to policy, on the basis of guidelines provided by COMEAP. Providing information to the public on air pollution, limits and targets, and air quality policy.
- **HPA** (Health Protection Agency). It produced a significant 2010 report on COMEAP's behalf.
- **RCP** (Royal College of Physicians). Together with the **RCPCH** (Royal College of Paediatrics and Child Health), it produced a 2016 report on the long term effects of air pollution in the UK.
- **LAQN** (London Air Quality Network). It reports, since 1993 and normally yearly, on air quality at various sites in inner and outer London, including kerbside, roadside and urban background sites. These reports indicate how well the air quality meets (or not) the limits and targets it is supposed to.

The pollutants

For cars, two pollutants are of interest: particulate matter (PM) and nitrogen oxides (NO_x).

Adverse health effects from PM come mainly from one kind of PM, called $PM_{2.5}$. These are particles smaller than 2.5 micrometres. The calculations made by COMEAP and the HPA regarding the health effects of PM have all concentrated on $PM_{2.5}$.

As to nitrogen oxides, the generic term NO_x means a combination of two oxides of nitrogen, nitric oxide (NO) and nitrogen dioxide (NO_2). Since NO rapidly oxidizes to NO_2, measuring it is

done, in effect, by measuring NO_2. Hence, in the context of air pollution, the terms NO_x and NO_2 are often used interchangeably.

Air quality limits and targets

In the UK, air quality standards are the province of DEFRA [3]. According to DEFRA, "Action to manage and improve air quality is largely driven by European (EU) legislation. The 2008 ambient air quality directive… sets legally binding limits for concentrations in outdoor air of major air pollutants that impact public health." The 2008 directive was incorporated into English law in 2010, around the time of the change of government from Labour to the Coalition.

The standards are supposed to be "acceptable in terms of what is scientifically known about the effects of each pollutant on health and the environment." Broadly, there are Limits and Targets. Limits are "legally binding EU parameters that must not be exceeded." Targets are "to be attained where possible by taking all necessary measures not entailing disproportionate costs." For the pollutants of interest, they are specified as annual concentration means, or as the mean over a period of time within a day, with an allowed number of exceedences.

Emissions standards

The EU sets emissions standards for vehicles for both PM and NO_x [4]. UK standards have generally been kept in line with EU ones.

Every five years or so, the EU makes new, tighter standards. The vast majority of cars now on the road in the UK were required to be built to one of four standards: Euro 3 (applies to cars built since 2001), Euro 4 (since 2006), Euro 5 (since September 2010) and Euro 6 (since September 2015).

For PM, the limits to be met by diesel cars have been successively reduced. Thus, Euro 5 and 6 diesels produce only a tenth as much PM as Euro 3 ones. For petrol cars, no limit was set until Euro 5, and this only applies to cars with direct injection engines (and is the same as the limit for diesels of the same year).

For NO_x, the standards for both petrol and diesel cars have also been tightened between Euro 3 and Euro 6. Of course, for diesels this is somewhat moot, since it's now clear that most diesel cars don't actually meet, in the real world, the NO_x limits they were supposedly designed for.

Half a century of progress

DEFRA produce each year a statistics release on emissions of air pollutants in the UK over that period. This covers pollution from all sources, not just cars. The latest report [5], published in December 2016, covers the period up to 2015.

As the graph on page 2 of the report shows, progress in reducing air pollution in the UK over the period of almost half a century since 1970 has been most impressive. Levels of $PM_{2.5}$ in 2015 were less than a quarter of what they had been in 1970, and levels of NO_x less than a third. And I don't remember the air being badly polluted back in 1970, at least not where I lived. Haven't we done well? Which prompts the question: having done so well, why should we be expected to make any more sacrifices?

Reports, Reports, Reports

There are five UK reports, on which I've based my calculations. I've put them in chronological order. If you're not interested in the gory detail, you can skip to the next section, as I've included brief summaries and some headline quotes from the documents below.

- COMEAP, "Long-Term Exposure to Air Pollution: Effect on Mortality," 2009 [6].
- HPA (on behalf of COMEAP), "The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom," 2010 [7].
- DEFRA, "Valuing impacts on air quality: Updates in valuing changes in emissions of Oxides of Nitrogen (NOX) and concentrations of Nitrogen Dioxide (NO2)," September 2015 [8].
- COMEAP, "Interim Statement on Quantifying the Association of Long-Term Average Concentrations of Nitrogen Dioxide and Mortality," December 2015 [9]. This included a copy of the recommendations COMEAP previously made to DEFRA in July 2015.
- RCP and RCPCH, "Every breath we take: the lifelong impact of air pollution," February 2016 [10].

Early Deaths and Mortality Costs

Most people will have heard sound bites like "23,500 early deaths a year" caused by the "toxic fumes" of nitrogen oxides. Or even 40,000. But this doesn't mean at all that each year there are 40,000, or even 23,500, corpses with death certificates that say "Killed by pollution from diesel cars". Rather, calculations suggest that of the people who died in a given year (in this case 2013), about 23,500 had lost a certain fraction of their lives due to NO_x pollution from all sources. That fraction turns out to be about 11.7 years on average. This can equally well be put as a loss of life expectancy from birth, for everyone, of a little less than five months.

To match that 23,500 figure, DEFRA give a social cost figure of £13.3 billion. Big scary number, heh? Dividing out, I get £566,000 per death caused by pollution.

I haven't found any document justifying this number of £13.3 billion. Some seem to think it only includes the effects of the pollution on those who die of it, not on everyone. (In technical terms, only "mortality," not "morbidity"). But looking at reports from as far back as 2004, it seems that DEFRA do aim to include both lethal and non-lethal health effects in their calculations. And they use the term "social cost" without qualifying it to say that it includes some costs but not others.

The backstory on PM

I'll deal with PM first. Not only because it was the first of the two pollutants to be investigated in terms of health effects, but also because the backstory is less controversial, and the calculation less convoluted, than for NO_x.

Following the 1992 Rio summit, attention was directed for the first time at trying to quantify the health effects of long term exposure to air pollution. A major study on $PM_{2.5}$ was carried out in the USA on behalf of the American Cancer Society in about 1995, and updated in 2002.

The 2009 COMEAP report

The first UK specific report on the matter was produced in 2009 by COMEAP [6]. Broadly, they agreed that the approach used in the 2002 US study was applicable in the UK too. They set out to estimate the value of the "risk coefficient" which should be used. (The risk coefficient is the percentage chance of death from a pollutant for a given unit of change of concentration. In this case, the unit of concentration was 10 micrograms per cubic metre). They agreed that the risk coefficient suggested by the US study, 6 per cent (also sometimes stated as a "relative risk" of 1.06) would also be appropriate as the best estimate of the risk in the UK.

However, they were unsure about the level of confidence that ought to be placed on this estimate, as it appeared that standard statistical methods could not be used. They therefore used a novel method they called "expert elicitation." Seven experts each made judgements on how likely they thought the risk coefficient was to be above each number from zero to 17 per cent. The results were pooled, and they concluded that the uncertainty in the risk estimate was so high that the true value of the coefficient could be anywhere between 1 per cent and 12 per cent. And even the chance of it being inside that range was only three-quarters.

As you can see from the numbers on page 157 of the report, the experts came up with wildly different ideas. One, expert A, gave almost every percentage the same chance. In other words, he was saying "I have no idea at all what the true risk value may be". At the opposite extreme, expert D reckoned there was a 50 per cent chance of the value being less than 1 per cent. That's an order of magnitude lower than the "consensus" estimate of 6 per cent.

So, there is very little certainty in this report's central estimate. There is a factor of 12 between the upper and lower bounds! Imagine if a businessman asked one of his staff to estimate the cost of a project so he could work out whether to go ahead with it or not, and got the answer "between £1 million and £12 million." Or if an engineer wanted to know how big a plug he needed to stop a particular gap, and was told "between an inch and a foot." And yet numbers with such wide error bounds, it seems, are considered good enough for social engineering. They are seen as good enough for making political policies which will severely affect, and if got wrong will unjustly hurt, millions of people. They're "good enough for government work."

The 2010 HPA report

The next report was produced in 2010, on COMEAP's behalf, by the HPA [7]. This used the figures from the earlier COMEAP report to derive specific estimates of mortality rates due to $PM_{2.5}$. The headline conclusion was:

"An effect on mortality in 2008 of nearly 29,000 deaths in the UK at typical ages and an associated loss of total population life of 340,000 life-years. The burden can also be represented as a loss of life expectancy from birth of approximately six months."

To their credit, the HPA went out of their way to make it clear that this did *not* mean 29,000 death certificates with "$PM_{2.5}$" as cause of death. At one extreme, it meant that 29,000 people who died in 2008 could be considered to have lost on average 11.7 years of their lifespan due to the effects of $PM_{2.5}$. At the other, it meant that everyone in the population would on average have their life expectancy lowered by about six months due to these effects.

The HPA were also careful to stress the huge uncertainty in COMEAP's risk estimate. They said:

"Using the 75% plausibility interval suggested by the expert elicitation in COMEAP (2009) this means a range of effects on mortality equivalent to 4,700–51,000 deaths with a loss of 55,000–597,000 years of life in 2008, or effects on average life expectancy of between 1 month and one year, for England and Wales."

The formula they used

I reverse engineered the calculation the HPA did for 2008 mortality due to $PM_{2.5}$ in the UK as a whole, using the data on pages 61 and 65-67 of their report. This is the formula I think they used:

$$D = D_0 \times \left(\frac{R}{1+R}\right) \times \left(\frac{C}{U}\right)$$

Here, D_0 is the total deaths in the population aged 30 and over (568,680). R is the risk coefficient (6% or 0.06). C is the actual concentration of the pollutant (8.97 micrograms per cubic metre), and U is the unit of concentration for which the risk coefficient is estimated (10 micrograms per cubic metre). When I plug these numbers into the equation, I get a figure for D of 28,874, against the HPA's 28,861. The difference, I think, is explained by the HPA having used in their calculation a more accurate value of the concentration (8.966 rather than 8.97) than the rounded one they gave in the report.

It struck me that there is a less sensationalist, and perhaps more informative, way to express this number than in deaths per year. The fraction

$$\frac{D}{D_0} = \left(\frac{R}{1+R}\right) \times \left(\frac{C}{U}\right)$$

represents the proportion of all deaths in the year, of those who died aged 30 or older, which can be attributed to this specific cause. Using the HPA's figures for UK wide $PM_{2.5}$ in 2008, this comes out as just over 5 per cent (to three significant figures, 5.08%). So it's possible to re-state the "29,000 deaths" meme as: "Among people who died aged 30 or older in 2008, just over 5 per cent died as a result of long term exposure to air pollution by particulate matter."

It's also worthy of note that the equation is linear in the concentration, C. As I understand from the HPA report, this is OK for small values of the concentration, where C is smaller than, or not much greater than, the unit U. But it wouldn't be correct, for example, to calculate the figure for 1970, when $PM_{2.5}$ levels were four times those in 2008, as four times the above, and so to say "over 20 per cent of deaths over age 30 in 1970 were due to particulate matter pollution." I'd be interested to know what COMEAP and HPA think was the percentage of deaths attributable to PM back in 1970.

A sanity check

I always like to sanity check my results by comparing with figures calculated in different ways from different sources. So, I looked at a WHO fact sheet [11]: "Ambient air quality and health."

It gives an estimate of 3 million premature deaths world-wide caused by air pollution of all types in 2012. It also says that 92 per cent of the world population live in places where the WHO's air quality guidelines are not met. Now the UK's population in 2012 was 0.9 per cent of the world population. So if the UK was average in pollution among all countries, we would expect about 27,000 of these deaths to be in the UK. But we know that the UK *does* meet the guidelines for all

pollutants except NO_x; it's in the least polluted 8 per cent of the world. So either the WHO's number is low, or the HPA's 29,000 for 2008 – and that's for $PM_{2.5}$ on its own! – is over the top.

The per-car social cost of PM from diesels

To work out the social cost of PM pollution per diesel car per year as at 2008, I needed to find out some more numbers.

- The fraction of $PM_{2.5}$ emissions attributable to road transport in 2008 – 24 per cent, from [12].
- The fraction of these emissions attributable to diesel cars as opposed to other diesel forms of transport. (I assumed that PM emissions from petrol engines were negligible compared to diesels). In a National Statistics fact sheet on fuel consumption [13], I found a graph of fuel consumption by vehicle types for a number of years, including 2008. This shows that diesel car fuel usage, and so presumably emissions, were one third of the total for diesels.
- The number of diesel cars on UK roads in 2008 – 7.16 million, from spreadsheet VEH0203 at [14].

I was now ready to calculate the social cost per car for emissions of PM from diesel cars as at 2008. It came out to £183 per car per year. So, if the numbers going in to my calculation are accurate, the problem of PM pollution from diesel cars was real back in 2008.

Apportioning PM costs from diesels between Euro standards

Next, I needed to apportion this cost of £183 between cars of different ages. In 2008, Euro 4 was the newest standard, having been in force since January 2006. I used spreadsheet VEH0207 at [14] to calculate how many of the cars on the UK roads were less than three years old in 2008. I assumed that the proportions for diesel cars were roughly the same as for all cars. I also assumed that the cars older than Euro 4 were, on average, meeting the Euro 3 standard. Dividing the social cost between these in proportion to the PM levels allowed by the standards, gave a social cost per car per year of £207 for Euro 3 and £103 for Euro 4 cars. And, as Euro 5 marked a five-fold decrease in the PM limit, with no further decrease for Euro 6, the social cost per car per year came out to £21 for both Euro 5 and Euro 6.

Note that these social cost figures don't depend on which year the data came from. As long as it keeps to the same standards it was originally built to, the contribution of any individual car to the social cost, ignoring inflation, will remain the same from one year to the next.

The backstory on NO_x

Now, it's time to look at NO_x. The history is chequered. It begins in 2001, when prime minister Tony Blair, chancellor Gordon Brown and chief science adviser David King decided to offer incentives to drivers to buy diesel cars. They did this, supposedly, because diesel engines emit less carbon dioxide (CO_2) per mile than petrol ones, and so were expected to cause less putative "global warming!"

By early 2006, a problem was becoming apparent. Insiders at the European Federation for Transport and Environment [15] had found out that, in the "real world" as opposed to laboratory testing, emissions of NO_x from diesel engines were much higher than the emissions limits the cars were supposedly built to meet.

And this had effects on measured air quality, too. The LAQN's report for 2006 and 2007 [16] – which, curiously, wasn't published until 2009 – stated that the EU limit value for NO_2 was being "consistently exceeded at background sites in inner London and at roadside sites throughout London." And that the increases: "are thought to be due to changes in diesel vehicle technologies ... and an increase in the proportion of diesel vehicles on London's roads."

More curiously still, the LAQN report for 2008 wasn't published until November 2012. In contrast to earlier reports, it was slim. It had no management summary, had only raw data with very little accompanying text, and drew no conclusions. The 2009 and 2010 reports followed during the next month. It's hard to avoid the suspicion that Gordon Brown, the prime minister in 2009/10 and one of the architects of the diesel scheme, had the original 2008 report suppressed. And that the Coalition either didn't find out about it, or continued to suppress it, until 2012.

In early 2014, the NO_x problem became "official," with a court case brought against the UK by the European Commission [17].

In July 2015, COMEAP issued guidelines to DEFRA on how to estimate the mortality associated with NO_x pollution. These are attached to reference [9]. They suggested a risk coefficient of 2.5 per cent, with a range of uncertainty from 1 per cent to 4 per cent. I haven't found any document justifying these numbers, so I can't assess how good or bad they might be.

COMEAP also suggested that this coefficient should be reduced by up to 33 per cent when calculating NO_x health effects in conjunction with PM, to avoid double counting. They also made a *caveat*: "there is uncertainty in the extent to which the association between long-term average concentrations of NO2 and mortality is causal." So, the science is not "settled" at all!

In September 2015, DEFRA issued their report on NO_x [8]. The bottom line, for NO_x alone and based on 2013 data, was a central estimate of 23,500 deaths and a £13.3 billion social cost. This is the source of the 23,500 deaths figure you hear in the media. The ranges were from 9,500 deaths to 38,000.

Around the same time, September 2015, the Volkswagen diesel scandal erupted in the USA. The fact that many diesels failed to meet the emissions standards they were supposed to have been built to – known to insiders as early as 2006 – became public knowledge for the first time.

In December 2015, COMEAP issued revised guidelines [9]. They said that the combined effects of $PM_{2.5}$ and NO_x together might not be any greater than the effects of $PM_{2.5}$ or NO_x calculated individually. Meaning, that the overlap factor by which one result should be reduced, before it can be added to the other, would be higher than the 33 per cent they had previously reported, and might be as high as 100 per cent. They also admitted that their previous figures of mortality effects of $PM_{2.5}$ were probably over-estimated.

The RCP report

In February 2016, the RCP and RCPCH published their report [10]. The chair of the RCP's working group, Stephen Holgate of Southampton University, was also on the panel that produced the COMEAP report back in 2009. (I wonder which of the seven experts he was?) And the vice chair, Jonathan Grigg, was quoted in the mayor of London's press release [1]: "To maximise the effectiveness of this initiative, the Government must now act to remove the current toxic fleet of diesel cars, vans and buses from all our roads."

Even the title of this report is alarmist. It has a general tone of rampant greenism and nanny-statism. And it includes the phrase "climate change" more than 70 times. This is zealotry, not science.

The bottom line paragraph in this report goes as follows:

"When quantifying the total impact associated with exposure to both NO2 and PM2.5, it is therefore necessary to account for this overlap in the response functions. Defra estimates that the annual equivalent number of attributable deaths associated with the two pollutants combined is 44,750–52,500, with an associated annual social cost of £25.3 billion – £29.7 billion. However, a subsequent paper issued by COMEAP in December 2015 indicates that the level of overlap in estimates between pollutants may be greater than originally thought. On this basis, while recognising that COMEAP's research on this issue is continuing, this report adopts a combined estimate of effect of around 40,000 deaths annually with an associated annual social cost of £22.6 billion (both with a range for a central estimate of ±25%)."

That's where the headline-grabbing figure of 40,000 deaths came from. For the overlap factor, they have reduced the NO_x deaths figure, before adding the two together, by a little more than half. And the reduction in the risk coefficient is also a little more than half. This is plausible, given COMEAP's advice. But the range given, ±25%, is way less than the error bounds in the numbers we started with – a factor of 12 for PM and a factor of 4 for NO_x. That can't be right.

The per-car social cost of NO_x

The calculation for NO_x is made harder than the one for PM by three things. First, DEFRA's deaths figure is based on 2013 data, not 2008. As I don't have numbers for 2013 on emissions from different types of transport, I'll have to move my window to a different year. So I'll use a year, 2015, for which I do have the data I need to complete the calculation. Second, petrol cars emit a significant amount of NOx. So their share has to be taken into account. And third, I want to estimate the cost of the manufacturers' failure to build their diesel cars to the standards they were supposed to meet. So I'll need to do the diesel calculations twice over: once with real world emission levels, and once with the values from the standards.

The first step is to move DEFRA's deaths figure of 23,500 from 2013 to its equivalent in 2015. NO_x levels in 2015 were roughly 11 per cent lower than they had been in 2013. But the total number of deaths of people aged 30 or older increased from 2013 to 2015 by about 4.6 per cent [18]. So the equivalent deaths figure for 2015 comes out to 21,883, to the nearest individual.

Now, the other numbers I need:

- The fraction of all NO_x emissions attributable to road transport in 2015 – 34 per cent, from [5].
- The fraction of road transport NO_x emissions attributable to diesel cars in 2015. In the recent air quality plan [19], produced jointly by DEFRA and the Department of Transport, I found a pie chart of emissions from different sources in 2015 (Figure 3a). Eyeball and protractor measured the sector for diesel cars as 34.4 per cent of all NO_x emitted by road traffic.
- The fraction of road transport NOx emissions attributable to petrol cars in 2015. This is shown in the same pie chart as the diesel emissions. It's 8.1 per cent.

- The number of diesel and petrol cars on UK roads in 2015 – VEH0203 at [14] gives 11.4 million and 18.5 million respectively.

Cranking the handle of the calculator, I get £127 per car per year as the social cost of NO_x emissions from all diesel cars, and £18 for all petrol cars.

Apportioning NO_x costs from diesel cars between Euro standards

Next, I need the numbers of diesel cars on the roads in 2015 that were (supposedly) built to each of the Euro standards. I found these in a working paper produced by the RAC [20]. Happily, the same table also shows estimates of actual NO_x emissions for each category. Happier yet, they match the numbers shown in the air quality plan [19].

I calculated the following social costs of NO_x from diesel cars, per car per year, broken down by Euro standard:

Standard	Social cost of real world emissions	Social cost if cars met their standards	Social cost due to manufacturer fault	%age due to manufacturer fault
Euro 3	£158	£79	£79	50.0%
Euro 4	£127	£40	£87	68.7%
Euro 5	£127	£29	£98	77.5%
Euro 6	£95	£13	£82	86.7%

Apportioning NO_x costs from petrol cars between Euro standards

For petrol cars, I don't have figures on the distribution of the cars among Euro standards. So I'll have to assume that the proportions are roughly similar to diesels. The calculated social costs, per car per year, are: Euro 3 £33, Euro 4 £18, Euro 5 and Euro 6 £13.

Putting PM and NO_x figures together

Here, I hit a problem. COMEAP recommend that the risk coefficient (and thus, approximately, the deaths figure and so the social cost) from one pollutant should be reduced by an overlap factor before adding it to the other. But it makes a difference whether you calculate PM first and then adjust the NO_x figure (as COMEAP initially recommended) or calculate NO_x first and then adjust the PM, or use coefficients each adjusted for the other pollutant. With a range of figures like mine, I think the third method would be the most appropriate. But I don't know the values of those coefficients. So, I decided to take a simple approach, and to apply the same overlap factor to the estimates for both pollutants. That is, I'll simply add up the two figures and then multiply by 40,000/52,500 (approximately 76.2 per cent) as suggested by the deaths figures quoted in the RCP report.

The results are as follows:

Standard	Social cost of real world emissions	Excess over 2017 car of same type	Social cost if cars met their standards	Driver excess over 2017 petrol	Social cost due to manufacturer fault	%age of total due to manufacturer fault
Euro 3 diesel	£278	£190	£218	**£205**	£60	21.6%
Euro 4 diesel	£175	£87	£109	**£96**	£66	37.7%
Euro 5 diesel	£113	£25	£38	**£25**	£75	66.4%
Euro 6 diesel	£88	N/A	£26	**£13**	£62	70.5%
Euro 3 petrol	£33	£20		**£20**		
Euro 4 petrol	£18	£5		**£5**		
Euro 5 petrol	£13	£0		**£0**		
Euro 6 petrol	£13	N/A		N/A		

The "excess over 2017 car of same type" column shows the difference in the social cost of real world emissions between a car built to one standard and a new car of the same type. The "driver excess over 2017 petrol" column (bolded) shows the difference in social cost between a diesel or petrol car built to one standard and a new petrol car, if the diesel cars had met the standards they were supposed to.

What do my figures imply?

To return to where I came in, the over the top level of proposed entry charges to London.

If I can believe the central estimates for both pollutants, there is a case to be made for charging drivers of Euro 3, and perhaps Euro 4, diesels a fee to drive in areas that are especially badly affected by air pollution. But there is no case, on social cost grounds, for such charges on Euro 5 diesels or on any petrol cars. For all these cars, the excess of the social cost of the pollution they emit, compared to a new (Euro 6) car of the same type, is £25 a year or less. Two entry fees to the London ULEZ would cover the social cost of this pollution for a *whole year*. To levy such outrageous charges on drivers of these cars (including me) is unreasonable.

Further, since new diesel cars have a higher social cost of pollution than Euro 3 petrol cars, the question must be asked why Euro 3 petrol cars are to be charged, and Euro 6 diesels not. If the aim was, as claimed, to reduce NOx levels quickly and so meet the EU limit, then drivers of even brand new diesel cars should have been charged. It's hard to avoid the thought that the decision on who to charge for entry to the ULEZ, and who not, was arbitrary and political.

On a longer term basis, there is a case to be made for some kind of pollution charge for diesels; and perhaps for Euro 3 petrol cars. But it should not be more than the difference between the social costs per year of these cars and of a new Euro 6 petrol car. Furthermore, diesel drivers should not be penalized for the part of the cost which is down to the manufacturers' fault; and most of all for Euro 5 and 6 diesels, where the manufacturers' component is more than two-thirds of the total social cost. So, on social cost grounds, no-one should be charged more than the figures in the "Driver excess over 2017 petrol" column in my table above. If the new taxes, when they are announced, are any bigger than this, we'll know we've been had. Again.

And let's not forget the uncertainty in the figures. The true impacts of the pollution might easily be a quarter, or even less, of the figures I used. What if that turns out to have been the case?

Millions of drivers will have suffered huge, unnecessary costs, and the unlucky will have lost their personal mobility entirely. And some of them may have lost their livelihoods as a result. If that happens, who will pay for the fiasco?

Life Expectancy

It's interesting to follow up on the HPA's estimates of life expectancy. Their worst case is 203 days of life expectancy lost due to all forms of PM pollution in 2008. This equates to about 16 days of loss caused by PM from diesel cars. However, I want to work with the year I did the NO_x calculations for, 2015. So I need to adjust this to take account of the generally cleaner vehicle fleet in 2015 compared with 2008. This brings it down to 11 days.

The loss of life expectancy due to NO_x alone will be in proportion to the number of deaths figure from NO_x. Thus the loss of life expectancy due to NO_x emissions from diesel and petrol cars combined is 22 days. Adding the numbers together and multiplying by the overlap factor gives an average loss of life expectancy due to air pollution from cars, at 2015 levels, of 25 days.

Which would you prefer? To travel where you want, when you want, in the comfort and privacy of a fast, smooth, quiet, spacious car? Or to be granted an extra 25 days at the end of your life, and in exchange to be forced to spend your travelling life waiting at bus stops in the pouring rain or standing on freezing station platforms, and when you finally do get moving it's noisy, rattling, uncomfortable, crowded and often slow? I know which I'd pick. Moreover, wouldn't you spend a lot more than 25 days of your life at those bus stops and on those platforms? (Exercise for the reader: how many days is 5 minutes a day over a lifetime?)

The political backstory

To grasp how this sad and sorry situation came about, it's necessary first to understand two things. One, that the United Nations, of which the WHO is an agency, is the force behind the world-wide environmentalist agenda, which is the cause of so much pain to ordinary people in the Western world. And two, that the UN has been pushing this agenda for more than 30 years. For those interested in the backstory behind the backstory, I myself have documented [21] the history of the 1987 UN report that set the green juggernaut rolling, and led to the 1992 Rio summit and all that has happened since.

If you read further into the WHO fact sheet [11] I referenced earlier, you will find a list of policies they recommend to reduce air pollution. Such as: Making us walk, cycle or use public transport instead of cars. Cramming us into compact cities and high-rises. Recycling as a religion. Dismantling our affordable, reliable energy infrastructure, and replacing it by energy that is expensive, intermittent and requires gigantic solar arrays or ugly, noisy wind farms. That's the deep green agenda. It's not designed for *our* benefit, is it?

And if you think that "fixing" the immediate problem of NO_x emissions from diesel cars will get the so called "green blob" off our backs, think again. For example, for $PM_{2.5}$ the EU (and so UK) limit today is two and a half times the WHO guideline set back in 2006. There will surely be pressure to drive that limit down. But as reported by the LAQN, in 2015 no sites in London, which could reliably make the measurement, actually met this guideline limit.

This is not about solving a problem and then getting on with our lives. It's about an agenda. Something I noticed about the HPA report is that much of it is concerned, not with the burden of

PM pollution as it was at the time, but with the effects of changes to, and especially reductions of, the concentration. This is, in my opinion, cart before horse. Rationally, the first question to ask should be, "How big is the problem?" And only when you have a good handle on that can you sensibly ask, "What might we do to fix it?" It's as if the agenda was already predetermined, and the HPA were simply told to fit in with it.

That agenda was hammered out in the late 1980s, and agreed by politicians from most countries, including the UK, at the 1992 Rio summit. John Major was prime minister at the time. They were setting out to transform Western societies, and the world as a whole, into a utopian model of so called "sustainable development." The narcissistic politicians and their cronies wanted the fame and glory of "saving the planet." And it didn't matter how much the little people suffered. So, in came Guidelines and Directives and Limits and Targets, and all the paraphernalia of the system under which we suffer today. And bad laws were made, which should never have even been contemplated. Bad laws which, as Edmund Burke told us, are the worst sort of tyranny.

The whole idea of setting hard, inflexible, ever tightening collective limits on what people may do is madness. As is the idea, that such limits should be set without any concern for cost-effectiveness. Most of all, it is madness even to try to set such limits when the underlying science isn't fully understood. If COMEAP, who are supposed to be the experts, can't accurately calculate the toxicity of the mixtures of pollutants that exist in the real world, and can't even estimate the toxicity of $PM_{2.5}$ on its own to better than a factor of 12, how can someone at the WHO, or at the EU, or at DEFRA possibly claim a right to set hard limits for concentrations?

Perhaps, in the heady atmosphere of the build up to Rio, Major and his cohorts failed to detect the zealotry of those pushing the deep green agenda. Or perhaps they may have, at least in part, bought into the agenda themselves. Or perhaps going along with it just seemed like a good idea at the time. But they were wrong, I think, to sign up to the Rio agreements. And that is the root cause of all these problems. Furthermore, to sign up to the idea of hard EU or WHO limits on air pollution was wrong too. If nothing else, allowing UK policies to be set by third parties – and third parties with agendas, to boot – is a denial of democracy.

Blair, Brown and King were wrong to encourage diesels, too. Not so much because of the pollution aspect, but because their push to reduce CO_2 emissions was (and still is) based, as anyone who has looked hard and objectively at the facts will know, on no more than bad "science," hype and skullduggery. If Brown or others had LAQN reports suppressed, that was wrong as well. The car manufacturers were wrong to hide for so long their failure to meet diesel emissions standards in the real world. If, as I suspect is possible, they were pressured into that position by the EU, that was wrong too. And we drivers are to be expected to make enormous sacrifices, both financially and in convenience, for the sake of bailing out those that have done these things to us? That's about as wrong, wrong, wrong as you can get.

How pollution might be dealt with in a sane world

I'll make it clear at this point that I'm not at all advocating that people should be allowed to pollute air, water or other common resources exactly as they want to. In fact, I entirely agree with the principle of "polluter pays." Those responsible for the pollution – and that includes politicians like Blair and Brown, and their advisers – should pay for its consequences to those who are harmed by it. This is a particular case of the general idea of personal responsibility; that people, who unjustly cause damage to others, have a responsibility to compensate those affected.

The problem of pollution is an example of a case where one group of people – I'll call them *A* – wants to do an activity *X*, which brings great benefits to them. However, it has side-effects which have negative consequences for another group of people, *B*. Here's an idea for how I think such problems might be dealt with in a world saner than today's.

First, you must get an objective, accurate estimate of the social cost of *X*. Plus or minus 10 per cent would be reasonable. If the cost of *X* to group *B* is so big that it outweighs the benefits to *A*, there may be a case for prohibiting *X* entirely. (That's not the case here, of course). Otherwise, you apportion the social cost of *X* according to how much of the problem each individual is responsible for. That's what I've been aiming to do here, by calculating costs per car per year.

Then you need to apportion the costs borne by group *B* among the members of *B*. In the case of air pollution from cars, this might be based on where an individual lives, and how close to badly polluted main roads. Then you simply require each individual in *A* to pay the relevant fraction of the cost, and pass the relevant fraction to each member of *B*.

In such a scheme, once the costs and compensations have been assigned, government acts as no more than a router. All it does is make sure the right amounts are collected from the right people, and the right amounts are distributed to the right people. There are no political policies in such a scheme, no arbitrary limits which must not be exceeded, and no infringements of freedom.

In conclusion

If my figures are right, then on the specific issue of air pollution from cars in the UK, there may be a case for charging drivers of Euro 3 and perhaps Euro 4 diesel cars to enter certain very limited areas like central London. There is no social cost case for any such charges for Euro 5 or 6 diesels, or for any petrol cars. There is a case for charging drivers of diesels, and of petrol cars which do not meet the latest standard, an amount equivalent to the social cost of the pollution they cause (excluding the part of the pollution from diesels which is the manufacturer's fault). There is no case for charging any more than this.

But there's a much wider issue behind all this. Car drivers today, and diesel drivers in particular, are victims of a sequence of collusions and wrongdoings, which stretches back more than 30 years. All this comes, ultimately, from an agenda that was hatched, and has been pushed forward, by the United Nations. And which most politicians and too many others in government, egged on by extremist cheerleaders like Greenpeace and their fellow travellers in academe and the media, have been all too happy to lend their weight to. Without any regard for the negative consequences on the people they are supposed to serve.

It is high time, I think, for the good people of the UK and of the world to wake up. To see the deep green agenda for what it is. To reject it and its proponents. And to seek to set up in its place just measures based on good science, honesty and common sense.

Links:

[1] https://www.london.gov.uk/press-releases/mayoral/mayor-plans-to-introduce-ulez-in-april-2019
[2] http://www.dailymail.co.uk/news/article-4730134/All-petrol-diesel-cars-banned-2040.html
[3] https://uk-air.defra.gov.uk/air-pollution/uk-eu-limits
[4] https://en.wikipedia.org/wiki/European_emission_standards

[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/579200/Emissions_airpollutants_statisticalrelease_2016_final.pdf
[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/304667/COMEAP_long_term_exposure_to_air_pollution.pdf
[7] https://www.gov.uk/government/publications/comeap-mortality-effects-of-long-term-exposure-to-particulate-air-pollution-in-the-uk
[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/460401/air-quality-econanalysis-nitrogen-interim-guidance.pdf
[9] https://www.gov.uk/government/publications/nitrogen-dioxide-interim-view-on-long-term-average-concentrations-and-mortality
[10] https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution
[11] http://www.who.int/mediacentre/factsheets/fs313/en/
[12] https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1009030925_2008_Report_final270805.pdf
[13] https://www.gov.uk/government/statistics/sub-national-road-transport-fuel-consumption-2011-factsheet
[14] https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars
[15] https://www.transportenvironment.org/docs/Bulletin/2006/2006-02_bulletin146_web.pdf
[16] https://www.londonair.org.uk/london/asp/reportdetail.asp?ReportID=lar2006&ReportType=All
[17] http://europa.eu/rapid/press-release_IP-14-154_en.htm
[18] https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/datasets/the21stcenturymortalityfilesdeathsdataset
[19] https://consult.defra.gov.uk/airquality/air-quality-plan-for-tackling-nitrogen-dioxide/supporting_documents/Draft%20Revised%20AQ%20Plan.pdf
[20] http://www.racfoundation.org/assets/rac_foundation/content/downloadables/Diesel_scrappage_scheme_calculation_Al_PG_Final_March_11_2016.pdf
[21] https://wattsupwiththat.com/2017/04/20/our-common-future-revisited-how-did-the-roadmap-for-the-green-juggernaut-fare-over-30-years/