The Alliance of British Drivers

A Review of the Evidence concerning Urban Air Quality and Public Health

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Summary: Air Quality and Public Health

- Average UK life expectancies are most heavily influenced by occupational-, wealth, and lifestyle factors
- Measures to restrict private car use on emissions grounds are based on junk epidemiology
- The effects on mortality of emissions from private vehicles are sufficiently insignificant to allow the situation to favourably evolve through the steady improvements in the composition and hence emissions performance of the private car fleet
- A typical taxi needs an average occupancy of 3 - 4 passengers to be as environmentally friendly as a typical car for NO_x, NO_2 & PM_{10}s.
- A typical bus needs an average occupancy of 8 - 9 passengers to be as environmentally friendly as a typical car for NO_x and PM_{10}s.
- Instatement of random, on-road emissions testing of all public service vehicles is highly advisable
- Mandatory fitment of particulate-recovery equipment to all unequipped diesel public service vehicles is also highly recommended.
- Legislation to make compulsory fuel vapour recovery equipment installation at all filling stations should be considered
- The advantages and drawbacks of greater adoption of oxygenated fuels should be investigated
- Lane-subtraction schemes that increase emissions, congestion and accident risk should be removed
- The effects on congestion and emissions of replacing current generation public service vehicles with latest generation driverless cars - especially in rural areas and during off-peak hours - should be urgently investigated, and
- The many bypass and other traffic flow enhancement schemes cancelled or postponed by the current and previous governments should be reinstated and expedited.

The Association of British Drivers was founded in 1992 to campaign for improvement in road safety, road user training and education, and for balance in transport policy.

In late 2012, the Association merged with the Drivers' Alliance to form the Alliance of British Drivers; retaining its ABD acronym. The ABD is the leading independent drivers' group in the UK.

The ABD is a wholly voluntary organisation, drawing its Directors, Committee Members and membership from a wide variety of industries and occupations. The ABD receives no corporate sponsorship and is funded entirely from the subscriptions of its members.

Introduction: Urban Air Quality & Public Health

In the latter part of 2014, strident demands were once again being made by certain environmental groups (and certain scientifically-misinformed politicians) that yet more stringent emissions controls be applied to private vehicles (mainly cars) and that measures should be implemented to further curtail car use.

Now, it should be clearly emphasised from the outset that the environmental "movement" is in fact a multi-billion pound business with some very specific institutional supporters (e.g., public transport operators). Consequently the objectives and interests of the environmental movement are not always fully aligned with the best interests of either the public or the environment.

Nevertheless a measured, reasoned response is required to the exaggerated claims, made by these groups and some poorly-advised politicians, that car emissions are responsible for thousands of premature deaths every year.

First, let's look at the of the context to these allegations.

The scale of the "problem":
Whether in city centres or elsewhere, due primarily to general improvements in the combustion efficiency and cleanliness of fuels used for domestic heating and in industrial processes (brought about by the Clean Air Acts and subsequent legislation); UK air pollutant concentrations have been falling steadily since the mid-1900s. They are probably at the lowest levels now since before prehistoric Man first created fire and used it for heating and light.

Indisputably, air quality is influenced by vehicle emissions. But these have themselves been declining dramatically since the early 1990s. By 2010 this fall in road transport emissions had exceeded 80% of the 1990 peak levels, dependent on the type of gaseous emission considered [1].

This should be pretty obvious when one realises that a modern, catalysed petrol car's emissions are 99.9% constituted of the benign components nitrogen, water and carbon dioxide. So clean are modern catalysed petrol models that a car in the Ford 'Focus' class produces less than one-sixtieth of the emissions of its 1970's 'Escort' counterpart.

Typical diesel cars in 2014 cars have 64% reduced NO_x emissions and 90% reduced particulate emissions compared with a 2004 model year vehicle[2]. This applies almost without exception across the model ranges of car manufacturers globally. Even assuming no further improvements in existing abatement technology, vehicle emissions will continue to decline for the foreseeable future - whatever the levels of traffic growth.

Those at risk:
The average UK life expectancy from UK births is at record levels: 78 for men and 82 for women. In Kensington & Chelsea (average salary £88,000) it is 85 for men and 90 for women. In Glasgow (average salary £23,500) it is 71 for men and 78 for women. Life expectancy is related to a number of factors, including genetics, wealth, lifestyle, and environment; but the balance of these factors in modern times strongly favours greater longevity. This is why the pension age is being raised, and why the Government struggles with the increased cost of elderly care.

So, we are entirely justified in asking: *"Who & where **are** the headline-grabbing 29,000 who supposedly die each year due to air pollution?"*.

The fact is that the 29,000 aren't real people - they are merely an extrapolation of 'life years lost' guesswork based on 'junk epidemiology'.

The media headline, that man-made air pollution causes 29,000 premature deaths in the UK, is from a report, dated 2010, by the Committee on the Medical Effects of Air Pollutants, CoMEAP. Its snazzy title is: *"The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom"*. The report runs to 108 pages.

However, note the following:

(a) The 29,000 are premature by only six months with an extraordinarily wide "75% plausibility limit" of one month to one year;
(b) the saving in lives may be achieved only if ALL man-made particulates are eliminated; and
(c) only about one-tenth of man-made particulates are from road traffic.

CoMEAP itself admitted that it: *'considers it very unlikely that this represents the number of individuals affected". Instead it speculated that: "air pollution, acting together with other factors, may have made some smaller contribution to the earlier deaths of up to 200,000 people"'*.

A separate inquiry to CoMEAP by independent transport researcher, Paul Withrington, revealed that removing all particles attributable to local traffic may increase average life-expectancy by 16 days for England and Wales and approximately 41 days in inner London. From these figures one may infer that plausibility limits may be from one-sixth to double those numbers, e.g. from seven to 82 days in inner London and from three to 30 days elsewhere.

The computations and assumptions underlying the CoMEAP data are (perhaps intentionally?) opaque. The report refers to an earlier one with the title, "*Long-term exposure to air pollution: effect on mortality"*, published in 2009. That report refers to relative risk coefficients derived from the American Cancer Society (ACS) study by Pope et al, 1995, 2002. CoMEAP uses those coefficients, together with other sources, to compute the changes in life expectancy. However, the complexity and opacity of the whole process undermines confidence. Indeed, commonsense suggests that it may be nigh-on impossible to isolate the effects of particulates from other factors.

In any event, a paper by Joel Schwartz, adjunct scholar of the Competitive Enterprise Institute, with the title, *"Particulate air pollution, weighing the risks"*, demonstrates that the ACS paper is deeply flawed – probably particulates have no effect on lifespan whatsoever. That conclusion is consistent with CoMEAP's own findings, where, at section 3.1.3, risk coefficients range from unity to 1.15 ***where a value of unity implies no effect***.

A paper published in The Lancet in March 2014 purporting to have studied the *"effects of long-term exposure to air pollution on natural-cause mortality"* exemplifies what is meant by 'junk epidemiology'.

The mortalities to which the study refers were mostly from the 1990s, yet air pollution was estimated using 2008 to 2011 data! Perhaps environmental activist group, Client Earth, which (perhaps even encouraged by the EU) recently successfully brought an action against the UK government for EU air quality breaches, would like to take up the cases of the people killed in the 1990s by air pollution in the 2000s?

All these various "research studies" seek to forge a link in the public mind between adverse air quality variations and the early mortality. But the mortality data used invariably all refer to estimated advancements of mortality - and usually within a very particular group: individuals whose respiratory function has been severely compromised.

The individuals in this group suffer chronic poor respiratory function. This may be a result of genetic inheritance (e.g., cystic fibrosis sufferers); occupational factors (e.g., jobs where fine particulate inhalation has, in the past, been a largely unregulated risk) and/ or lifestyle choices (such as smoking heavily).

Consequently, the sensitivity to air quality variations of these individuals is highly magnified. Variations that would have little to no effect on healthy people can be seriously detrimental to individuals in this target group.

The climatic context:
The conditions that constitute a life-threatening régime for such vulnerable individuals as those mentioned above are invariably the outcome of **a very specific combination** of factors: those typically prevailing during temperature inversions; very low humidity in combination with either very high or very low temperatures. Vehicle emissions are a peripheral influence on this problem.

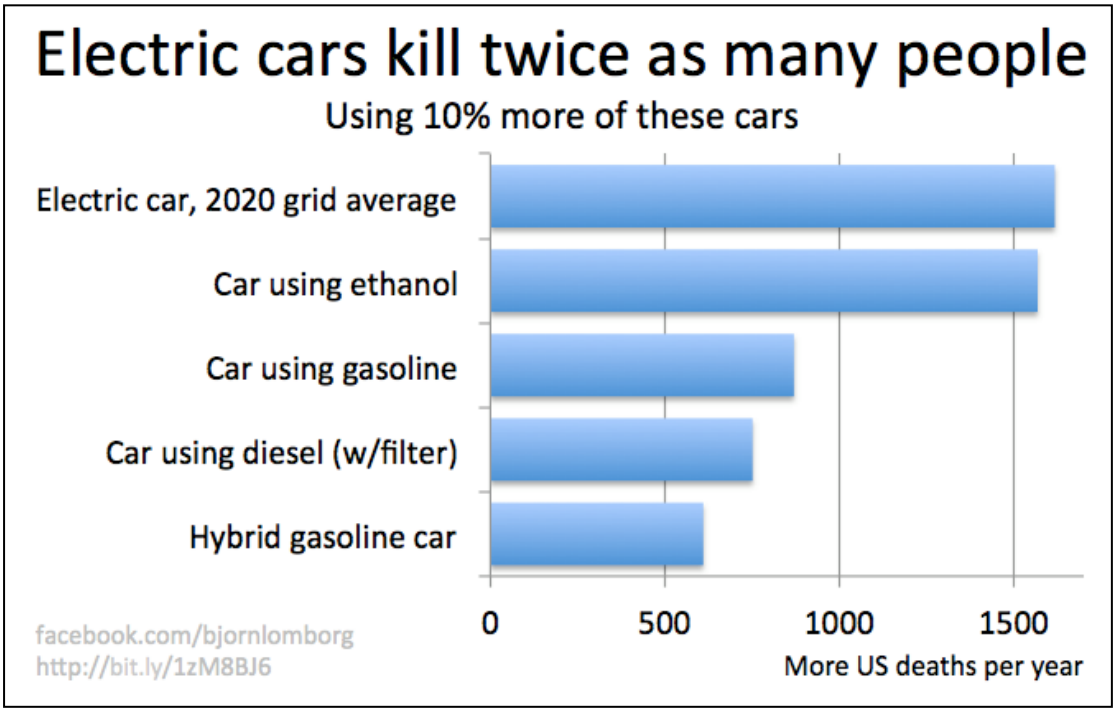
There is no scientifically valid link between emissions from modern catalysed petrol or DPF (Diesel Particulate Filter) -equipped cars and breathing disorder incidence. For example, the country with the world's highest asthma incidence is New Zealand, which coincidentally has probably the cleanest air in the world. Incidence of the disease there exceeds levels of it in Mexico City; which has probably the greatest problem with vehicle emissions of any city in the developed world.

In the UK, levels of asthma incidence are similar in the green fields of Kent and in the Western Isles of Scotland to those prevailing in the centre of our cities.

The British Asthma Foundation itself discounts as scaremongering smears attempting to implicate transport emissions; and points out that in modern, almost hermetically sealed, centrally heated and carpeted homes, the indoor air quality can be up to 70 times as polluted as it is outdoors.

Regarding diesel cars, enormous strides have been achieved in the last decade in curbing NOx and particulate emissions: a 2014 model year diesel cars

Even expressed in the alarmist terms used by eco-activist groups: estimated mortality advancement specifically amongst air quality vulnerable individuals; latest statistics suggest that the vehicles with the lowest impacts are actually DPF-equipped diesel-, and petrol hybrid-, cars[3].



The problem emissions:
Three significant emissions admittedly continue to affect urban air quality: oxides of nitrogen (NO_x), ground level ozone and particulates. None of these is a wholly road transport problem; and nor are any predominantly a result of the use of modern, catalysed petrol-, or DPF-equipped diesel-, vehicles.

OK, so let's examine the problem areas in turn:

Oxides of Nitrogen, NO_x:
The chemistry of the interactions between vehicle emission types is covered in Appendix 1. Because of: (a) the higher concentrations of nitrogen-containing species in diesel fuels and (b) nature of the Diesel Compression-Ignition cycle, diesel vehicles produce higher proportions of NO_x emissions than petrol ones, when compared on a like-for-like basis.

However, the NO_x emissions of a modern DPF-equipped, high-pressure, common-rail diesel engine (such as used in modern private cars) are several orders of magnitude lower than those of an old technology, high capacity diesel power-plant, such as the ones equipping many older, still-in-service HGVs and PSVs.

As already mentioned , environmental activist group, Client Earth, recently publicised a court decision over the failure of some areas of the UK to meet EU 2010 targets for nitrogen dioxide (NO_2: *'Pressure grows for air quality action following European court ruling'* ***LTT***, 28 Nov 2014).

These breaches came about in part because the EU continues to remorselessly ratchet down permissible vehicle emissions levels; ***irrespective of***: (a) the absence of any scientifically-compelling public health need; or (b) the fact that the new emissions limits exceed the capabilities of current conventional automotive technology. Many road users do not wish to switch to hybrid vehicles - due to their highly environmentally-questionable credentials when subjected to full Life Cycle Analysis.

The situation has been exacerbated by the UK government's policy for the last two decades or so, of forcing drivers out of petrol-, and into 'low CO_2' diesel vehicles. This was in a misguided bid to curb CO_2 emissions, based on "global warming" concerns which are being called into increasing question.

There has been no significant warming - in fact slight cooling - over the past two decades (while atmospheric CO_2 levels continued contemporaneously to rise. So, empirically these measures can only be considered both unnecessary and pointless. However, an unintended consequence of them has been an adverse effect on overall urban NO_x emissions.

We would do well to remember, however, that the economy that sustains us all runs on diesel and petrol; providing the wealth that has generated increased life expectancies.

Perhaps we should be fining the EU, given the fact that Euro V diesel engines (and the accompanying Particulate Filter (DPF) technology imposed by the EU) has apparently elevated NO_x exhaust emissions back to 1992 levels? A stark demonstration - as if any were needed - that the myopic focus on abating one specific exhaust component can worsen the emissions of others.

Furthermore, it's a known fact that a significant proportion of UK NO_x (and indeed particulate) concentrations is blown over from mainland Europe (see below and Endnote 6). Perhaps London Mayor, Boris Johnson, who; as custodian of London's congestion charge, has exempted 'low-CO_2' diesel cars along with diesel buses and taxis, should be fined for not acting to abate these 'imported' emissions?

'Government money' is actually taxpayers' money; so the burden of fines, new taxes levied, damage to the economy and mobility resulting from the ruling will unjustly be shouldered by the British people.

Ground-level Ozone

Ground level ozone is the product of a complex series of reactions (see Appendix 1). These reactions take place between NO_x gases[4] , VOCs[5] and oxygen in the presence of appropriately energetic electromagnetic radiation - in this case visible/ ultraviolet light provided by the sun.

Ground level ozone is destroyed by reaction with one of the combustion products of internal combustion engines: the mixture of oxides of nitrogen known as NO_x gases.

Unfortunately, the dramatic reductions in road transport emissions arising from the adoption of modern, ultra low emissions catalysed petrol cars has also resulted in a reduction in the extent to which ground level ozone is destroyed. Nevertheless, ground level ozone levels in are generally lower in urban-, than rural areas because the higher nitric oxide levels in towns results in faster ozone breakdown.

The current urban situation is not aided by the fact that the remaining major sources of emissions of VOCs are essentially outwith the motorists' control.

The largest single source of VOCs - particularly in the Summer months (and then being responsible for up to 60% of VOC concentrations) - is vegetation. The second most important source nowadays is fuel vapour released during refuelling operations.

In the United States all the automotive fuel companies have been 'encouraged' by legislation to install refuelling vapour recovery (RVR) systems to stem emissions from this totally unnecessary source of VOCs. No such determination has been shown by the UK government, which clearly prefers that all this uncombusted fuel vapour be wastefully exhausted to atmosphere, bolstering its tax revenues and allowing it to blather on about urban air quality while doing little substantive to improve the situation.

Further improvements could potentially be achieved through the adoption of so-called oxygenated fuels, such as those containing MTBE (methyl tertiary butyl ether). While these oxygenated fuels undoubtedly lead to cleaner emissions, there is currently concern in the United States about contamination of watercourses with these polar-, water-miscible substances. This need not be a problem given adequate vigilance regarding the prevention of runoff of fuel spills into watercourses; a level of environmental concern and awareness that that already exists within the UK anyway.

The final problem is that of particulates.

Particulates

In 1994 the cleanest 70% of vehicles (mainly modern, catalytic exhaust converter equipped petrol cars) produced 18% of road transport emissions; while the dirtiest 10% of vehicles (mainly older diesel powered buses, taxis, heavy- and light goods vehicles) were responsible for 44%[6] . The situation has only become more polarised since then, with the proportion of modern, ultra-low emissions catalysed petrol-, and DPF (diesel particulate filter)-equipped cars getting ever higher - and with only very limited steps having been taken to clean up the emissions of public transport.

In 1993, the Government's Expert Panel for Air Quality Systems (EPAQS) concluded that old technology diesel powered vehicles, with primary industrial sources, were responsible for nearly 50% of the nation's particulate emissions. More recent studies have confirmed this[7].

1997 National Environment Technology Centre figures were damning of 1950's technology diesel-powered vehicles. Annually an average bus produced NOx gases equivalent to the emissions of 39 modern cars; and particulates equivalent to the emissions of 128 modern cars (see Table 1 below).

Indeed, the then Deputy Prime Minister and environmental supremo, the Rt. Hon. John Prescott, admitted at the time that the particulate problem (i.e., of emissions from industrial and old technology diesel transport sources) would not be solved until well into the second decade of this century at prevailing rates of progress.

From Table 2 below, even that premise would appear to have been optimistic.

Public versus private transport: "Good" versus "Bad"?:

Table 1: Relative Emissions - Typical Car vs. Typical Bus (1997)

Cars	1992 tonnes	1997 tonnes	% Change	Vehicle Nos. (1997)	1997 kg/vehicle	Car Equivalent
NO_x	192000	140000	-27%	24000000	5.83	1
PM_{10}	3900	3300	-15%	24000000	0.14	1
CO	1158000	805000	-30%	24000000	33.54	1
VOC	182000	124000	-32%	24000000	5.17	1
Benzene	7300	4700	-36%	24000000	0.20	1
Buses						
NO_x	17000	17000	0%	74000	229.73	39
PM_{10}	1600	1300	-19%	74000	17.57	128
CO	16000	17000	6%	74000	229.73	7
VOC	4000	3000	-25%	74000	40.54	8
Benzene	100	100	0%	74000	1.35	7

Data source: National Environment Technology Centre figures, 1997

While the situation has improved since the late 1990s; public transport and goods vehicles are still significantly less environmentally friendly than private cars:

Table 2: Typical Car vs Typical Taxi and Typical Bus (City of Sheffield, UK: 2013 figures:)[8]

2013 (Sheffield City)	gkm^{-1}		
	Car	Taxi	Bus
NO_x	0.6	1.5	5.2
NO_2	0.2	0.8	0.6
PM_{10}	11.3	44.4	92.3
Normalised (Car = 100%)			
	Car	Taxi	Bus
NO_x	100.0%	270.5%	944.2%
NO_2	100.0%	347.2%	267.1%
PM_{10}	100.0%	391.8%	813.7%

Emissions survey of 28,200 vehicles; 2013

The figures in Table 2 above mean that a typical taxi needs an average occupancy of 3 - 4 passengers to be as environmentally friendly as a typical car for NO_x, NO_2 & PM_{10}s. A typical bus needs an average occupancy of 8 - 9 passengers to be as environmentally friendly as a typical car for NO_x and PM_{10}s.

Even more worryingly, researchers at Japan's University of Kyoto[9] have shown that particulate exhaust emissions from old technology, large-capacity diesel-engined vehicles contain high proportions of carcinogenic nitrated polycyclic aromatic hydrocarbons (nitro-PAHs) such as 1,8-dinitropyrene (1,8-DNP) and 3-nitrobenzanthrone (3-NBA). The latter has been identified as the most potent currently-known carcinogen.

The proportion of this compound (& others such as 1,8-DNP) in the exhaust emissions of these old-technology, large-capacity diesel vehicles increases with vehicle acceleration and deceleration under load. These chemicals may conceivably contribute to urban lung cancer incidence and other breathing disorders.

It is therefore a matter of public concern that buses, trains and other diesel powered public service vehicles - major transport sources of particulates - are currently exempt from the random emissions testing régime applicable to private catalysed petrol-, and DPF-equipped diesel-, cars.

Yet we are constantly exhorted, by evidently ill-informed people, to abandon more environmentally-friendly (and infinitely more convenient) private cars in favour of particulate-belching public transport.

It is a certainty that the present emissions-based attack on the private car only has its basis in junk science.

Yet London's Mayor is planning a programme; the outcome of which would amount to banning diesel cars from urban areas. This is likely to cost the economy (unnecessary) millions - if not billions - of pounds.

Road space allocation:
A further, less immediately obvious point is that successive governments' penchant for schemes which actually obstruct and reduce the steady flow of road traffic (e.g., the M4 bus lane) do not just impose an economic burden in terms of increased journey times and therefore wasted economic resources.

Emissions of NO_x, SO_x, VOCs and PMs (both $_{10}$ and $_{2.5}$) are at their highest under acceleration in low gear at low speeds; thereafter becoming comparatively speed-inelastic. So prioritising public service vehicles (PSVs) through lane-subtraction techniques is Luddite from both economic and environmental perspectives.

There is nothing more wasteful than vehicles stationary with running engines. Ill-judged lane-subtraction schemes do nothing to make public transport more attractive; they actually increase emissions, and create the very congestion to which government is reportedly committed to minimising.

At the same time the lane-changes that occur at the start-, and end-points of such schemes lead to increased potential for accidents.

Such has been the experience in the United States (and indeed lately also in e.g., Liverpool here in the UK); - one by one - such schemes are being removed.

This is without even broaching the issue of whether PSVs - which typically (outside the major conurbations like London) carry high proportions of the least economically-active members of society - should be prioritised over generally more economically-active car-, LGV-, and HGV-drivers.....

Driverless vehicles the perfect public transport system replacement?:
Indeed there is an increasingly strong argument for replacing current generation (heavily subsidised) PSVs with latest generation driverless cars. This is particularly relevant in rural areas and during off-peak hours - under which circumstances average per km riderships as low as 2 individuals per vehicle are common[10] .

So, let's not jeopardise our new-found longevity with flawed policies rooted in unfounded environmental alarmism. Instead, let's continue to reduce air pollution on an achievable timescale, rather than on one set by such bodies as the autocratic EU; whose scientific literacy and objectivity are both open to question.

Recommendations:

If we are to meaningfully address the important issue of urban air quality and the valid concerns of many people, the following policies need to be instituted now:

- Introduction of random on-road emissions testing of all public service vehicles
- Mandated fitment of particulate-recovery equipment to all unequipped diesel public service vehicles (at the operator's expense: public transport is already far too heavily subsidised!).
- Legislate to make compulsory the installation of fuel vapour recovery equipment at all filling stations to capture VOC's currently emitted during vehicle refuelling operations
- Investigate the advantages and drawbacks of greater adoption of oxygenated fuels
- Remove lane-subtraction schemes that increase emissions, congestion and accident risk
- Urgently investigate the effects on congestion and emissions of replacing current generation public service vehicles with latest generation driverless cars - particularly in rural areas and during off-peak hours, and
- Reinstate and expeditiously proceed with the many bypass and other traffic flow enhancement schemes cancelled or postponed by the current and previous governments.

Appendix 1[11]: Formation of ground level ozone

To form ozone, O_3; an oxygen molecule, O_2, has to react with an excited oxygen atom O*. Sunlight, VOC's and NO_x all play a part in the formation and perpetuation of atmospheric ozone.

Oxygen atoms are generated in the reaction of nitrogen dioxide with sunlight:

$$h\nu \text{ (sunlight)} + NO_2 \rightarrow NO + O^* \quad (1)$$

$$O_2 + O^* \rightarrow O_3 \quad (2)$$

Normally the ozone would be short-lived due to reaction with nitrous oxide to regenerate molecular oxygen and nitrogen dioxide:

$$NO + O_3 \rightarrow NO_2 + O_2 \quad (3)$$

However, in the presence of sunlight, VOC's interfere with this removal mechanism by creating competing reactants which remove NO and thus prevent its reaction with ozone.

In the presence of sunlight, peroxy radicals are formed from VOC's by photochemical oxidation of the hydrocarbon chains of the VOC. These species are capable of oxidising nitrous oxide, NO, back to nitrogen dioxide, NO_2.

The ability of VOC's to enhance the stability of ozone varies: four of the 300 VOC's on the UK inventory – toluene, butane, ethylene and xylene – account for 40% of the photo-oxidant chemical potential.

If the failure of environmentalists, politicians and the media to adequately publicise facts like those above worries you, join the Alliance of British Drivers.

For what does the ABD stand?

- Publicisation of the truth about air pollution and global warming
- Freedom to use your car
- Fairer disposition of motoring taxes
- An end to motorway and urban road pricing proposals
- Opposition to anti-car policies
- Better driver training
- Enlightened enforcement of realistic speed limits
- An end to the official abuse of speed camera technology for purely revenue raising purposes.

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[1] 1994 Royal Commission on Transport and the Environment, Appendix B, pp.289-300.
[2] See : http://www.smmt.co.uk/industry-topics/air-quality/#responsiveTabs1
[3] See facebook.com/bjornlomborg, and http://bit.ly/1zM8BJ6
[4] Oxides of nitrogen predominantly arising from old technology diesel road transport exhaust emissions
[5] Volatile organic compounds: organic vapours from transport exhaust and refuelling emissions or evaporated organic materials from the leaf and bark saps of vegetation; e.g., alphapinene from pine trees
[6] 1994 RAC Survey on road transport emissions.
[7] "Fine ($PM_{2.5}$) and Coarse ($PM_{2.5-10}$) Particulate Matter on A Heavily Trafficked London Highway: Sources and Processes", Charron, A. and Harrison, M.; Environ. Sci. Technol., 2005, 39 (20), pp. 7768–7776.

Abstract:

'A large dataset for $PM_{2.5}$ and PM_{coarse} ($PM_{2.5-10}$) concentrations monitored near a busy London highway (Marylebone Road) has been analyzed to define the factors that lead to high concentrations. The following have been highlighted as major influencing parameters: wind speed, prevailing wind direction (because of its role on the microscale dispersion within the street), the daily cycle of the atmospheric boundary layer (stable during the night/ convective and mixed during the day), and traffic density. The mainly diesel heavy-duty vehicles are the main source of fine particulate matter at Marylebone Road. In particular, lorries (trucks) dominate PM_{10} exhaust emissions which are mainly in the fine (<2.5 µm) size range. A strong correlation with PM_{coarse} suggests that the heavy-duty traffic is largely responsible for this component also. Substantial local increments in $PM_{2.5}$ and PM_{coarse} due to traffic have been estimated and a large part of the increment in PM_{coarse} concentrations is inferred to arise from re-suspended road dust emissions since the contribution of abrasion processes estimated from emission factors is modest. Despite the strong influence of traffic on PM concentrations measured at Marylebone Road, the analysis of factors leading to the highest 5% of hourly concentrations of PM_{10} at Marylebone Road reveals that almost half of these events were due to building works. The other events occurred when all or most of the key factors occurred simultaneously (heavy traffic, poor dispersion, etc.). Some episodes of high $PM_{2.5}$ concentrations were associated with long-range transport in which the regional $PM_{2.5}$ constituted most of the local concentrations.'

[8] Tate, Dr. James, University of Leeds: "Vehicle Emission Measurement and Analysis - Sheffield City Council", December 2013
[9] "Deadly Diesel", *Chemistry in Britain*, December 1997, p.10.
[10] Overview of Bus Industry Performance, Great Britain, since Deregulation, p.5, Alan Howes Associates, December 2011.
[11] The interested reader should see, e.g.: 'The Long Road to VOC Abatement", *Chemistry in Britain*, May 1996, pp.9-11.