

Improving Air Quality

Final

AECB Submission to the House of Commons Environment, Food and Rural Affairs; Environmental Audit; Health and Transport Committees

1. Summary

The four Committees have invited submissions on the following:

- How effectively do Government policies take into account the health and environmental impacts of poor air quality?
- Do these plans set out effective and proportionate measures to achieve necessary emissions reductions as quickly as possible?
- Are other nations or cities taking more effective action that the UK can learn from?
- Is there enough cross-government collaboration to set in place the right fiscal and policy incentives?
- How can those charged with delivering national plans at local level be best supported and challenged?

After some comments on the severity of the problem in Sections 2 & 3, we respond to the above points in Section 4.

To sum up:

- The UK government appears to be subsidising air pollution
- Ill-informed and conflicted energy policy has overridden attempts at a sound public health policy.

Our main arguments to support this are set out mainly in Section 3.

AECB's main remit is the built environment, predominantly the energy, comfort and health-related performance of domestic and non-domestic buildings. The AECB is also concerned with:

- buildings' impact on wildlife and biodiversity
- the building stock's relationship with UK energy security
- associated material waste and recyclability
- liquid and gaseous emissions from services in buildings themselves
- ditto from the primary energy sources used to supply them.

The AECB prides itself on having a holistic, interdisciplinary approach across all its activities and promoting the same to its broad membership base.

In this response, we concentrate on external air quality. By implication, *indoor* air quality is also fundamentally related to the questions being asked in this call for evidence. Most people spend the bulk of their life indoors.

This submission concentrates on the single most damaging component of UK air pollution. This is the concentration of airborne particles smaller than 2.5 microns, the so-called PM_{2.5}.

A common measure being used to compare sources of particle pollution is the emissions from diesel-engined road vehicles. As we show later, the current policy appears to be to phase out diesel car and van engines, yet meanwhile to phase them in again but in a different form, i.e. individual wood heating equipment and large district heating systems wood-burning plant. The logic of this escapes us.

The AECB is concerned that policymakers seem to be unaware of some key facts affecting air pollution levels:

- UK wood-fired heating systems emit 2.4 times more PM_{2.5} than the transport sector
- New diesel cars and 'clean' wood-fired pellet boilers are roughly equally polluting, but the first are discouraged and the second are subsidised
- Wood pellet-fired heating systems usually emit thousands of times more particles, per unit of heat than the gas- or oil-fired boilers they replace
- UK wood- and coal-fired power stations emit as many particles as several million diesel vehicles. Electric transport and heat pumps are 'emissions elsewhere', not 'zero emissions' devices
- Given the NO_x emissions from power stations, a UK dwelling is likely to emit three times more NO_x in its normal electricity consumption than a Euro 6-compliant diesel car emits
- UK power station NO_x emissions have seemingly not been cut to the levels achieved by Germany, Italy and Japan.

2. Existing Pollution Levels and Sources

After the EU and Client Earth sued the UK for breaching EU air quality law, ¹ the government published an 11 pp plan to improve air quality in respect of nitrogen oxide (NO_x) emissions. ² We looked but did not find a UK plan to deal with particles.

Overall, particles are thought to cause more harm to health than NO_x. Some medical conditions to be causally linked to PM_{2.5} exposure include:

- a) asthma
- b) lung cancer
- c) respiratory diseases, e.g. bronchitis
- d) cardiovascular disease, e.g. heart attacks or strokes
- e) type 2 diabetes
- f) dementia
- g) premature delivery
- h) birth defects
- i) low birth weight
- j) premature death.

2.1. NO_x

60% of the UK population breathe unlawful levels of NO_x . Vehicles produce 34% of NO_x emissions. ³ Heating systems and power stations produce much of the rest.

Until at least 2009, the UK failed to match Germany, Italy or Japan's cuts in power station NO_x emissions; Figure 1. The UK appears to combine a population density as high as Germany, Italy or Japan with allowed emissions rates (g/kWh) as high as the US or Canada, with their ten- to 100-fold lower population densities. ⁴

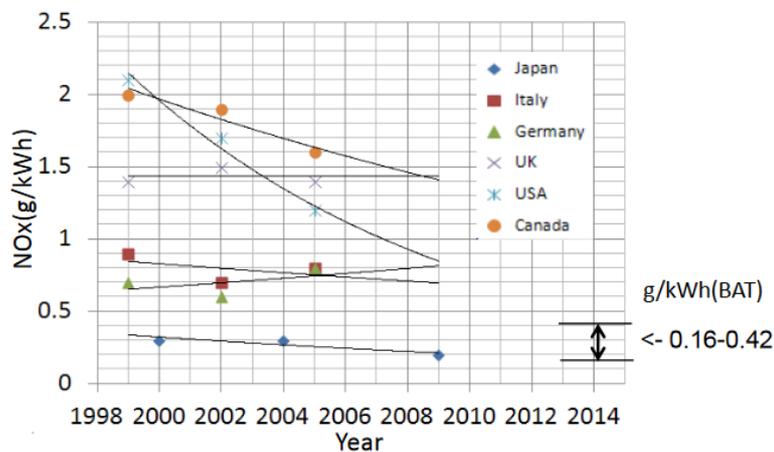


Figure 1. Power Plant NO_x Emissions. ⁵

Note: BAT = best available technology.

With allowed emissions of between 80 and 180 mg/km, a Euro 5 or 6 diesel car sold since 2011 emits:

$$(12,000 \times 80) \text{ to } (12,000 \times 180) \\ = 1.0\text{-}2.2 \text{ kilograms per year.}$$

UK household electricity consumption averages 3,300 kWh/y. ⁶ Assuming that it comes 60% from thermal power stations, a dwelling's normal electricity consumption leads to NO_x emissions of:

$$3,300 \times 0.60 \times 1.45 \\ = 0.6 \times 4,785 \text{ g} \\ = 2.8 \text{ kilograms per year.}$$

This is 1.2 times as much as a Euro 5 diesel car or 2.8 times more than a Euro 6 car.

2.2. Particles

A typical indoor 'passive smoking' PM_{2.5} level is 100 µg/m³.⁷ Table 1 has illustrative ambient UK PM_{2.5} levels in the second half of October 2017.⁸

Location	PM _{2.5} Level µg/m ³	Location	PM _{2.5} Level µg/m ³
<i>United Kingdom</i>			
Euston Road, London	57	Cambridge	36
Southampton	35	Leamington Spa	14
Chilbolton, Hants.	15	Birmingham	28
Plymouth	28	Sheffield	24
Bristol	24	York	34
Cardiff	20	Hull	36
Oxford	22	Carlisle	26
<i>France</i>		<i>Belgium</i>	
Paris	32	Brussels	44
Marseilles	40	<i>US</i>	
<i>Sweden</i>		Sacramento, California	14 ²
Malmö	14	New York City	34 ³

Table 1. PM_{2.5} Levels.

Notes:

¹ Afternoon of 24 October 2017 unless otherwise stated

² Air Resources Board website, 19.00 h BST, 24 October 2017

³ 12.00 h BST, 26 October 2017.

So on a 'random day', all but two of the UK locations breached the EU PM_{2.5} limit of 20 µg/m³. The EU limit is proposed to fall to 18 µg/m³ in 2020.⁹

The live data in Table 1 from the UK monitoring stations is a 48 hour average. The World Health Organisation (WHO) recommends an *annual* average PM_{2.5} level of ≤10 µg/m³. The WHO's *annual* average, as compared to the EU's three year average makes the WHO target even more demanding to achieve.¹⁰

Public Health England modelled PM_{2.5} levels in 2010, giving the map in Figure 2 (see next page).¹¹ This may be the source of the official UK statement that the average level is 12 µg/m³.¹² However, most readings we cite in Table 1 are considerably higher than 12. They may not necessarily be consistent with levels in Figure 2.

If repeated readings as per Table 1 equal or exceed 20, the long-term average in that location will exceed 20. We are unaware of any weather conditions causing air pollution to be particularly elevated in the last 7-10 days of October 2017. It may therefore be wise to investigate this further. *Are the long-term average readings in all UK locations really ≤20?* We briefly checked a few more PM_{2.5} readings on 31 October and 6 November. They were higher than on 24 October, e.g. levels in Oxford and Chilbolton had more than doubled. *They certainly give cause for doubt that the average UK figure is only 12.*

We suggest that further checking of the model's assumptions against actual measurements may flag up understated health risks.

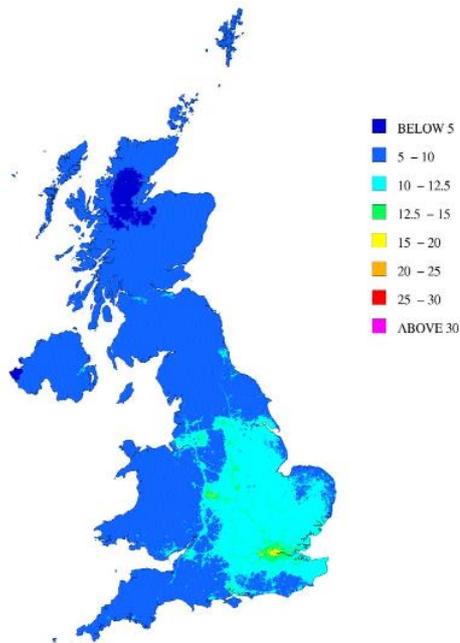


Figure 2. Average Ambient PM_{2.5} Levels Modelled by Public Health England.

3. Subsidising Air Pollution?

3.1. Wood Heating

Woodstove sales in London tripled in 2010.¹³ Sellers assert, rightly that wood stoves are cleaner than open fires. But this is irrelevant. London banned most open fires 60 years ago.

The message is being spread that stoves are 'clean' if they burn 'the right fuel'.¹⁴ Stove emissions are high even when burning the 'right' fuel. They rise further when using the 'wrong' fuel, e.g. unseasoned wet wood, treated timber from building sites, treated ex-window frames, treated timber from demolished greenhouses.

New pellet-burning appliances are sold as 'cleaner' than log-burning woodstoves. But they emit more particles than gas- or oil-fired condensing boilers, i.e. they still worsen air pollution. To quote a US Brookhaven National Laboratory 2009 report:

' E. Comparison of Results for all Residential Heating Appliances

A summary comparison of results averaged by fuel types is shown in Figure 2 for the equipment included in this study. This summarizes the basic conclusions of the study with regard to fine particulate emissions:

- Gas-fired equipment has the lowest current particulate emissions, averaging 0.014 milligrams per megajoule (mg/MJ)
- Oil-fired units currently have emissions averaging 1.7 mg/MJ with typical sulfur levels and this is approximately 120 times greater when compared to those for gas-fired units; reductions of 71% can be accomplished by using low sulfur fuel oil (500 ppm limit)
- In the near future, when fuel oil will be required to meet ultra-low sulfur limits of 15 ppm, the particulate emissions will be of the same order of magnitude as those found for gas-fired units. In parts of New York [state] this may happen by 2011
- Wood pellet stoves have emissions averaging 25 mg/MJ and this is approximately 15 times greater than those of oil-fired units or *approximately 1,800 times greater than gas-fired units*
- Wood pellet stoves are considered to have the lowest level of all wood-fueled heating systems in the United States ...'

Note: Our bold italics. The shift cited to low-sulphur oil has also happened in the EU.

Brookhaven lists the PM_{2.5} emissions of an average gas-fired boiler as 0.014 mg/MJ. On that basis, the 'clean' wood-fired plant proposed in a Scottish government report ¹⁵ emits *1,400-4,300 times more particles* than the gas-fired plant it replaces.

Light diesel vehicles have avoided hundreds of millions of tonnes of CO₂ emissions since they began displacing petrol engines. But unlike diesels, there are few arguments for promoting wood-fired boilers:

- The combustion efficiency is lower than gas and oil
- The fuel is bulkier
- Automatic control is harder
- The plant is costlier
- The exhaust is more toxic
- They rarely reduce CO₂ emissions. ¹⁶

If a new diesel car just meets Euro 6, ¹⁷ it emits PM_{2.5} at a rate of 80 mg per km. Over a year's driving, say 13,000 km, ¹⁸ it emits *1.0 kg per vehicle*. A new large 'clean' wood-burning boiler, receiving the RHI, supplying a heat network or other load, emits 25 mg per MJ or 90 mg per kWh. Over a year's heating, say 13,000 kWh(t), it emits 0.09 x 13,000 g = *1.2 kg per house*.

So broadly, new diesel cars and new 'clean' wood-fired pellet boilers pollute equally badly. But the cars are discouraged and the boilers are subsidised. It is hard to defend this, given that the cars cut CO₂ emissions.

A new woodstove, i.e. log-burning, emits 1,000 to 10,000 times the PM_{2.5} of a gas- or oil-fired boiler. A 15-20 year-old diesel car would possibly emit as much

as the woodstove. But by default, the diesel cars are being scrapped as they age and new woodstoves are going into buildings. ¹⁹

3.2. Electricity Generation

15% of UK electricity comes from coal, wood and other solid fuels. Drax power station generates half our solid fuel-fired electricity. But Drax allegedly emits as many PM_{2.5} as three million diesel cars. ²⁰

Given power station pollution, 'zero emissions' is the wrong term for electric cars and heat pumps. The term should be strongly discouraged, so as to clarify the debate.

The NO_x emissions from using an electric car are lower than from diesel or petrol cars. But they are not zero. ²¹ It is not unlikely that electric heat pumps emit more particles from the power plant chimney than gas- and oil-fired boilers emit from their balanced flue.

To reduce particle pollution from electricity generation, we can take various actions:

- a) reduce electricity consumption, via A+++ appliances and beyond
- b) stop building and operating solid fuel-fired power plants.

These moves seem to be of elementary simplicity.

3.3. Overall

Taxpayers unwittingly subsidise particles and CO₂ pollution via the Renewable Heat Incentive for wood-fired heating systems; see Figure 3. They reward particle, CO₂ and NO_x pollution via the subsidy to Drax to burn wood. This is repeated with the Renewable Heat Incentive for electric heat pumps and the electric car subsidy. A muddled energy policy overrides attempts at a sound public health policy.

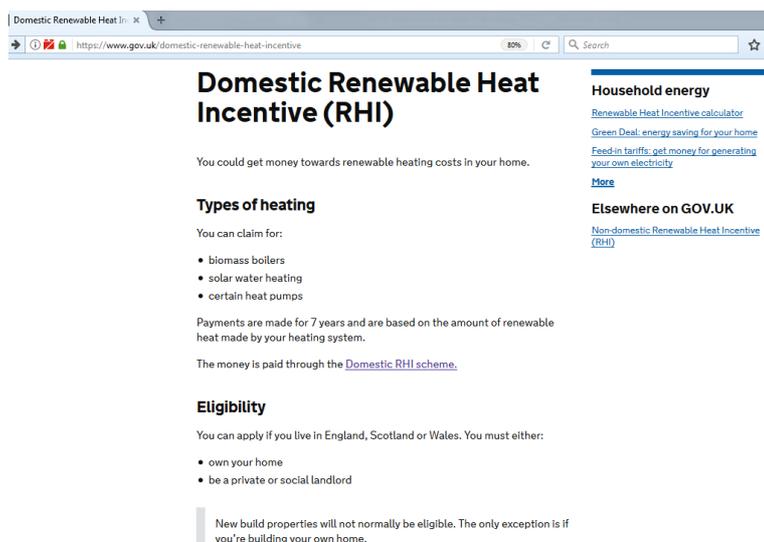


Figure 3. UK Renewable Heat Incentive

Note: Page accessed and screenshot taken 10.10.17.

4. Response to Consultation Points

4.1. How effectively do government policies take into account the health and environmental impacts of poor air quality?

Not very well. The government's keenness to reduce particle pollution²² seems to be similar to its 'enthusiasm' to tackle acid rain in the 1980s or its earlier inclination to clean up domestic coal smoke. To quote Wikipedia:

'London had long been noted for its pea soup fog, [2] but when the "Great Smog" fell over the city in December 1952 the effects were unprecedented: 4,000 people are thought to have died in the immediate aftermath, [3] triggering great public concern, with fog so thick it stopped trains, cars, and public events. [4] A further 8,000 died in following weeks and months.

It quickly became clear that pollution had become a real and deadly problem, and the smog's terrible effects may have helped inspire the modern environmental movement. Despite this, however, and data from the Ministry of Health indicative of substantially elevated death rates in London, the Government initially resisted pressure to act, and was keen to downplay the scale of the problem due to economic pressures. [5] It took the recommendations of the Select Committee on Air Pollution and moves by backbench MPs (including Conservative member Gerald Nabarro, its sponsor [6]) to pass a Private Member's Bill on domestic coal burning to persuade the Government to support a change in the law.

The Clean Air Act built on earlier efforts to regulate pollutants, particularly in London, where air quality had long been poor. Indeed, London had seen a succession of acts and rules over the centuries to improve its air—most recently the Smoke Nuisance Abatement (Metropolis) Acts 1853 and 1856 and the Public

Health (London) Act 1891. However, despite the link between air pollution and health being well understood by the late 19th century, such efforts had not proven to be effective public health measures. [7]

Apparently few governments learn lessons from the past. Without any external pressure, it took the UK 100 years to go from awareness of the toxicity of coal smoke to nationwide legislation.

The latest proceedings against the government probably only succeeded due to EU membership. If we leave, the UK needs a new legal and constitutional mechanism to force governments to learn from the past and avoid new public health disasters recurring every 30-40 years, as they seem to do under the UK political system.

It is wrong to blame diesels *per se* or all vehicle manufacturers.²³ Euro 6 diesel vehicles pollute 90-95% less than older diesels and pollute less than woodstoves and open fires. Many parties are culpable:

- a) governments allowed 'dirty diesels', i.e. pre-Euro 5 and 6, to be sold after a health problem became clear, i.e. arguably by the 1990s or early 2000s
- b) some car manufacturers sell vehicles that do not meet Euro 5 or 6 on the road
- c) government failed to regulate these vehicle manufacturers.

By 'government', we mean the UK *and* the EU.

4.2. Do these plans set out effective and proportionate measures to achieve necessary emissions reductions as quickly as possible?

No. If they did, they would address all emission sources and prioritise actions according to the:

- a) cost
- b) speed of implementation
- c) reduction in emissions.

Table 2 lists some PM_{2.5} sources, probably in broadly descending order of significance.

Source	Description
1	wood- and coal-fired individual heating systems
2	diesel road vehicles, e.g. cars, buses and HGVs
3	wood-, coal and other solid fuel-fired power stations
4	wood-fired pellet and chip boilers on district heating systems
5	shipping
6	diesel rail vehicles ²⁴
7	petrol-engined road vehicles
8	the clay brick industry
9	the cement industry
10	the steel industry
11	the aluminium industry
12	other industries
13	individual oil-fired heating systems
14	construction industry mechanical plant
15	burning of 'wood waste'
16	refuse incineration
17	domestic bonfires

Table 2. PM_{2.5} Sources.

Source 1 emits 2.4 times more particles than sources 2 and 6 combined.²⁵ UK awareness seems limited to 2 and 4. The UK will not succeed in protecting public health if it focusses only on 2 and ignores 4.

PM₁₀ emissions from new diesel vehicles fell by 91% over 14 years; Figure 2. If we take this as a rough surrogate for PM_{2.5}, the majority may now come from vehicles sold between 1992 and 2011. If so, subsidies to retire or replace these Euro 1 to 4 vehicles²⁶ could be a useful and cost-effective route to reduce PM_{2.5} levels.

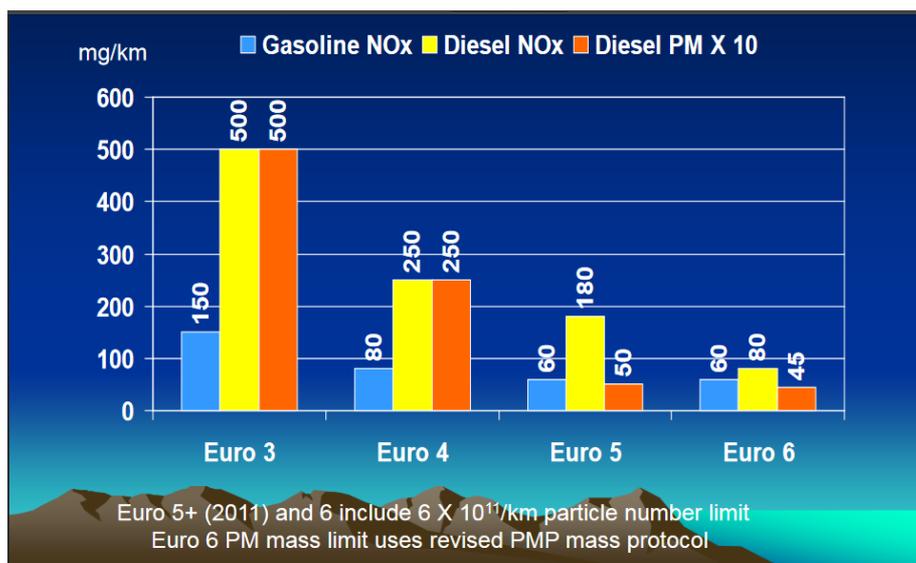


Figure 2. PM-10 and NO_x Emissions, New Diesel Vehicles Sold in the EU.²⁷

4.3. Are other nations or cities taking more effective action than the UK can learn from?

Yes. Since 1967 the US state of California has reduced per capita PM_{2.5} emissions by a factor of 20. Between 1970 and 2013, UK per capita PM_{2.5} emissions fell by a factor of six; Figure 4. It appears that UK emissions levelled off after 2011.

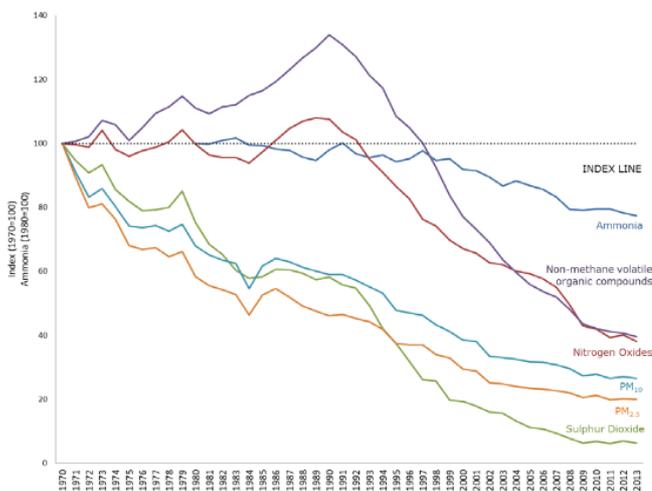


Figure 4. UK PM_{2.5} Emissions.

Figure 5 shows Beijing on clear and 'smoggy' days in August 2005. Figure 6 shows London 'smog'. Figure 7 shows Los Angeles seen from the Hollywood hills.



Figure 5. Beijing Clear Air / Smog.²⁸



*Figure 6. London Smog.*²⁹



*Figure 7. Los Angeles Smog.*³⁰

4.4. Is there enough cross-government collaboration to set in place the right fiscal and policy incentives?

If 'cross-government' means inter-department, no. The UK lacks either a full Environmental Protection Agency *or* a Department of Energy. To deliver a joined-up policy, it needs both. Most countries with a creditable record have both.

Government decisions affecting energy production, conversion and consumption are split between at least three departments, i.e. BEIS, DEFRA and DCLG. This is unhelpful.

4.5. How can those charged with delivering national plans at local level be best supported and challenged?

We think that expecting local government to impose diesel car bans or penalties is arbitrary, negative and punitive. Modern Euro 6 diesels are cleaner than older petrol cars. The older the vehicle, the higher the penalty and/or the more extensive the ban should be.

We think that small inducements to upgrade from Euro 5 to 6 cars and for other similar moves would be more effective. Human nature is to prefer carrots to stick, so use carrots first and sticks only second.

There are tradeoffs. One must not increase CO₂ only at the expense of other emissions. CO₂ emissions are arguably linked to serious injury and death as much as PM_{2.5} emissions are.³¹ The UK has arguably gone straight from one extreme position to the other.

Over the last 70 years, many of local government's powers have been centralised.³² To reverse the trend, perhaps some local authorities can be freed to experiment and can become centres of 'best practice', with less central government hindrance,³³ i.e. no longer treated as a branch office of Whitehall.

We doubt that all local authorities have enough knowledge or expertise in-house. So, one source of help might be to provide councils with access to disinterested expertise, just as the former Energy Design Advice Scheme (EDAS) helped those commissioning buildings and refurbishments 20-25 years ago.³⁴ The savings were worth much more than EDAS cost to run.

Another route might be to seek help from regions abroad with a good record in tackling air pollution, e.g. California. Could staff be seconded here for 2-3 years or more to impart their hard-won experience, mainly to their counterparts in UK central government?

Notes and References

¹ <http://www.bbc.co.uk/news/science-environment-26257703>.

² https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/633269/air-quality-plan-overview.pdf.

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https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/579200/Emissions_airpollutants_statisticalrelease_2016_final.pdf.

⁴ Lower population density and relying on 'dilution' may explain why the US and Canada have maintained laxer NO_x emission standards. However, it appears that they have also started to reduce their emissions.

⁵ <https://www.iea.org/media/workshops/2011/cea/lto.pdf>.

⁶ <https://www.ofgem.gov.uk/ofgem-publications/76112/domestic-energy-consump-fig-fs.pdf>.

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https://www.ashscotland.org.uk/media/4450/REFRESH_HowtoGuide.Create%20a%20smokefree%20home.Jan12.pdf

⁸ <http://aqicn.org/city/london/> and similarly for other locations.

⁹ <http://ec.europa.eu/environment/air/quality/standards.htm>. The EU allows figures to be averaged over three years, making it laxer than an annual average of ≤ 20 .

¹⁰ http://apps.who.int/iris/bitstream/10665/69477/1/WHO_SDE_PHE_OEH_06.02_eng.pdf. About 10% of people breathe air this clean.

¹¹

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332854/PHE_CRCE_010.pdf

¹² <https://data.worldbank.org/indicator/EN.ATM.PM25.MC.M3>.

¹³ <http://www.telegraph.co.uk/finance/property/7527570/Why-wood-burning-stoves-are-the-hot-must-have.html>.

¹⁴ The Mayor of London unintentionally repeated this untruth when speaking on the BBC Radio 4 *Today* programme, 8.10-8.22 h, 23 October 2017.

¹⁵ <http://www.gov.scot/resource/doc/243574/0067768.pdf>.

¹⁶ Noted during work on the Biomass Calculator by the late Professor Sir David MacKay, former Chief Scientist at the Dept. of Energy and Climate Change. Arguments were presented earlier in Olivier, D and Simmonds, A, *LESS IS MORE: Energy Security After Oil*, AECB (2012) for using solid biomass more as a means to sequester carbon than as a fuel.

¹⁷ The main difficulty with Euro-6 appears to be the after-treatment of the exhaust gases to limit NO_x output. The maintenance liabilities of this and particle filters on small vehicles may lead to a switch to petrol or, preferably in our view, CNG.

¹⁸ <http://www.bbc.co.uk/news/uk-england-28546589>.

¹⁹ Partly because they can provide heat in a power cut. An easy way to avoid the need for this is, for instance, for the Building Regulations to ask for a UPS in buildings, allowing essential electrical loads to operate for several days if the mains supply is interrupted.

²⁰ <http://www.biofuelwatch.org.uk/2017/briefing-drax-coal-to-biomass-conversion-increases-levels-of-dangerous-small-particles/>. The PM_{2.5} emissions from Drax when burning wood fuel are higher than when it burned coal. However, the paper does not specify which diesel cars it means, i.e. Euro 3, 4, 5 or 6.

²¹ http://www.eprg.group.cam.ac.uk/wp-content/uploads/2013/01/EEJan13_EconomicsEVs.pdf. They appear to be well below those of a Euro 6 petrol or diesel car.

²² Assuming that Client Earth takes proceedings again. See <http://www.independent.co.uk/environment/air-pollution-plan-quality-government-sued-clientearth-third-time-high-court-a7765066.html>.

²³ http://www.theicct.org/sites/default/files/publications/ICCT_PEMS-study_diesel-cars_20141010.pdf.

²⁴ The government has cancelled proposed rail electrification from a) Didcot Parkway to Oxford b) Cardiff to Swansea and Carmarthen c) Bristol Temple Meads to Taunton, Exeter, Plymouth and Penzance. Given the lifespan of railway locomotives, diesel trains will now operate until 2050-60 on one of the UK's busiest railways.

It is hard to reconcile this with the need to clean up particle emissions. Although we would expect diesel trains and buses to meet Euro 6 standards on particles, so will all diesel cars once the pre-2014 ones are scrapped.

²⁵ <http://www.bmj.com/content/350/bmj.h2757/rr-1>.

²⁶ We provisionally suggest that an appropriate incentive may be to retire Euro 1 to 2 and replace Euro 3 to 4 vehicles but not necessarily take them off the road. Re-selling Euro 3 and 4 vehicles to owners who drive, say, not 15,000-20,000 but 6,000-8,000 km per year cuts emissions by 60%.

²⁷ http://ec.europa.eu/environment/archives/greenweek2013/sites/default/files/content/presentations/5-4_walsh.pdf.

²⁸ Thanks to https://en.wikipedia.org/wiki/File:Beijing_smog_comparison_August_2005.png.

²⁹ <https://www.independent.co.uk/news/uk/home-news/london-air-pollution-breathing-toxic-levels-pollutants-particles-world-health-organisation-a7984371.html>

³⁰ Thanks to

https://en.wikipedia.org/wiki/Air_pollution_in_the_United_States#/media/File:Los_Angeles_Pollution.jpg

³¹ <https://news.stanford.edu/news/2008/january9/co-010908.html>.

³² Secondary education, for instance, has been mostly transferred from local to central government. Academies and free schools report to the Secretary of State for Education. Local government freedom to act independently, e.g. to issue bonds for investment, has been limited.

³³ They *can* experiment more in Germany, Sweden or most US states.

³⁴ The government later decided that because EDAS could not be privatised - few 'mainstream' clients were willing to pay for the service - it should be closed down. Arguably, ideology overrode the national interest.