

Air quality

THIS BRIEFING COVERS

Legal duties, strategies and standards; road transport emissions; effects on health and equality; costs; reducing pollution from road transport; central and local government roles, responsibilities and actions.

HEADLINE MESSAGES

- Motor vehicles are a major source of pollution, which imposes significant human and financial costs on society.
- Cyclists are probably less exposed to pollution than drivers and, in any case, the health benefits of cycling significantly outweigh the risks presented by pollution.
- Cycling should therefore be encouraged as a way of reducing pollution. This would help the UK comply with its legal limits on air quality and improve public health.

KEY FACTS

- In the UK, road transport is responsible for about a third of nitrogen oxides emissions, and over a quarter of particulate matter. These are known health hazards.
- Poor air quality in urban areas costs the English economy between £4.5 to £10.6 billion a year (at 2009 prices and values).
- Road transport is likely to be responsible for about half of the deaths attributed to air pollution in the 34 OECD countries.
- Every year in the UK, outdoor pollution is linked to around 40,000 deaths.
- 74% of Londoners see air cleanliness as a problem in central London, and 67% think the same of London as a whole.
- Exposure to roads with high vehicle traffic accounts for 14% of all asthma cases in children (a similar impact to that of passive smoking).
- Air pollution has been classified by the World Health Organisation (WHO) as a leading cause of cancer, especially lung cancer. WHO recognises that transportation is one of the predominant sources.



CYCLING UK VIEW

- The cumulative effect of traffic-related pollution undoubtedly causes serious, significant and costly harm to health, leads to health inequalities and has a detrimental impact on cyclists, pedestrians and drivers alike.
- Evidence suggests, however, that the health benefits of cycling still outweigh the risks, even when exposure to pollutants is taken into account.
- Cycling should be seen and promoted to the public as a way to help reduce a major source of pollution (i.e. motor traffic), for improving compliance with EU air quality laws (especially on NO₂) and for improving public health.
- Given its wider benefits, cycling should be seen as a preferable solution to reliance on 'green' cars and other 'techno-fixes'.
- The UK should introduce a new Clean Air Act.
- Central government and its agencies should:
 - Co-ordinate effective action by local authorities and other bodies to tackle air pollution, and in particular in areas with Clean Air Zones (CAZs);
 - Take full account of the impact of road building on air quality;
 - Use the tax system to discourage activities that contribute to traffic-related air pollution through, for example, fuel duty, vehicle tax and emissions-based road user charging;
 - Make it clear in national planning guidance that all development projects should be vetted for the impact they are likely to have on road traffic pollution, and ensure that local planning authorities can easily dismiss applications on air pollution grounds.
 - Work through Public Health England to ensure that local authorities recognise air pollution as an urgent public health problem.
- Local authorities should:
 - Recognise that tackling air pollution is a key duty;
 - Build strong partnerships between those responsible for transport, air quality and public health to address the harm caused by road transport pollution in the locality, and promote cycling as a healthy and sustainable alternative;
 - Make the most effective use of local air quality management measures available to them (e.g. Ultra Low Emission Zones, Air Quality Management Areas CAZs);
 - Promote car-free days and other events as a means of highlighting the need to improve air quality through local action and behaviour change.



BACKGROUND INFORMATION

1. Legal duties, strategies and standards

a. European legislation

The UK will be leaving the European Union (EU) in due course, but for now the following applies:

All EU members, including the UK, must comply with the EU directives on ambient air quality and cleaner air for Europe (2008/50/EC)¹, and on arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (Fourth Daughter Directive) (2004/107/EC).²

These directives require all Member States to carry out air quality assessments, and to report back to the European Commission (EC) each year. The directives are legally binding, and the EC can take action against any breaches. Also, a *National Emission Ceilings Directive* sets pollution limits for each Member State.³

Amongst other requirements, the 2008 Directive says that Member States must report on measures: “to limit transport emissions through traffic planning and management (including congestion pricing, differentiated parking fees or other economic incentives; establishing low emission zones”; and “to encourage a shift of transport towards less polluting modes”.

In 2013, the European Commission (EC) proposed a new *Clean Air Policy Package* to: set stricter national emission ceilings (NEC); ensure that existing targets are met by 2020; and pave the way for tighter standards in future.⁴ In June 2016, the EU Council and Parliament came to a provisional agreement on reducing NECs and amending the relevant Directive 2003/356/EC.⁵ The aim is to cut air pollution across Europe by 2030.

b. The UK's National Air Quality Strategy

The UK's *National Air Quality Strategy*, first published in 1997 and last reviewed in 2007, sets out the issues for the UK and its policies for reducing various hazardous pollutants.⁶ It also includes standards and objectives, most of which are subject to regulations made under the *Environment Act 1995* and European law (see above).

For more on the strategy, see: www.environmental-protection.org.uk/policy-areas/air-quality/air-pollution-law-and-policy/air-quality-policy/

c. UK Air Quality Plans and ClientEarth's challenge

In November 2014, following a successful case brought by ClientEarth against the UK Government for failing to meet its legal limits on air pollution, the European Court of Justice ruled that the UK courts must order the Government to produce a plan to achieve the limits for nitrogen dioxide (NO₂) as soon as possible. The UK Supreme Court acted accordingly and, as a result, the UK was tasked with considering a number of remedial measures to reduce NO₂, including low emission zones, congestion charging and other economic incentives.⁷

In response, DEFRA released a new air quality plan in December 2015, which included proposals to introduce Clean Air Zones (CAZs) in Birmingham, Leeds, Nottingham, Derby and Southampton. The plan also referred to the Government's support for existing plans for the 'Ultra Low Emission Zone' in London.⁸

ClientEarth did not believe that the plan went far enough, especially it did not require other cities such as Glasgow, Manchester and Liverpool to create CAZs, while the Zones were only targeted at old diesel buses, coaches, taxis and lorries, rather than private cars.

ClientEarth thus launched another challenge and, in November 2016, won its second High Court case. The judge (Mr Justice Garnham) agreed that: the Government's 2015 air quality plan failed to comply with the Supreme Court ruling and relevant EU Directives; that ministers knew that the pollution modelling being used was over-optimistic; and that the Environment Secretary had failed to take measures that would bring the UK into compliance with the law "as soon as possible", opting instead to achieve compliance by 2020 for some cities and by 2025 for London only because it was then that EC fines were likely. The court also heard evidence that Defra had originally planned a more extensive network of CAZs, but this had been ruled out on grounds of cost.

Subsequently, Mr Justice Garnham ordered the Government to draw up an improved and final air quality plan by July 2017 and publish the technical data behind it. He also granted ClientEarth permission to go back to court in the event of any further problems.

Campaigners are now calling on the Government to re-work their 2015 plan and come up with a credible alternative, including a commitment to a much wider network of CAZs, and modelling forecasts that are based on reality.

See www.clientearth.org/uk/ for updates.

d. Parliamentary committees

- **Environment, Food and Rural Affairs (EFRA) Committee**

In April 2016, the House of Commons' Environment, Food and Rural Affairs Committee reported back on its inquiry into air quality, highlighting a wide range of deficiencies in the Government's approach to tackling air pollution.⁹ They said:

"Many witnesses, including the Local Government Association (LGA), considered that Defra failed to take a "coherent, cross-government approach", which, if true, would be a critical omission given the range of sectors including transport, energy and agriculture which contribute to poor air quality. The LGA cited Defra's lack of dialogue with the Department for Transport as particularly problematic." (Para 8)

"Despite mounting evidence of the costly health and environmental impacts of air pollution, we see little evidence of a cohesive cross-government plan to tackle emissions. The Cabinet Office must establish clearly with all government departments their duty to consider air quality in developing policies. Furthermore, Ministers must tell the public more clearly how it is co-ordinating action since the work of the inter-ministerial Clean Growth Group is opaque". (Para 9)

"We recommend that the Department publish by the end of 2016 a comprehensive strategy for improving air quality and report annually to Parliament on progress". (Para 14)

"... the Government must publish proposals to make it easier for local authorities to use powers over traffic movement and new development to tackle air pollution as and when the need arises, whether inside or outside Clean Air Zones." (Para 35)

"Since Defra's plans rely on local action to cut pollution, councils must be given support to implement programmes to encourage people to drive less and use public transport and cycle and walk more. [...]. Defra and the Department for Communities and Local Government must also preserve funding for wider programmes, such as those supported by the Local Sustainable Transport Fund, which can demonstrate they deliver benefits in a cost-effective manner." (Para 40)

- **Environmental Audit Committee**

EFRA's conclusions (above) echo many of the points made during the Environmental Audit Committee's *Action of Air Quality* inquiry (December 2014).¹⁰ In its final report, the Committee urged the Government to clarify the responsibilities of local and central government, and of individual Government departments, identify cross-departmental actions, and ensure that localism does not undermine countrywide air quality monitoring, which *"must be a responsibility that central government cannot absolve itself from."*

The Committee came to a number of other conclusions about the role the Government needs to play, many relating specifically to road transport because the bulk of the submitted evidence focused on it. It recommended, for instance, that the Government should:

- Encourage active travel;
- Establish a national framework of Low Emission Zones, all with the same approach and standards;
- Rebalance fuel duty and Vehicle Excise Duty to reduce NO₂ and PM impacts
- Toughen up on diesel emissions;
- Issue National Policy Planning Framework (NPPF, England) guidance on protecting air quality;
- Impose a legal obligation on the Highways England to protect air quality;
- Call an independent public inquiry on air pollution and update the *Air Quality Strategy* of 2007.

Responding to the Committee's inquiry report, the Government broadly accepted most of the above recommendations, saying that they had or already were taking action on the matter, or were reviewing it. However, it did not support the idea of an independent public inquiry on air pollution on the basis that: *"We are working, and will continue to work, with all the relevant organisations to ensure a consistent approach to air pollution."*

2. Road transport emissions and the UK's record

a. Main emissions

Pollutants come from a variety of sources, some of them natural and some of them generated by human activity, e.g. industrial processes, agriculture and transport. They are not only harmful to human health - outdoor pollution causes around 3.7 million deaths worldwide a year¹¹ - but can also adversely affect habitats and wildlife, and contribute to climate change. Most pollutants from road transport are regulated by EU vehicle emission standards.¹²

The main pollutants emitted by petrol, diesel and alternative fuel engines are:

- **Nitrogen oxides** (NO_x): a generic term for nitric oxide (NO) and nitrogen dioxide (NO₂)
- **Particulate matter** (PM): this is classified by size, i.e. PM₁₀ (coarse particles) and PM_{2.5} (fine particles). Tyre and brake wear can also produce fine particles.
- **Carbon monoxide** (CO)

Road transport also emits benzene, 1,3 butadiene and polycyclic aromatic hydrocarbons.

b. Emission levels

A single car - especially if it's a newer model - may emit only a small quantity of pollutants, but the cumulative impact of emissions from motor vehicles is both significant and harmful, despite technological advances and increasingly stringent limits.

Road transport is one of the most substantial sources of NO_x, CO and PM

Source: DEFRA Emissions of Air Pollutants in the UK, 1970 to 2015.¹³

Emissions of air pollutants by source, UK (2015)			
Pollutant	NO _x	PM ₁₀	PM _{2.5}
All sources	918.3	145.5	104.8
Road transport	311.45	20.6	13.9
Road transport - % of all sources	33.92%	14.16%	13.26%

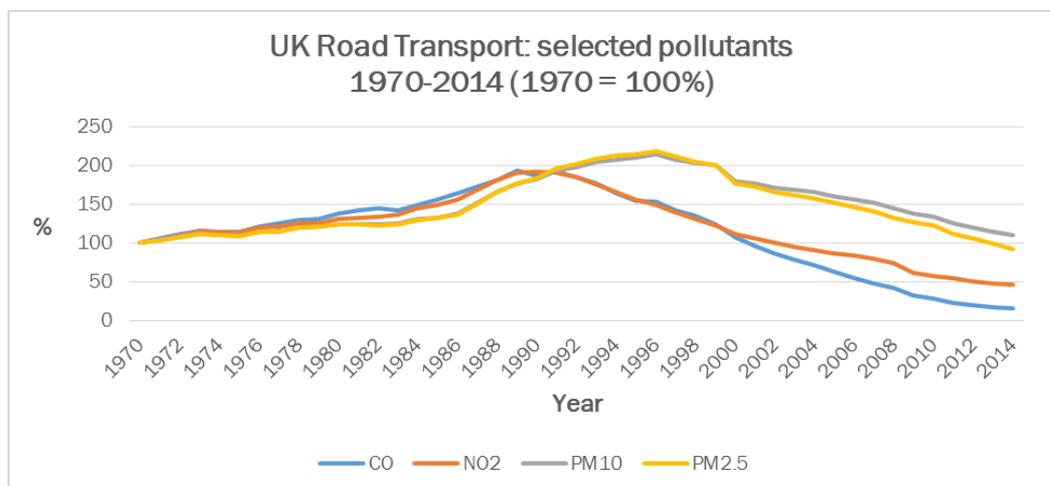
Diesel: this fuel emits significantly more NO_x than petrol, but the Government has encouraged its use in the past because it emits far less carbon dioxide (CO₂), a greenhouse gas that has an impact on climate change. Diesel engines are more efficient. According to a report released in 2015, diesel road traffic is responsible for around 40% of London's NO_x emissions and a "broadly similar proportion" of particulate matter PM₁₀.¹⁴

c. The UK's record on its emission limits

Europe: in the European Union as a whole, most air polluting emissions from transport have been decreasing. According to the European Environmental Agency's (EEA) 2015 TERM (Transport and Environment Reporting Mechanism) report: "... emissions of three important air pollutants - sulphur oxides (SO_x), nitrogen oxides (NO_x) and particulate matter (PM) - from transport activities decreased in the period 2000 to 2013 in the EU."¹⁵

However, the report also says: "Despite these advances, achieving levels of good air quality in Europe is still a challenge, especially in urban areas with high volumes of traffic. For example, the annual EU limit value for NO₂, one of the main air quality pollutants of concern and typically associated with vehicle emissions, was widely exceeded across Europe in 2013, with 93% of all exceedances occurring at road-side monitoring locations. As noted for CO₂, there are also significant differences currently observed between official and real-world vehicle emissions of NO_x."

UK: the UK's emissions of the principal pollutants emitted by road transport (CO, NO_x, PM₁₀ and PM_{2.5}) began to fall in the 1990s (see table right).



Source: <http://naei.defra.gov.uk/data/>

However, while the UK met almost all of its EU limits on CO and particulate matter in 2013, it has failed badly on NO₂:

- As mentioned in section 1c, the UK Government has been successfully challenged in court for its failure to meet its legal limits for NO₂.
- The UK is divided into 43 zones for air quality assessment. In 2015, only six of them met the annual mean limit value for NO₂ in 2015. The remaining 37 zones had locations with measured or modelled annual mean concentrations higher than the annual mean limit value.¹⁶
- Official projections published in 2014 estimated that three zones in the UK will not meet the annual mean limit set by the EU until after 2030, 20 years after original deadline. The zones are Greater London, West Midlands and West Yorkshire.¹⁷
- According to data compiled by Friends of the Earth (FoE) Scotland, 13 monitoring sites breached the EU annual average limit for NO₂ in 2014, while 19 sites breached the annual limit for PM₁₀. The data also show that levels of NO₂ increased from the year before slightly at five sites (two of them in Edinburgh); and levels of PM₁₀ also rose slightly at five sites.¹⁸
- As far as World Health Organisation (WHO) guidance on particulate matter is concerned, ten urban areas in the UK were found to be in breach of its PM₁₀ limits in 2013 (Oxford, Southampton, Nottingham, Eastbourne, Leeds, Scunthorpe, London, Glasgow, Stanford-Le-Hope and Port Talbot). Also, 39 urban areas exceeded WHO limits for PM_{2.5}.¹⁹

Even with the progress made on tackling other pollutants, serious public health problems remain. This suggests that the UK should have supported moves to make EU limits far more stringent. Instead, it has been criticised amongst other Member States for trying to dilute them.²⁰

Leaving the EU: Whatever the UK's future relationship with the EU, campaigners want to ensure that the legal protections afforded by EU membership are safeguarded in future. This means that the UK must remain bound by the National Emissions Ceiling Directive (see section 1a) and press for tougher EU limits. Stronger domestic legislation would help make sure that the UK's potential withdrawal from the EU does not compromise the protection against harmful levels of air pollution that citizens enjoy from the law. ClientEarth is therefore calling for a new *Clean Air Act*.²¹ As part of ClientEarth's Healthy Air Campaign, Cycling UK is supporting these calls (see 5a below).

For more on air pollution in the UK, see the European Environment Agency's fact sheet:
www.eea.europa.eu/themes/air/air-pollution-country-fact-sheets-2014/united-kingdom-air-pollutant-emissions/view

The 'How polluted is my school?' webpage allows users to identify the 1,148 schools located within 150 metres of roads used by 10,000 or more vehicles per day and at substantial risk from air pollution. www.howpollutedismyroad.org.uk/schools.php



3. The effects of road transport pollutants: health, equality and the economy

Cycling UK view:

- The cumulative effect of traffic-related pollution undoubtedly causes serious, significant and costly harm to health, leads to health inequalities and has a detrimental impact on cyclists, pedestrians and drivers alike.
- Evidence suggests, however, that the health benefits of cycling still outweigh the risks, even when exposure to pollutants is taken into account.

a. The main pollutants and their impacts

According to the *British Social Attitudes Survey*, 67% of respondents were 'very' or 'fairly' concerned about exhaust fumes from traffic in 2011; and in 2014, 50% felt that exhaust fumes from traffic in towns and cities were either a very serious, or serious problem.²² Also, results of a survey carried out in 2016 suggest that 74% of Londoners see air cleanliness as a problem in central London, and 67% think the same of London as a whole.²³

All the following traffic-related pollutants are harmful to health, and people who live near busy roads and/or in urban areas are particularly affected. In general:

- **NO_x (nitrogen dioxide):** At high levels, NO_x can inflame the airways, and long-term exposure may affect lung function. For those who are sensitive to allergens, NO₂ can make their symptoms worse.
- **PM (particulate matter):** Both short and long-term exposure to PM are consistently associated with respiratory and cardiovascular illness and mortality. The 'Fraction of mortality attributable to particulate air pollution (PM_{2.5})' is an indicator for health protection in the *Public Health Outcomes Framework for England 2016-2019*.²⁴
- **CO (carbon monoxide)** reduces the blood's capacity to carry oxygen to the body's tissues. It is also associated with admissions to hospital or death from strokes.²⁵
- **Benzene, 1,3 butadiene and some polycyclic aromatic hydrocarbons:** These are human carcinogens (i.e. can cause cancer).

b. Health

- Every year in the UK, outdoor pollution is linked to around 40,000 deaths.²⁶
- The OECD has estimated that people in its 34 Member countries would be willing to pay USD 1.7 trillion to avoid deaths caused by air pollution. Road transport is likely to be responsible for about half.²⁷
- Air pollution has been classified by the World Health Organisation (WHO) as a leading cause of cancer, especially lung cancer. WHO recognises that transportation is one of the predominant sources.²⁸
- In London, in 2010:²⁹
- The total mortality burden of long-term exposure to NO₂ is estimated to be up to 88,113 life-years lost, equivalent to 5,879 deaths at typical ages;
- The total mortality burden of human-generated PM_{2.5} for 2010 was 52,630 life-years lost, equivalent to 3,537 deaths at typical ages;
- NO₂ and PM_{2.5} were associated with approximately 420 and 1,990 respiratory hospital admissions respectively; an additional 740 cardiovascular hospital admissions were associated with PM_{2.5}.

- The table to the right shows how many deaths are thought to be attributable to PM2.5 in the UK, in 2010.

Deaths from PM2.5, 2010			
	Attributable deaths (aged 25+)	Life years lost	% deaths
England (inc. London)	25,002	264,749	5.6%
London	3,389	41,404	7.2%
Scotland	2,094	22,474	3.9%
Wales	1,320	13,549	4.3%
Northern Ireland	553	6,063	3.8%
UK	28,969	306,835	5.3%

Source: Public

Health England. *Estimating Local Mortality Burdens associated with Particulate Air Pollution*. 2014.³⁰
This report also estimates the deaths attributable to PM2.5 in every local authority in England.

- There is a significant association between PM generated by road traffic and lung cancer.³¹
- In 2012, The International Agency for Research on Cancer (part of WHO), classified diesel engine exhaust as carcinogenic to humans as it increases the risk of lung cancer.³²
- Roadside pollution exacerbates bronchiectasis (a condition in which the airways in the lungs become abnormally widened), and makes sufferers more likely to die from it.³³
- NO2 and PM all have a marked association with admissions to hospital for stroke or likely death from stroke. PM2.5 appears to be the worst offender.³⁴
- Nearly 4,800 early deaths amongst people with heart problems in England and Wales are caused by long-term exposure to PM2.5.³⁵
- Air pollution, particularly from PM (but also NO2 and CO) is closely associated with being admitted to hospital for heart failure and dying from it.³⁶
- A study of more than 100,000 people for an average of 11.5 years confirms that long-term exposure to PM is associated with heart problems. The authors also found that this effect persisted at levels below the current EU limit values, leading for calls for them to be lowered.³⁷
- A study in ten European countries estimated that an average of 37,200 coronary heart disease (CHD) cases (28% of all older adults with CHD) were attributable to near-roadway traffic-related pollution.³⁸
- There seems to be a significant association between PM2.5 from road traffic and anxiety amongst women with an average age of 70.³⁹

For a summary of the main health effects of pollutants, see:

http://uk-air.defra.gov.uk/assets/documents/What_are_the_causes_of_Air_Pollution.pdf

c. Air pollution and children

- Research carried out in ten European countries calculated that exposure to roads with high vehicle traffic accounted for 14% of all asthma cases in children (a similar impact to that of passive smoking).⁴⁰
- PM has been associated with type 1 diabetes in children.⁴¹
- Studies have found that children who live in areas with high levels of traffic-related air pollution during their first year of life are three times as likely to develop autism.⁴²
- Exposure to traffic pollution during pregnancy (particularly PM2.5) could cause low birthweight at term and reduced average head circumference at birth.⁴³

d. Air pollution and inequality

Researchers who found higher concentrations of PM10 and NO2 in the most deprived 20% of neighbourhoods in England and that air pollution inequalities were mainly an urban problem, suggested that “... measures to reduce environmental air pollution inequality should include a focus on city transport.”⁴⁴

e. The effects of pollution on cyclists and other road users

Although cyclists usually ride in close proximity to motor traffic in urban areas, assessments of the overall health impacts of cycling have consistently concluded that the benefits outweigh the disbenefits. Not all assessments have factored in traffic pollution, but even those that have still suggest that cycling as a physical activity does more good than harm.

For instance, a study that weighed up the health benefits of switching from driving to cycling for a 5km commute, and included the impact of injuries, breathing in polluted air and the effects on society of a non-polluting form of transport, estimated that the annual value of mortality benefits outweighed the disbenefits by 19:1, per person per year.⁴⁵

For a table summarising various estimates of the health benefit of cycling v the health risks, see Cycling UK's briefing on cycling and health:

www.cyclinguk.org/campaigning/views-and-briefings/health-and-cycling

Other studies have specifically examined the health impact of cycling in a polluted environment, some of which have compared cyclists' exposure to that of drivers. While cyclists may inhale larger doses of pollutants because of their faster breathing rate, car drivers are at risk because vehicles in close proximity suck in each other's emissions through the engine compartment, or via open windows etc.

Generally speaking, the findings show that it is better to exercise (or cycle) in a polluted environment than to remain inactive. Chosen routes, breathing rates and other factors do make a difference to how much pollution a cyclist is likely to inhale, of course. Research also tends to suggest that car drivers are exposed to more pollution than cyclists, although not all studies come to this conclusion:

- In 2016, the authors of an academic paper which examined the risk v benefits of travelling actively at the same time as being exposed to polluted air, concluded that the benefits “*outweighed the harm caused by air pollution in all but the most extreme air pollution concentrations.*” They also said that if cycling replaces driving, the trade-off would be even more beneficial.⁴⁶
- A paper published in 2014 concluded that: “*In a healthy population, intermittent moderate PA [physical activity] has beneficial effects on pulmonary [lung] function even when performed in a highly polluted environment.*” The researchers chose cycling as the physical activity to test, and the participants were exposed to traffic-related pollution.⁴⁷



- A review of various studies comparing cyclists with car drivers concluded that, overall, “*air pollution exposures experienced by car drivers were modestly higher than those experienced by cyclists.*” However, assuming cyclists’ breathing rate per minute is just over twice that of car drivers, the authors concluded that cyclists inhale larger doses of PM2.5. They also pointed out that exposure for both types of road user depends on many factors, e.g. route, car speed, trip duration, car type, whether the window is open or not, the street, weather, etc. Nevertheless, the authors still concluded that: “*On average, the estimated health benefits of cycling were substantially larger than the risks relative to car driving for individuals shifting their mode of transport.*”⁴⁸
- An earlier study (2001) from Copenhagen, concluded that “... *even after taking the increased respiration rate of cyclists into consideration, car drivers seem to be more exposed to airborne pollution than cyclists.*”⁴⁹
- A Dutch study from 2008 that specifically looked at ultra-fine particles, found that in the Netherlands, car drivers’ exposure to “particulate number concentration” and PM2.5 was slightly higher than that of cyclists. The authors also said that cyclists are confronted with mainly short, but very high peaks, yet could take more direct routes avoiding busy roads. Car drivers, on the other hand, encounter lower peaks for a longer time. For cyclists, peaks were caused by passing vehicles, waiting for traffic lights, passing different types of (large) intersections, and cycle lanes/paths close to motorised traffic.⁵⁰
- Despite the fact that exercising in a polluted environment means that the lungs take in more pollutants because of an amplified breathing rate, a study of residents aged 50-65 living in Aarhus and Copenhagen suggested that the long-term benefits outweigh the risks. The researchers focused on NO₂, and looked at various activities, including cycling.⁵¹
- A 2010 study carried out in Belgium concluded that previous research had underestimated cyclists’ ventilation rate and that it was 4.3 higher than that of car drivers (i.e. not just above twice as much). They found, for instance, that in Brussels and Louvain-la-Neuve, concentration of PM2.5 and PM10 “*was significantly higher for the bicycle compared to the car*”. The authors also said that concentrations are heavily dependent on location. (In their trials, however, they examined the effects of cycling and driving along identical routes, whereas in practice cyclists often choose routes with less traffic and better air quality. Also, the type of cyclists who do this may well be slower and/or less confident, who probably breathe more slowly).⁵²
- A 2011 study found that: “*Use of off-road cycle routes in the city of York led to a significant reduction in the time-weighted concentration of, and exposure to, NO₂ compared to on-road routes. Therefore the provision of additional off-road cycle routes has benefits beyond improved safety.*”⁵³
- A Canadian study from 2011 concluded that: “*Short-term exposures to traffic pollution may contribute to altered autonomic modulation of the heart in the hours immediately after cycling.*” As this is a detrimental effect on heart function, the authors suggested: “*it may be prudent to select cycling routes that reduce exposure to traffic and to avoid cycling outdoors or to exercise indoors on days with elevated air pollution levels.*” The study did not, however, “... *observe strong associations between traffic-related air pollution and acute changes in respiratory outcomes.*”⁵⁴
- Research from the University of Surrey (2015) found that although commuting drivers spend just 2% of their journey time passing through junctions with traffic lights, it contributed to about 25% of their total exposure to PM. This is caused by decelerating, stopping and then revving-up to move away. Peak PM concentration proved to be 29 times higher than it is in free-flowing traffic conditions.⁵⁵

- Monitoring devices fitted to five MPs from the Environmental Audit Committee as they travelled round London showed that their greatest exposure to carbon particles occurred during taxi rides.⁵⁶

f. Costs to the economy

- According to The Cabinet Office Strategy Unit, poor air quality in urban areas costs the English economy between £4.5 to £10.6 billion a year at 2009 prices and values.⁵⁷
- WHO estimated the economic cost of deaths from air pollution (both outdoor and indoor) in the UK to be around £54 billion, or about 3.7% of GDP.⁵⁸
- The cost of the health impact of air pollution in OECD countries (including deaths and illness) was about USD 1.7 trillion in 2010. Road transport almost undoubtedly accounts for about 50% of this cost.⁵⁹

4. Reducing pollution from road transport in the UK

a. Active travel and air quality

Cycling UK view:

- Cycling should be seen and promoted to the public as a way to help reduce a major source of pollution (i.e. motor traffic), for improving compliance with EU air quality laws (especially on NO₂) and for improving public health.
- Given its wider benefits, cycling should be seen as a preferable solution to reliance on 'green' cars and other 'techno-fixes'.

Cycling is zero-emission and is a viable and healthy alternative for most people for many short trips, or in combination with public transport for longer journeys. As such, it can make a significant contribution to reducing levels of pollution from road transport in urban areas, and its value should be fully recognised by national and local government. Likewise, the link between air quality and travel choice should be made clear to the public via the media and behaviour change programmes.

Increasing levels of active travel as one of the solutions to air pollution has many supporters, including the Parliamentary Environmental Audit Committee. Following its 2014 inquiry on air quality (see 1d), it urged the Government to: "... encourage active travel such as walking and cycling - the ultimate low emission options." In its response, the Government expressed support for efforts to encourage active travel and said that it is working to ensure that this is embedded in all departmental policies.

Also, having examined the impact of lifetime exposure to outdoor air pollution, in 2016, The Royal College of Physicians, together with the Royal College of Paediatrics and Child Health, set out six steps for the public to take to reduce the threat, including: "Take the active travel option: bus, train, walking and cycling".⁶⁰

For more on cycling as part of local and national government transport policy, see:
www.cyclinguk.org/campaigning/views-and-briefings/national-transport-policy-cycling
www.cyclinguk.org/campaigning/views-and-briefings/cycling-and-local-transport

b. Technological solutions and low emission (motorised) vehicles

The Government has invested in a number of schemes to advance technological solutions to improve air quality. For example, it has set up The Office of Ultra Low Emission Vehicles (OLEV), a team working across government to support the early market of such vehicles.

However, while technological solutions do make a contribution to improving air quality in urban areas where motor vehicle is high, shifting people away from driving to walking and cycling, especially for short trips, makes the best sense as it helps tackle physical inactivity and all the associated health problems it causes at the same time.

Also, while electric cars may help clean up the air in urban areas, the impact on the wider environment is compromised unless their power comes from a sustainable, pollutant-free source. Only about 7% of the UK's energy supply is generated from renewables, while 84.5% still comes from fossil fuels, which are responsible for high levels of pollutants, including NO_x, CO, PM, along with the greenhouse gas CO₂.⁶¹

5. Roles, responsibilities and actions: central government and its agencies

Cycling UK view:

- The UK should introduce a new Clean Air Act.
- Central government and its agencies should:
 - Co-ordinate effective action by local authorities and other bodies to tackle air pollution, and in particularly in areas with Clean Air Zones (CAZs);
 - Take full account of the impact of road building on air quality;
 - Use the tax system to discourage activities that contribute to traffic-related air pollution through, for example, fuel duty, vehicle tax and emissions based road user charging;
 - Make it clear in national planning guidance that all development projects should be vetted for the impact they are likely to have on road traffic pollution, and ensure that local planning authorities can easily dismiss applications on air pollution grounds.
 - Work through Public Health England to ensure that local authorities recognise air pollution as an urgent public health problem.

Cycling UK believes that central government should take a lead role on improving air quality, and ensure that all its departments work together on the issue, including those for transport, health, environment, education and local communities. After all, the Government has a financial incentive to tackle air pollution, given its huge costs to the economy (see 3f).

As mentioned above (see 4a), promoting and providing for active travel makes an important contribution to managing air quality and, in Cycling UK's view, should be integral to all policies and strategies at both national and local level.

However, we share concerns that 'localism' (i.e. expecting more and more action at local level with less central intervention) confuses responsibilities over managing air quality and who is supposed to pay for what. It also means that there is a lack of consistency in the way that air quality is addressed at local level. This was one of the problems highlighted in the Parliamentary Environmental Audit Committee's inquiry into air quality (see 1d).

a. New Clean Air Act

As mentioned above (2c), a new *Clean Air Act* would help make sure that the UK has domestic legislation in place to protect its citizens more effectively against air pollution, particularly if legally binding EU limits no longer apply or are weakened as a result of leaving the Union. The last Clean Air Act was passed in 1956 following the 'great smog' of 1952.

ClientEarth is campaigning for a new Act to:

- tackle the sources of modern air pollution such as diesel;
- safeguard the legal protections that we could be stripped of on leaving the EU;
- improve on existing legislation, both EU and domestic, to ensure that we enshrine the right to breathe clean air in law.⁶²



The Healthy Air Campaign aims to encourage behaviour that helps cut air pollution and our exposure to it. It also wants the Government to:

- Support a more ambitious EU air package which delivers real improvements in urban air quality through strict national emissions targets;
 - Develop and deliver a cross-government national air quality strategy;
 - Set stricter national air quality objectives for 2030 which align with WHO guidelines;
- Drive a dramatic decrease in the use of diesel, through a range of measures including a national network of low emission zones, and taxation changes;
- Commit to measures to increase sustainable transport, which would reduce overall levels of motor traffic;
- Provide better public information on air pollution, including a comprehensive warning system for pollution episodes and clinical advice.

Cycling UK is a partner of Healthy Air. <http://healthyair.org.uk/>

b. Clean Air Zones

As mentioned above (1c), in December 2015, the Government proposed CAZs for five cities: Birmingham, Leeds, Nottingham, Derby and Southampton. These plans, however, have been successfully challenged on the grounds that they will not enable the UK to meet its legal air quality limits. Along with ClientEarth, therefore, Cycling UK is calling for a much wider network of CAZs, and for them to tackle emissions from private cars (i.e. not just old diesel buses, HGVs etc.)

Cycling UK also believes that the Government should issue guidance on establishing and operating CAZs, ensuring that it takes account of the powers and duties that local authorities have under the Road Traffic Reduction Acts of 1997 and 1998. Putting both of these Acts into practice has the potential to make significant contributions to air quality objectives.

With regard to the charges for non-compliant vehicles entering a CAZ, we believe they should be set at a level likely to maximise levels of compliance. Furthermore, the revenue generated should be sufficient not merely to cover the cost of administering the Zone, but also to provide funding for high quality walking and cycling schemes within it to encourage non-polluting travel.



c. Polluter pays principle: tax and emissions based road use charging

Tax: Cycling UK believes in the 'polluter pays' principle, i.e. that those who cause pollution should pay for the harm it causes. The most effective means of doing this is through the tax system - e.g. via fuel duty, taxing vehicles on the basis of their emissions, and road pricing. These measures also help encourage people to cycle and walk instead. The Government consistently freezes fuel duty, however.

Also, from 2017, the Government has decided to introduce new vehicle excise duty (VED) bands for new cars: zero emission (exempt), standard and premium (for which charges will apply). The money raised will go towards a new 'road fund' for road improvements, including road-building, unfortunately.

For more on tax, see:

www.cyclinguk.org/campaigning/views-and-briefings/cycling-and-economy

Emissions-based road use charging: this would require drivers to pay to use roads, taking account of their vehicle's emissions, the time of day, location and distance driven by size of vehicle.

d. Road building

Although the Government is investing in technology to make motor travel less polluting (see 4b), promoting active travel and reducing the need to travel by car in the first place makes better sense. Spending large sums on road building is counterproductive but, despite this, in 2015 the Government launched a £15billion 'road investment strategy' to increase the capacity and improve the condition of England's roads. Also, major investment in road building is hard to reconcile with Highways England's new duty, under The *Infrastructure Act 2015*, to consider the impact of its operations on air quality.

For Cycling UK's views on road building see:

www.cyclinguk.org/campaigning/views-and-briefings/national-transport-policy-cycling

Excessively 'smoky' buses, coaches or lorries can be reported to the DVSA through
www.gov.uk/report-smoky-vehicle

e. Planning

National guidance on planning covers how local authorities should approach pollution control when they draw up their development plans and make decisions on planning applications.⁶³

For instance, in England, the *National Planning Policy Framework* (NPPF) says: "*Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan.*"

However, the Environmental Audit Committee (EAC) highlighted concerns that the "*NPPF does not provide any guarantee of avoiding worse pollution as a result of development, but rather a means of considering all aspects of sustainability, balancing or trading-off sometimes conflicting economic, social and environmental objectives.*" The Committee therefore suggested that the NPPF should be much clearer about the importance of protecting air quality.

In July 2015, a Planning Inspector dismissed an appeal to build 97 homes in West Sussex close to an Air Quality Management Area (AQMA), saying: "*I cannot be certain that the development would not be detrimental to air quality, and therefore to human health, within the designated AQMA. Consequently, it would conflict with the environmental role of sustainable development.*"
www.scribd.com/doc/270316561/Appeal-Decision

As all national and local planning policies and local decisions on development make a significant impact on travel patterns and travel choice, Cycling UK believes that they need to promote cycling and other healthy, non-polluting and sustainable options. They can do this, for example, by locating development where it can be easily reached by walking, cycling and public transport, and providing good cycle access to and within new developments.

For more on planning, see Cycling UK's briefing:
www.cyclinguk.org/campaigning/views-and-briefings/national-planning-policies

Environmental Protection UK and the Institute of Air Quality Management have published guidance for professionals working in the planning system on how best to consider air quality within the land-use planning and development control processes.

www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

f. Public Health England (PHE)

PHE already recognises that air pollution causes a serious threat to health and regularly issues advice and information on it. The Environmental Audit Committee also recommended that PHE should engage with the local authority Health and Wellbeing Boards in England (see 6b) to make sure that they give air pollution the priority it deserves. www.gov.uk/government/organisations/public-health-england

6. Roles, responsibilities and actions: local government

Cycling UK view: local authorities should:

- Recognise that tackling air pollution is a key duty;
- Build strong partnerships between those responsible for transport, air quality and public health to address the harm caused by road transport pollution in the locality, and promote cycling as a healthy and sustainable alternative;
- Make the most effective use of local air quality management measures available to them (e.g. Ultra Low Emission Zones and Air Quality Management Areas);
- Promote car-free days and other events as a means of highlighting the need to improve air quality through local action and behaviour change.

In Cycling UK's view, tackling pollution from road transport is a key duty for local authority health and transport departments to share and prioritise. There are a number of channels and schemes that local authorities can use to do this.

a. Local Enterprise Partnerships (LEPs, England)

LEPs are voluntary partnerships between local authorities and businesses set up in 2011 by the Department for Business, Innovation and Skills to help determine local economic priorities and lead economic growth and job creation within the local area. There are 39 of them. As they have control over much of the local transport budget, they are in a good position to prioritise investment in sustainable and non-polluting transport but, unfortunately, the Campaign for Better Transport's 'LEP Watch' suggests that this is far from the case: www.bettertransport.org.uk/roads-nowhere/local-transport

b. Health and Wellbeing Boards and Directors of Public Health (England)

Under the *Health and Social Care Act 2012* (England), each local authority is expected to set up a Health and Wellbeing Board and produce a Health and Wellbeing Strategy. Directors of Public Health (DsPH) now operate within local authorities, making it easier to build partnerships between departments responsible for health and those responsible for transport. Both the Board and the DsPH, working in partnership with transport departments, are in a good position to take a leading role in promoting public awareness about air quality and promoting active travel.

For more about Boards and their duties, see Cycling UK's briefing on health:
www.cyclinguk.org/campaigning/views-and-briefings/health-and-cycling

c. Local air quality management (LAQM), Air Quality Management Areas (AQMAs)

Under the *Environment Act 1995* (s.83(1)), all local authorities (borough, district, city and metropolitan etc.) in England, Scotland and Wales, have to designate areas where national air quality objectives are not being (or are unlikely to be) met as Air Quality Management Areas (AQMAs). Most councils have declared at least one AQMA, the vast majority as a result of NO₂ road transport pollution. PM₁₀ features heavily too.

Once an AQMA has been declared, the authority has to develop and implement an *Air Quality Action Plan*, but they are not obliged to achieve the objectives because they do not have enough control over all the sources of pollution (e.g. from a road for which Highways England is responsible). This arrangement has meant that direct responsibility for achieving air quality objectives is diffuse.

Under *Road Traffic (Vehicle Emissions) (Fixed Penalty) Regulations*, local authorities in England, Wales and Scotland can carry out emissions testing on vehicles being driven through or about to pass through, an AQMA. Offenders are subject to a fixed penalty fine.

Having analysed all AQMAs and published a map of them (2015), the Institution of Environmental Science highlighted inconsistencies in the approach that local authorities take - e.g. some declare their whole area or a large part of it (making the problem harder to tackle), while others target only a small proportion.⁶⁴ As discussed above (section 5), Cycling UK believes that it is the Government's role to ensure that local authorities all take consistent approach to air quality management.

For more on each local authority's AQMAs, see: <http://uk-air.defra.gov.uk/aqma/list>

d. Ultra Low Emission Zones (ULEZs)

Another measure is to charge drivers for entering urban areas if their vehicles do not meet emission standards.

London: Following a consultation demonstrating significant public support,⁶⁵ an ULEZ will operate in London from 7 September 2020 (or maybe earlier), to "encourage the use of newer, cleaner vehicles, improving the quality of life and health of Londoners." Reducing NO₂ is the main target (as mentioned, London is in breach of its legal limit).⁶⁶

The zone will operate all the time and require all cars, motorcycles, vans, minibuses and HGVs entering the current congestion charging zone to pay an additional daily charge unless they meet EU exhaust emission standards. TfL says that it would prefer drivers to meet the standards than pay the charge, and says that making journeys by public transport, walking and cycling instead is one good way for people with non-compliant vehicles to avoid it.

Some campaigners believe, however, that 'emissions based road charging' (see 5a) is a more effective option - i.e. requiring drivers to pay to use roads, taking account of their vehicle's emissions, the time of day, location and distance driven by size of vehicle.⁶⁷ Cycling UK supports this form of road charging.

Air Quality in the City Regions: A Transport Toolkit

This is a toolkit for transport and planning professionals in the UK's city regions who want to know what options there are to tackle the air pollution from transport (e.g. reducing travel, behaviour change, and technological developments). It offers cost comparisons, advice on the likely effectiveness of the interventions, examples of good practice and case studies.

Produced by Transport & Travel Research Ltd (TTR) in partnership with TRL; commissioned and published by pteg (Passenger Transport Executive Group).

www.pteg.net/resources/types/reports/air-quality-city-regions-transport-toolkit

e. Car-free days

One way for local authorities to promote non-polluting transport is to organise 'car-free' days by temporarily closing off roads to motor vehicles through traffic regulation orders. This can be done regularly, as part of annual nationwide events (e.g. on Car Free Day during European Mobility Week on 22nd September⁶⁸), or so that the public can temporarily enjoy motor-traffic free routes as part of a mass ride, cycling festival etc. (e.g. Prudential RideLondon).

These events do make a difference to levels of pollution in the area affected: when dozens of roads were closed to accommodate a stage of the 2014 Tour de France in Huddersfield, the council noticed a "dramatic and immediate" drop in pollution levels.⁶⁹

Exeter City Council has adopted a three-year low emission strategy (2015-18) which aims to cut traffic pollution from council, business and private vehicles. This will be complemented by promoting sustainable travel choices and championing the development of enhanced walking and cycling routes alongside new infrastructure and development.

<https://exeter.gov.uk/clean-safe-city/environmental-health/pollution-control/air-pollution/>

FURTHER READING

- Travelwest's series of one-page briefings, including a set on air quality - <http://travelwest.info/essentialevidence/air-noise> -
- European Cyclists' Federation briefing on cycling and urban air quality - https://ecf.com/files/150119-Cycling-and-Urban-Air-Quality-A-study-of-European-Experiences_web.pdf
- *Air Quality in Europe Report 2015*. <http://www.eea.europa.eu/publications/air-quality-in-europe-2015>
- *Explaining road transport emissions – A non-technical guide*. European Environmental Agency. Jan 2016. <http://www.eea.europa.eu/publications/explaining-road-transport-emissions>

WEBSITES

- UK Air quality and emissions statistics:
 - www.gov.uk/government/collections/air-quality-and-emissions-statistics
 - www.scottishairquality.co.uk
 - www.welshairquality.co.uk
 - www.airqualityni.co.uk

- www.gov.uk/government/groups/committee-on-the-medical-effects-of-air-pollutants-comeap - Committee on the Medical Effects of Pollutants: provides independent advice to government departments and agencies on how air pollution impacts on health.
- <http://healthyair.org.uk/> - UK campaign for clean and healthy air
- www.airqualitynews.com/ - regular news updates on air quality
- www.lsx.org.uk/ - London Sustainability Exchange (campaigns on air quality in the capital)
- <http://cleanair.london/> - campaign to achieve full compliance with WHO guidelines for air quality throughout London and elsewhere

REFERENCES

- ¹ European Union. *Directive 2008/50/EC of The European Parliament and of the Council on ambient air quality and cleaner air for Europe*. 21 May 2008. <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32008L0050&from=EN>
- ² European Union. *Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air*. 26 Jan 2005. <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004L0107>
- ³ <http://ec.europa.eu/environment/air/pollutants/ceilings.htm>
- ⁴ European Union Press Release. *Environment: New policy package to clean up Europe's air*. 18/12/2013. http://europa.eu/rapid/press-release_IP-13-1274_en.htm
- ⁵ EC. Press Statement. 1/7/2016. https://ec.europa.eu/commission/2014-2019/vella/blog/commissioner-press-statement-first-reading-agreement-nec_en/ see also Client Earth press release 1/7/2016. *Brussels deal will deliver cleaner air*. <http://www.clientearth.org/brussels-deal-will-deliver-cleaner-air/>
- ⁶ DEFRA, Welsh Assembly, DOENI, Scottish Executive. *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland*. July 2007. www.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf
- ⁷ The Supreme Court. *Judgment. R (on the application of ClientEarth) (Appellant) v Secretary of State for the Environment, Food and Rural Affairs (Respondent)*. 29 April 2015. <https://www.supremecourt.uk/cases/docs/uksc-2012-0179-judgment.pdf> / ClientEarth press release. *UK Supreme Court orders Government to take "immediate action" on air pollution*. 29 April 2015. <http://www.clientearth.org/news/latest-news/uk-supreme-court-orders-government-to-take-immediate-action-on-air-pollution-2844>
- ⁸ Defra. *Air Quality Plan for Nitrogen Dioxide*. Dec 2015. <https://www.gov.uk/government/collections/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2015>
- ⁹ Environmental, Food and Rural Affairs Committee. *Air quality: Fourth report of session 2015-16*. April 2016. <http://www.publications.parliament.uk/pa/cm201516/cmselect/cmenvfru/479/479.pdf>
- ¹⁰ Environmental Audit Committee. *Action on Air Quality: Sixth Report of Session 2014-15*. Nov 2014. <http://www.parliament.uk/documents/commons-committees/environmental-audit/HC-212-for-web.pdf>
- ¹¹ WHO. *Burden of disease from Household Air Pollution for 2012: Summary of results*. 2014. http://www.who.int/phe/health_topics/outdoorair/databases/FINAL_HAP_AAP_BoD_24March2014.pdf?ua=1
- ¹² European Commission. *Transport and the Environment: Road Vehicles* (web page - 17/9/2015) <http://ec.europa.eu/environment/air/transport/road.htm>
- ¹³ DEFRA. *Emissions of Air Pollutants in the UK, 1970 to 2015*. December 2016. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/579200/Emissions_airpollutants_statisticalrelease_2016_final.pdf
- ¹⁴ London Assembly Environment Committee. *Driving away from diesel: Reducing air pollution from diesel vehicles*. July 2015. www.london.gov.uk/about-us/london-assembly/london-assembly-publications/driving-away-diesel-reducing-air-pollution
- ¹⁵ European Environment Agency. *Evaluating 15 years of transport and environmental policy integration - TERM 2015: transport indicators tracking progress towards environmental targets in Europe*. Dec 2015. <http://www.eea.europa.eu/publications/term-report-2015>
- ¹⁶ DEFRA. *Air Pollution in the UK 2015*. Sept 2016. https://uk-air.defra.gov.uk/library/annualreport/viewonline?year=2015_issue_1
- ¹⁷ DEFRA. *Updated projections for Nitrogen Dioxide (NO2) compliance*. July 2014. http://uk-air.defra.gov.uk/assets/documents/no2ten/140708_NO2_projection_tables_FINAL.pdf
- ¹⁸ Friends of the Earth Scotland. *Revealed: Scotland's most polluted streets*. Jan 2014. www.foe-scotland.org.uk/air-pollution-streets-2014



- ¹⁹ World Health Organisation. *Urban Ambient Air Pollution Database* (updated 2016). http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/ (the 39 urban areas which exceeded WHO limits for P.M2.5 were: Glasgow, Scunthorpe, Leeds, Eastbourne, Salford, London, Southampton, Port Talbot, Birmingham, Stanford-le-Hope, Chepstow, Portsmouth, Stoke-on-Trent, Oxford, Thurrock, Warrington, Armagh, Cardiff, Norwich, Leamington Spa, Newport, Bristol, Wigan, Manchester, York, Hull, Nottingham, Plymouth, Swansea, Carlisle, Prestonpans, Liverpool, Belfast, Londonderry, Brighton, Middlesbrough, Birkenhead, Saltash and Southend).
- ²⁰ Environmental Audit Committee. *Twelfth Special Report 12th Special Report - Action on Air Quality: Government Response to the Committee's Sixth Report of Session 2014-15*. 24 (para 96) February 2015. <http://www.publications.parliament.uk/pa/cm201415/cmselect/cmenvaud/1083/108302.htm>
- ²¹ ClientEarth calls for new Clean Air Act to tackle air pollution. Press release. 4/7/2016. <http://www.clientearth.org/clientearth-calls-new-clean-air-act-tackle-air-pollution/>
- ²² DfT. *British Social Attitudes survey (ATTO30)*. 2015. Table ATTO341 (this question was not asked in the surveys 2012, 2013 & 2014); and Table ATTO339). www.gov.uk/government/statistical-data-sets/att03-attitudes-and-behaviour-towards-roads-and-road-travel
- ²³ GLA. *Clean Air Consultation - July 2016*. <https://data.london.gov.uk/dataset/clean-air-consultation-july-2016>
- ²⁴ Public Health England. *Public Health Outcomes Framework 2016-2019 at a glance*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/520457/At_a_glance.pdf
- ²⁵ Shah, Anoop S V et al. *Short term exposure to air pollution and stroke: systematic review and meta-analysis*. Published in *BMJ* 24/3/2015. <http://www.bmj.com/content/350/bmj.h1295>
- ²⁶ Royal College of Physicians / Royal College of Paediatrics and Child Health). *Every breath we take: the lifelong impact of air pollution*. March 2016. www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution
- ²⁷ OECD. *The Cost of Air Pollution: Health impact of road transport*. May 2014. www.oecd.org/env/the-cost-of-air-pollution-9789264210448-en.htm
- ²⁸ WHO. International Agency for Research on Cancer. Press release. *IARC: Outdoor air pollution a leading environmental cause of cancer deaths*. 17/10/2013. http://www.iarc.fr/en/media-centre/iarcnews/pdf/pr221_E.pdf
- ²⁹ Walton, H et al. *Understanding the Health Impacts of Air Pollution in London*. Kings College London for Transport for London and the Greater London Authority. July 2015. https://www.london.gov.uk/sites/default/files/HIAinLondon_KingsReport_14072015_final_0.pdf
- ³⁰ Public Health England. *Estimating Local Mortality Burdens associated with Particulate Air Pollution*. 2014. www.gov.uk/government/uploads/system/uploads/attachment_data/file/332854/PHE_CRCE_010.pdf
- ³¹ Raaschou-Nielsen, Ole. *Air pollution and lung cancer incidence in 17 European cohorts: prospective analyses from the European Study of Cohorts for Air Pollution Effects (ESCAPE)*. Published in *The Lancet Oncology*. Volume 14, No. 9, p813-822, August 2013 <http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045%2813%2970279-1/abstract>
- ³² WHO. International Agency for Research on Cancer. Press release. *IARC: Diesel engine exhaust carcinogenic*. 12/6/2012. http://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf
- ³³ European Lung Foundation. Press release. *Road traffic pollution increases risk of death for bronchiectasis patients*. 7/9/2013. <http://www.europeanlung.org/en/news-and-events/media-centre/press-releases/road-traffic-pollution-increases-risk-of-death-for-bronchiectasis-patients>
- ³⁴ Shah, Anoop S V et al. *Short term exposure to air pollution and stroke: systematic review and meta-analysis*. Published in *BMJ* 24/3/2015 <http://www.bmj.com/content/350/bmj.h1295>
- ³⁵ Tonne, Cathryn et al. *Long-term exposure to air pollution is associated with survival following acute coronary syndrome*. Published in *European Heart Journal*. 19/2/2013. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3640199/>
- ³⁶ Shah, Anoop S V. et al. *Global association of air pollution and heart failure: a systematic review and meta-analysis*. Published in *The Lancet* 21/9/2013. www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736%2813%2960898-3.pdf
- ³⁷ Cesaroni, Giulia et al. *Long term exposure to ambient air pollution and incidence of acute coronary events: prospective cohort study and meta-analysis in 11 European cohorts from the ESCAPE Project*. Published in *BMJ*. 21/1/2014. <http://www.bmj.com/content/348/bmj.f7412>
- ³⁸ Perez, Laura. *Chronic burden of near-roadway traffic pollution in 10 European cities (APHEKOM network)*. Published in the *European Respiratory Journal* 1/9/2013. <http://erj.ersjournals.com/content/42/3/594.long>
- ³⁹ Power, Melinda C. *The relation between past exposure to fine particulate air pollution and prevalent anxiety: observational cohort study*. Published in *BMJ*. 24/3/2015. www.bmj.com/bmj/section-pdf/893386/4
- ⁴⁰ Perez, Laura. *Chronic burden of near-roadway traffic pollution in 10 European cities (APHEKOM network)*. Published in the *European Respiratory Journal* 1/9/2013. <https://www.ncbi.nlm.nih.gov/pubmed/23520318>
- ⁴¹ <http://www.airqualitynews.com/2015/03/27/air-pollution-increases-stroke-and-anxiety-risk/>
- ⁴² Air Quality News. Release. *Air pollution 'increases stroke and anxiety risk*. 27/3/2015 <https://www.urmc.rochester.edu/news/story/4100/new-evidence-links-air-pollution-to-autism-schizophrenia.aspx>

- ⁴³ NHS Choices news. *Air pollution associated with low birthweight*. 15/10/2013. <http://www.nhs.uk/news/2013/10October/Pages/Air-pollution-associated-with-low-birth-weight.aspx>
- ⁴⁴ Fecht, Daniela. *Associations between air pollution and socioeconomic characteristics, ethnicity and age profile of neighbourhoods in England and the Netherlands*. Published in *Environmental Pollution*. Volume 198, March 2015, Pages 201–210 www.sciencedirect.com/science/article/pii/S0269749114005144
- ⁴⁵ Rabl, Ari; de Nazelle, Audrey. *Benefits of shift from car to active transport*. Published in *Transport Policy*. 4/10/2011. www.locchiodiromolo.it/blog/wp-content/uploads/2012/02/science.pdf
- ⁴⁶ Tainio M, et al. *Can air pollution negate the health benefits of cycling and walking?* Published in *ScienceDirect*. 2016. <http://www.sciencedirect.com/science/article/pii/S0091743516000402>
- ⁴⁷ Kubesch, N., de Nazelle, A., Westerdahl, D. et al. *Respiratory and inflammatory responses to short-term exposure to traffic-related air pollution with and without moderate physical activity*. Published in *Occupational and Environmental Medicine*, 4/12/2014/ <http://oem.bmi.com/content/early/2014/12/04/oemed-2014-102106.short?rss=1>
- ⁴⁸ de Hartog, Jeroen Johan et al. *Do the Health Benefits of Cycling Outweigh the Risks?* Published in *Environmental Health Perspectives*, 30/6/2010. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2920084/>
- ⁴⁹ Rank J et al. *Differences in cyclists and car drivers exposure to air pollution from traffic in the city of Copenhagen*. Published in *Science of the Total Environment*, vol 279, p 131-136, 2001. <http://www.sciencedirect.com/science/article/pii/S0048969701007586>
- ⁵⁰ Boogaard, Hanna et al. *Exposure to ultrafine and fine particles and noise during cycling and driving in 11 Dutch cities*. Published in *Atmospheric Environment*. Volume 43, Issue 27, September 2009, Pages 4234–4242 <http://www.sciencedirect.com/science/article/pii/S1352231009004506>
- ⁵¹ Andersen, Zorana Jovanovic et al. *A Study of the Combined Effects of Physical Activity and Air Pollution on Mortality in Elderly Urban Residents: The Danish Diet, Cancer, and Health Cohort*. Published in *Environmental Health Perspectives*. June 2015. <http://ehp.niehs.nih.gov/1408698/>
- ⁵² Int Panis, Luc et al. *Exposure to particulate matter in traffic: A comparison of cyclists and car passengers*. Published in *Atmospheric Environment*, Volume 44, Issue 19, June 2010, Pages 2263–2270 <http://www.sciencedirect.com/science/article/pii/S1352231010003225>
- ⁵³ Bean, T et al. *How does exposure to nitrogen dioxide compare between on-road and off-road cycle routes?* Published in the *Journal of Environmental Monitoring*. 18/2/2011. <http://pubs.rsc.org/en/content/articlelanding/2011/em/c0em00332h#divAbstract>
- ⁵⁴ Weichenthal, Scott. *Traffic-Related Air Pollution and Acute Changes in Heart Rate Variability and Respiratory Function in Urban Cyclists*. Published in *Environmental Health Perspectives*. 14/6/2014. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3230442/>
- ⁵⁵ Goel, Anju. *Characterisation of nanoparticle emissions and exposure at traffic intersections through fast-response mobile and sequential measurements*. Published in *Atmospheric Environment*, Volume 107, April 2015, Pages 374–390. <http://www.sciencedirect.com/science/article/pii/S1352231015001193>
- ⁵⁶ Environmental Audit Committee. *Action on Air Quality: Sixth Report of Session 2014-15*. (Para 42, p17). Nov 2014. <http://www.parliament.uk/documents/commons-committees/environmental-audit/HC-212-for-web.pdf>
- ⁵⁷ Cabinet Office Strategy Unit. *An Analysis of Urban Transport*. Nov. 2009. http://webarchive.nationalarchives.gov.uk/+http://www.cabinetoffice.gov.uk/strategy/work_areas/urban-transport.aspx
- ⁵⁸ World Health Organisation. *Annex: Economic cost of deaths from air pollution (outdoor and indoor) per country, as a percentage of GDP WHO European Region, 2010*. http://www.euro.who.int/_data/assets/pdf_file/0008/276956/PR_Economics-Annex_en.pdf?ua=1
- ⁵⁹ OECD. *The Cost of Air Pollution*. May 2014. <http://www.oecd.org/environment/the-cost-of-air-pollution-9789264210448-en.htm>
- ⁶⁰ Royal College of Physicians / Royal College of Paediatrics and Child Health. *Every breath we take: the lifelong impact of air pollution*. 2016. <https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution>
- ⁶¹ DECC. *Digest of United Kingdom Energy Statistics 2015*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/450302/DUKES_2015.pdf
- ⁶² ClientEarth calls for new Clean Air Act to tackle air pollution. Press release. 4/7/2016. <http://www.clientearth.org/clientearth-calls-new-clean-air-act-tackle-air-pollution/>
- ⁶³ <http://www.environmental-protection.org.uk/policy-areas/air-quality/air-pollution-and-planning/>
- ⁶⁴ <https://www.the-ies.org/analysis/local-authority-agma>
- ⁶⁵ GLA. *Clean Air Consultation – July 2016*. <https://data.london.gov.uk/dataset/clean-air-consultation-july-2016>
- ⁶⁶ <https://tfl.gov.uk/modes/driving/ultra-low-emission-zone>
- ⁶⁷ Birkett, Simon. *Emissions-based charging by 2018 and paid to walk or cycle by 2020*. Posted on 15/6/2015. <http://cleanair.london/sources/emissions-based-road-charging-by-2018-and-paid-to-walk-or-cycle-by-2020/>
- ⁶⁸ <http://www.mobilityweek.eu/>
- ⁶⁹ Air Quality News release. *Tour de France boosts Huddersfield Air Quality*. 15/8/2015. <http://www.airqualitynews.com/2014/08/15/tour-de-france-boosts-huddersfield-air-quality/>