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CONTENTS

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SUMMARY

Air pollution has significant impacts on public health. Across the UK as many as 40,000 deaths a year are attributed to outdoor air pollution, mainly from nitrogen oxides (NO_X), including nitrogen dioxide (NO_2), and particulates (PM10 and PM2.5). The problem is particularly acute in London, where the mortality impact of PM2.5 and NO_2 pollution in 2010 was estimated at 141,000 life years lost, or the equivalent of up to 9,400 premature deaths. **Air pollution is therefore the second most significant factor impacting on public health in London, after smoking**.

KEY FINDINGS

- **London is breaking legal and WHO limits for NO_2 and WHO limits for particulate matter**. Under the existing policy regime the capital is not set to reach compliance with the legal limits on NO_2 until 2025 or beyond.
- **Most air pollution in London is caused by road transport, of which diesel vehicles are the most polluting**. Efforts must be made to reduce the number of diesel vehicles on the road, both by increasing the proportion of cleaner and greener vehicles and by a continued shift towards alternative forms of transport, including public transport, walking and cycling.
- **It is likely that diesel cars will have to be completely phased out on London's roads over the next decade** in order to reach compliance with safe and legal levels of air pollution. Such a shift would not be easy to achieve in such a short space of time, but it would not be impossible.

RECOMMENDATIONS

New modelling undertaken by King's College London for this project shows the scale of the changes required. **Policy will be required at European, national and local levels.**

European policy changes

At the European level **tighter emissions standards** will be required, as well as **bringing forward the 'real world' emissions testing regime** (with conformity factor 1.5 or less) which is not currently being planned until 2021.

National policy changes

At the national level, the UK government will need to **progressively reform vehicle excise duty (VED) to disincentivise diesel vehicles**. If it is unwilling to go far enough at the national level to drive compliance in places with acute air pollution problems like London, the government could **devolve VED rates to those cities that wish to go further**. Finally, to increase the pace of transition towards a diesel-free car fleet,

the government could introduce a scrappage scheme for older diesel cars across the UK or in areas of non-compliance with air pollution laws.

Local policy changes

At the local level the new mayor of London, Sadiq Khan, has already indicated a willingness to take much more radical action than his predecessor. Policy measures that are likely to be needed in order to achieve compliance with legal air pollution limits include:

- the **expansion of the new ultra low emissions zone** (ULEZ) across the whole of inner London; this could be progressively tightened to eventually include all diesel cars, including Euro 6
- the **progressive tightening of emissions standards** within the low emissions zone (covering the whole of London) for lorries, vans, buses and taxis, with the **aim of progressively phasing out diesel buses and taxis altogether**
- the introduction of **new policies to promote alternative forms of sustainable transport**.

1. LONDON'S AIR POLLUTION CRISIS

1.1 WHY IS AIR POLLUTION A PROBLEM?

Air pollution can be defined as 'the presence in or introduction into the air of a substance which has harmful or poisonous effects'.[1] The most common air pollutants are listed in table 1.1, alongside their main sources. Emissions of these pollutants damage the environment, in some cases contribute to climate change, and are significant determinants of human health. A large body of evidence exists that suggests air pollutants increase the prevalence of numerous health conditions (as listed in table 1.1). Of particular concern are nitrogen dioxide (NO_2) – a nitrogen oxide (NO_X) – and particulate matter (PM10 and PM2.5[2]), both of which have high recorded concentrations in the UK (Defra 2015a).

TABLE 1.1

Air pollutants and their health impacts

Pollutant name	Main sources	Health impacts
Benzene	Evaporation and combustion of petroleum products	Cancer, leukaemia
Carbon monoxide (CO)	Road transport (particularly petrol), combustion, industry – CO arises from incomplete combustion	Headaches, nausea, dizziness, affects lung performance
Heavy metals	Combustion, industrial processes	Nausea, diarrhoea, abdominal pain, irritation of eyes, nose, throat and lungs, brain and kidney damage, asthma, respiratory diseases, lung cancer
Nitrogen dioxide (NO_2)	Transport, combustion	Lung irritation, decrease lung function, and increase chance of respiratory infections – long-term exposure is associated with low birth weight babies and excess deaths
Ozone (O_3)	Reaction of hydrocarbons, NO_X, and volatile organic compounds (VOCs) in sunlight	Harms lung function and irritates respiratory system; can increase incidence and severity of asthma and bronchitis – long-term exposure can lead to cardiorespiratory mortality
Particulate matter (PM10 and PM2.5)	Transport (exhaust, tyre and brake wear), combustion, industrial processes and construction	Linked to asthma, lung cancer, respiratory and cardiovascular diseases, infant mortality and low birth weight
Sulphur dioxide (SO_2)	Combustion (coal) and road transport	Causes irritation of lungs, nose and throat, and exacerbates asthma

Source: WHO 2013

1 See for example http://www.oxforddictionaries.com/definition/english/air-pollution

2 Air pollutants with a diameter of 10 and 2.5 micrometres (μm) or less, respectively.

These health impacts have led the World Health Organisation (WHO) to set out 'guideline levels' for the concentration of each pollutant (WHO 2005). These guideline concentration limits have generally been translated into law via the European Union's Ambient Air Quality Directive 2010, and then into UK law through the Air Quality (Standards) Regulations 2010, with equivalent regulations in Scotland, Wales and Northern Ireland. This means that any area within the UK that breaches these limits is breaking both UK and (currently) EU law. The limits for NO_2 and PM are set out in table 1.2.

TABLE 1.2

Pollutant concentration limits within the European Union

Pollutant name	Averaging period	Limit (micrograms per cubic metre, µg/m³)	Permitted exceedances (per year)	Deadline	WHO guideline levels
NO_2	1 hour	200 µg/m³	18	Jan 2010 (extended Jan 2015)	As per EU values
	1 year	40 µg/m³	N/A	Jan 2010 (extended Jan 2015)	As per EU values
PM10	1 day	50 µg/m³	35	Jan 2005 (extended Jan 2011)	As per EU values
	1 year	40 µg/m³	N/A	Jan 2005	20 µg/m³
PM2.5	1 year	25 µg/m³	N/A	Jan 2015	10 µg/m³
	1 year	20 µg/m³	N/A	Jan 2020	10 µg/m³

Source: EC 2016

Notes: Concentration limits are expressed either in the form of an annual average concentration or as a restriction on the number of 'exceedances' over shorter time periods in a whole zone.

As table 1.2 shows, European PM concentration limits that are enshrined in UK law do not all meet the WHO's guideline levels. For the purposes of this paper, we shall refer to 'legal limits' as those EU concentration limits currently enshrined in UK law, and 'WHO levels' as those concentration limits for PM that differ to the EU concentration limits.

1.2 THE IMPLICATIONS OF THE EU REFERENDUM RESULT

The UK's expected exit from the European Union could significantly reduce the pressure on the UK government to cut concentration levels. In the event of the UK leaving the EU, the Air Quality (Standards) Regulations 2010 will remain in law unless repealed. However, these regulations will not automatically change should the EU revise its concentration limits to more closely align with WHO guidelines in any future revision of the Ambient Air Quality Directive.

As an EU member, the UK government faces legal action – through both the European Court of Justice and the national courts – for failing to comply with the law. This process followed the legal case brought against the UK government by ClientEarth, and the two legal processes are separate but closely related. The UK's continued failure to comply with the law has led to the threat of fines from the European Court of Justice, upon recommendation by the European Commission. These fines could be handed down from the UK government to local government, including to the Greater London authority (GLA) and the London boroughs.

If the UK leaves the EU the continuation of these arrangements will depend on whether or not the UK remains a member of the European Economic Area (EEA) and therefore part of the single market. If it does, EU air pollution law will apply, though enforcement will be weaker as there is no threat of fines within the EEA. If it does not, the UK government would no longer be liable to fines by the European Commission, could repeal its current air pollution regulations, and would not be required to meet new air pollution regulations with higher ambition. As such there have been calls, supported by IPPR, for a new Clean Air Act[3] to further embed tough standards on air pollution in UK law and retain the right of people to hold the government to account if they fail to achieve them (ClientEarth 2016).

1.3 AIR POLLUTION IN LONDON

Emissions of nitrogen dioxide (NO_2) exceed legal limits across much of the UK, while particulate matter levels, though meeting legal limits, are above WHO levels. In the case of NO_2, 38 zones, covering 194 local authorities, exceeded legal limits as of 2014 (Defra 2015a). While this problem is serious for the UK as a whole, it is at crisis point in London.

- NO_2 concentrations at roadside locations in inner London[4] have remained largely static since the early 2000s. Around 12.5 per cent of the total area of London – including central London – remains above the legal limit of 40 µg/m3, with significant localised variation. For example, the average NO_2 concentration at Oxford Street in the 12 months to August 2015 was more than 150 µg/m^3, almost four times the legal limit (Howard 2015).
- Levels of PM10 and PM2.5 have improved over the same period and now sit within legal limits. However, as previously mentioned, this is one of the few areas where EU and UK law does not reflect the guideline levels set by by the WHO. In total, 88 per cent of the total area of London has PM10 levels above the WHO limits (ibid).

These figures put London 15th out of 36 major global cities in terms of overall air quality, behind other European cities such as Stockholm, Vienna and Berlin, and with levels of NO_2 comparable to those of cities such as Shanghai and Beijing (AMEC 2014).

These emissions are having a significant impact on health in the capital: increasing the prevalence of respiratory, cardiovascular and cancers; shortening life expectancy; and imposing additional cost and capacity burdens on already strained health services (WHO 2014). According to one estimate, in 2010 there was a mortality burden of 53,000 life-years lost, or the equivalent of 3,500 deaths due to PM2.5 pollution, and NO_2 pollution cost 88,000 life-years, or the equivalent of 5,900 deaths – a total impact of 141,000 life-years, or 9,400 premature deaths (Walton et al 2015). This makes air pollution the second most significant determinant of ill health in London, outranking alcohol abuse and obesity and behind only smoking (LAEC 2015). Furthermore, the impacts of air pollution fall disproportionally on children, with nearly 25 per cent of schoolchildren in the capital exposed to levels of air pollution that break legal and health limits (Howard 2015).

3 The Clean Air Act 1993 consolidated the original 1956 and subsequent 1968 Clean Air Acts.

4 Central London is defined as the area bounded by the Congestion Charge Zone; inner London as the area bounded by the inner and south circular roads; and Greater London as the total area of London.

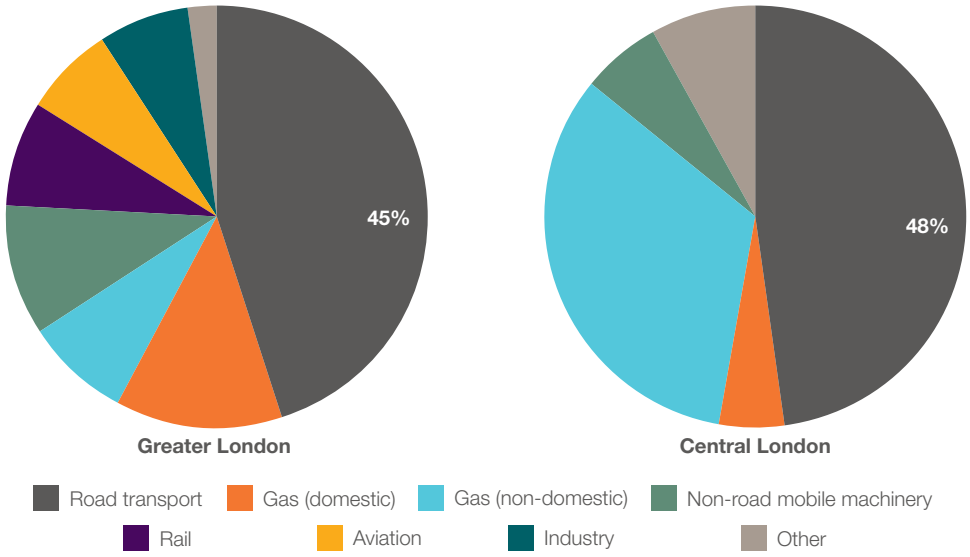
1.4 WHAT IS CAUSING THE PROBLEM?

While there are many causes of air pollution in London, including energy use and industry, the majority of emissions come from road use (see figures 1.1 and 1.2).

FIGURE 1.1

The largest share of NO_X emissions comes from road transport in greater London (left) and central London (right)

NO_X emissions by source, 2010

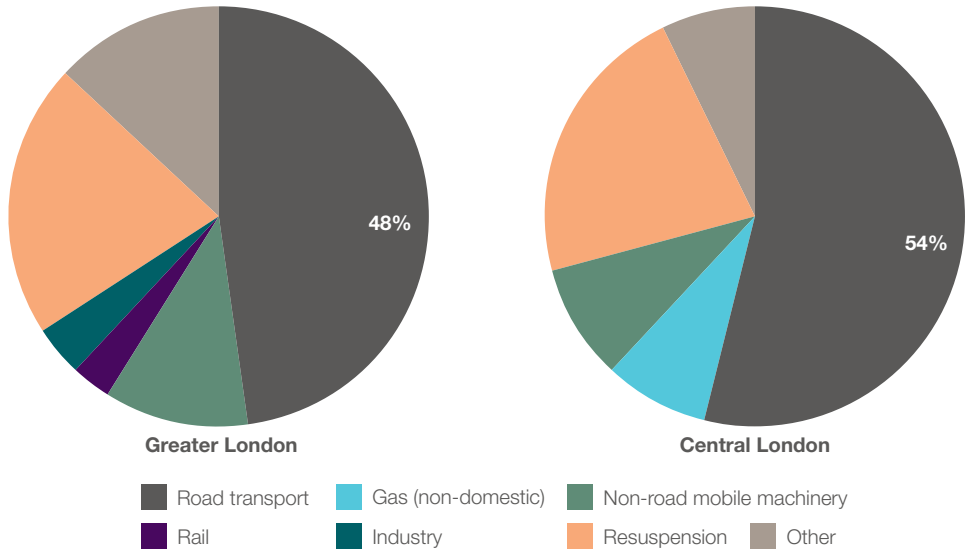


Source: Howard 2015

FIGURE 1.2

The largest share of PM10 emissions comes from road transport in greater London (left) and central London (right)

PM10 emissions by source, 2010



Source: Howard 2015

In fact, transport air pollution is driven primarily by diesel vehicles, which are considerably more polluting than those using petrol fuels. Table 1.3 shows the EU pollution limits for NO_X and PM10 emissions from petrol and diesel cars, in order of the least (Euro 1) to most stringent (Euro 6), along with the year in which it was mandatory for cars sold to achieve the standard. As the table shows, petrol cars have emitted less NO_X than diesel cars since 1996.

TABLE 1.3

Euro emissions standards (grams of pollutant per km)

	Petrol car		Diesel car	
Pollutant name/emissions standard (introductory year)	NO_X	PM10	NO_X	PM10
Euro 1 (1992)	0.97	-	0.97	0.140
Euro 2 (1996)	0.50	-	0.70	0.080
Euro 3 (2000)	0.15	-	0.50	0.050
Euro 4 (2005)	0.08	-	0.25	0.025
Euro 5 (2009)	0.06	0.005	0.18	0.005
Euro 6 (2014)	0.06	0.005	0.08	0.005

Source: Transport & Environment 2015

However, Euro emissions standards may not be an effective barrier against illegal levels of air pollution, particularly for diesel cars. This is because they are based on testing methods undertaken in laboratory conditions. There is evidence that these tests significantly underestimate the amount of pollution cars actually produce when driving in real-world conditions. For example, studies show that Euro 6 diesels produce between 2.5 and 7 times their own standard when driven on the road (Weiss et al 2011). Confidence in the ability of car manufacturers to meet the Euro standards was further eroded by the Volkswagen emissions scandal that was exposed in September 2015, in which it was revealed that Volkswagen cars were fitted with 'defeat' devices to falsify results during laboratory tests.

2.
CURRENT POLICY

Policymakers, at both national and local levels, have so far failed to respond with adequate measures to reduce the UK's and London's air pollution to within legal limits. Modelling by the Department for the Environment, Food and Rural Affairs (Defra) has previously shown that, without significant policy changes, most of the UK would remain in breach of legal limits into 2025 and beyond, with London not reaching compliance with legal limits until 2030 (Defra 2015b). The projected failure to achieve compliance resulted in the European Court of Justice ruling that the UK must ensure it has plans to reach legal limits as soon as possible, and requiring all member state courts to take any measure necessary to ensure compliance (ECJRC 2015). Subsequently, in 2015 the UK supreme court ordered the government to introduce measures within the national action plan for NO_2 to meet compliance across air pollution zones in the shortest time possible (UKSC 2015).

To meet this requirement, Defra has produced a new plan for improving air quality in the UK, including the introduction of 'clean air zones' in which the most polluting vehicles will be charged. These will come into force in Birmingham, Leeds, Nottingham, Derby and Southampton by 2020 (Defra 2015c). While bringing forward the date of compliance for many UK cities, Defra's estimates that NO_2 will not reach legal limits until 2020 – with London's compliance only being brought forward five years to 2025 – raise questions over whether compliance is set to be reached within the shortest time possible. This has led environmental groups to conclude that the plans are inadequate and that the responsibility for compliance has been passed to local authorities without the devolution of the resources and powers necessary to achieve this end (Birkett 2015).

Slow progress on reducing NO_2 is partly the result of the tax incentives provided over recent years for people to buy and run diesel cars. Motivated by a desire to reduce CO_2 emissions in order to tackle climate change, the last Labour government (2005–2010) favoured diesel over petrol vehicles in the rates of both vehicle excise duty and company car tax. At the same time, EU CO_2 emissions targets incentivised diesel vehicle manufacturing. Together, these policies contributed significantly to a recomposition of the UK's vehicles fleet, with diesel cars now making up over 50 per cent of all new cars sold and 36 per cent of the total car fleet, up from around 10 per cent in 1995 (Howard 2015). The light goods vehicle fleet has gone from a 51 per cent diesel composition in 1994 to 96 per cent in 2014 (ibid).

2.1 POLICY IN LONDON

At the London level, progress has been slow: the capital is the only area in the UK that is still forecast to fail to reach compliance before 2025 under the new Defra plans. However, this forecast is disputed by many air quality groups, as the new air quality plans fail to provide any new measures for tackling air pollution in London above those already proposed by the previous mayor of London. There are also concerns about the emissions factors used in the modelling given that many Euro 6 diesel cars currently fail to meet the limits (Leake 2016). The incoming mayor inherits two main policies that help to reduce air pollution – the low emissions zone (LEZ) and the planned ultra low emissions zone (ULEZ).

The LEZ operates across the whole of Greater London and levies a charge on the most polluting vehicles: lorries, buses and coaches below the Euro 4 emissions standard; and vans, minibuses, and ambulances below Euro 3 (TfL 2016). It operates at all times, 24 hours a day, 365 days a year. Number-plate-reading cameras police the zone, and eligible vehicles not paying the charge are fined.

The ULEZ, which is currently due to come into force in September 2020 and cover the congestion charge zone of central London,[5] will levy a charge on vehicles that do not meet the Euro 6 emissions standard for diesel, and Euro 4 for petrol (and Euro 3 for motorcycles). The charge will be £12.50 for cars, vans and motorcycles, £100 for HGVs, buses and coaches. Fines will be levied on eligible vehicles not paying the charge. At the same time newly registered private hire vehicles will be required to meet these standards by 2018, and new buses by 2020. Residents of the zone will be given three additional years before their vehicles need to comply.

Transport for London projects the ULEZ to at least halve emissions of NO_X and PM10 from vehicle exhausts, primarily in central London. Because the majority of traffic entering the ULEZ will come from outside the zone,[6] reducing this flow is expected to produce significant reductions in the number of people living in areas of poor air quality: by 74 per cent in central London, 51 per cent in inner London and 43 per cent in outer London (TfL 2015a). This will be due both to an increased replacement rate of high-emissions vehicles and a reduction in the total number of car journeys within the zone, which are predicted to fall by 5 per cent by 2025 (Jacobs 2014). Critically, however, the ULEZ will not immediately bring London into compliance with legal limits – along with other policies, the expected date of compliance is only brought forward to 2025 (TfL 2015b).

2.2 THE NEW MAYOR'S PLANS

A growing understanding of the health impacts of air pollution, and the inadequacy of previous mayoral policy, has seen air pollution rise up the political agenda, providing an unprecedented opportunity for the

5 That is, it will cover the same area as the congestion charge zone (CCZ), which covers approximately 22 km^2 in the centre of London, where congestion is most acute. Introduced in 2003, the scheme has led to small decreases in air pollution, being too small to have produced major improvements (Kelly et al 2011).

6 96 per cent of ULEZ traffic is expected to originate outside the zone (Kelly et al 2011).

introduction of policies that will ensure more rapid compliance with the legal limits on air pollution. Accordingly, London's new mayor Sadiq Khan has chosen to make the improvement of air quality one of his highest priorities. In early July he launched a consultation on new measures to address air pollution, including the creation of a new vehicle charging zone across London. He has suggested that these measures could include:

- a new £10 emissions surcharge (or 'T-Charge') on vehicles not reaching the Euro 4 emissions standard in central London, to be introduced in 2017 (this largely applies to vehicles registered before 2005)
- bringing forward the introduction of the planned ULEZ from 2020 to 2019
- expansion of the ULEZ across the whole of inner London, up to the north–south circular roads, from 2020
- the potential for a diesel scrappage scheme, as part of a wider scheme introduced by central government
- lowering of bus fleet emissions, including the purchase of hybrid or zero emission double-decker buses only from 2018 (TfL 2016).

The consultation period comprises a three-part process that will conclude with a full statutory consultation on measures in the new year.

2.3 PUBLIC OPINION[7]

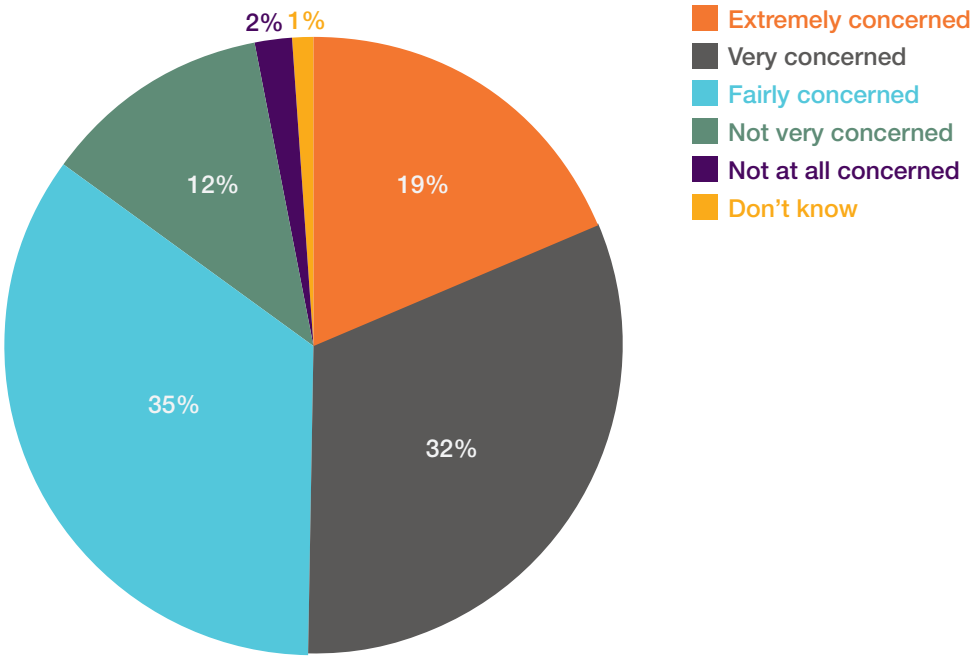
New polling commissioned as part of this project suggests that Londoners in general support the new mayor's ambition on air pollution.

- **There is a high level of concern about air pollution** – 51 per cent of those Londoners polled are extremely or very concerned, with a further 35 per cent fairly concerned.
- **People are feeling the health impacts of air pollution** – 42 per cent of respondents claimed to have experienced negative health symptoms as a result of air pollution.
- **There is strong support for policies to combat the problem** – 50 per cent of Londoners polled were in favour of a new clean air zone to address air pollution, a figure which rose to 62 per cent following a more detailed explanation of clean air zones.

7 Poll conducted by nfpSynergy for Greenpeace. Fieldwork: 23–28 March 2016. Sample size: 1,000 Londoners, representative by age and gender.

FIGURE 2.1

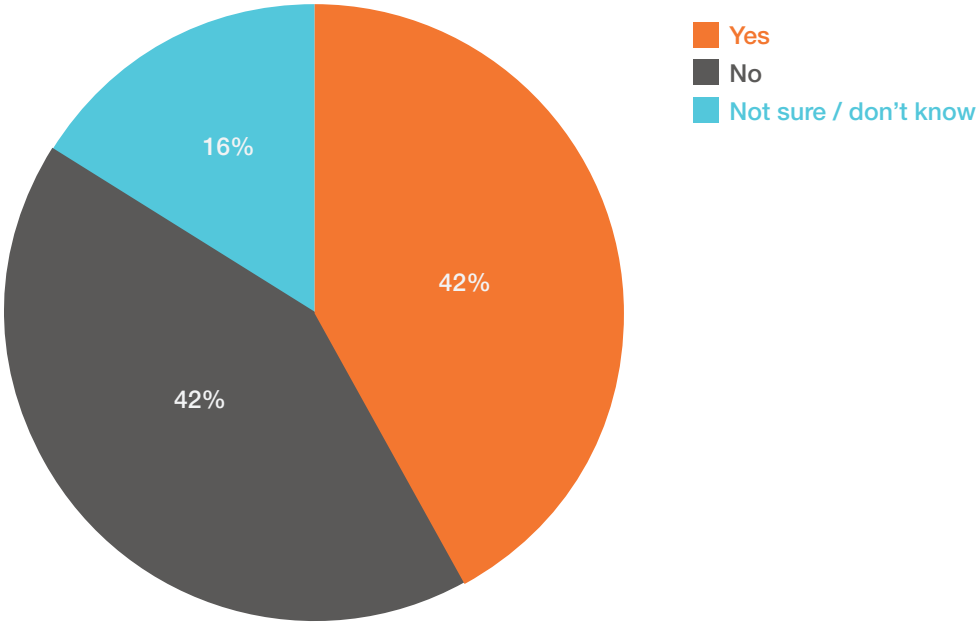
A majority of London residents are concerned about air pollution in the capital



Poll conducted by nfpSynergy for Greenpeace. Fieldwork: 23–28 March 2016. Sample size: 1,000 Londoners, representative by age and gender.

FIGURE 2.2

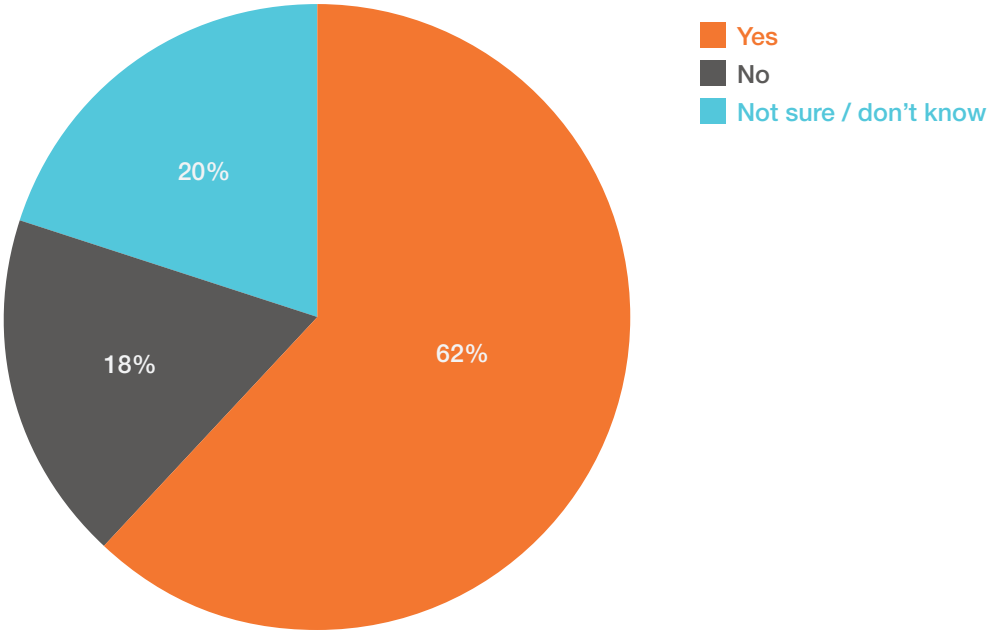
Over 40 per cent of London residents claim they have personally felt the effects of air pollution in the capital



Poll conducted by nfpSynergy for Greenpeace. Fieldwork: 23–28 March 2016. Sample size: 1,000 Londoners, representative by age and gender.

FIGURE 2.3

62 per cent of London residents support a clean air zone



Poll conducted by nfpSynergy for Greenpeace. Fieldwork: 23–28 March 2016. Sample size: 1,000 Londoners, representative by age and gender.

3.
WHAT COULD BE DONE?

3.1 A SHIFT IN ROAD USAGE

To ensure that London's air pollution reaches legal limits in the coming years, policymakers will need to effect a fundamental shift in road usage across the capital. This policy effort needs to focus on driving a move away from diesel vehicles – which are at the heart of the air pollution problem (see chapter 1) – towards petrol and, ultimately only, hybrid and electric alternatives.

As part of this project, IPPR have commissioned new modelling from King's College London's Environmental Research Group, using their London Air Quality Toolkit, which attempts to understand the scale of the transformation in road usage required to clean up London's air.

Previous modelling of potential measures to achieve compliance with legal limits in London has proved unsuccessful. The general conclusion is that they have not gone far enough to tackle the problem caused by diesel vehicles. With this in mind, King's College London have conducted new modelling of a more ambitious policy scenario.

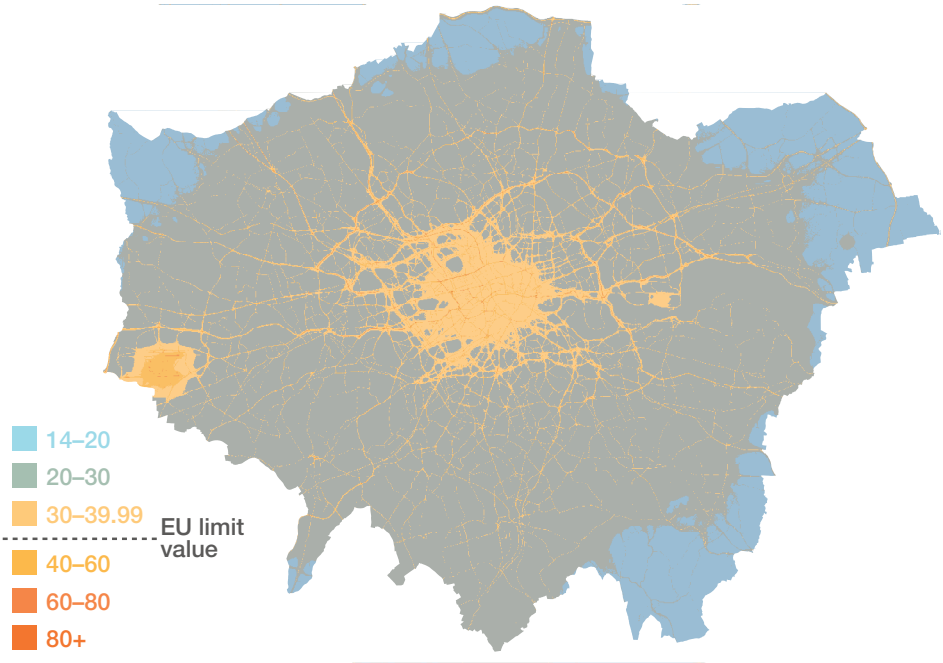
This modelling illustrates the impact on pollution levels if the capital were to return to the lowest recorded level of diesel car ownership in the UK, at around 10 per cent of the car fleet (as it was in 1995), from its current position of 57 per cent of cars. (The other assumptions included in this modelling are set out in the annex to this report.)

The results from this modelling are set out in figures 3.1 and 3.2 below. These show annual mean (background) levels of NO_2 concentrations across the capital (the background colour) as well as, in figure 3.2, areas of London where the hourly exceedance limit is breached (purple dots).

The modelling makes clear that a reduction in the percentage of diesel cars to 1995 levels would have a significant impact both on background levels of air pollution and on the number of areas where hourly exceedance limits would be breached. However, this reduction in diesel use alone would not allow London to reach legal compliance before 2025. The inescapable conclusion is that as long as some diesel cars (along with diesel buses, taxis, vans and lorries) remain on London's roads, the capital will remain in breach of UK law.

FIGURE 3.1

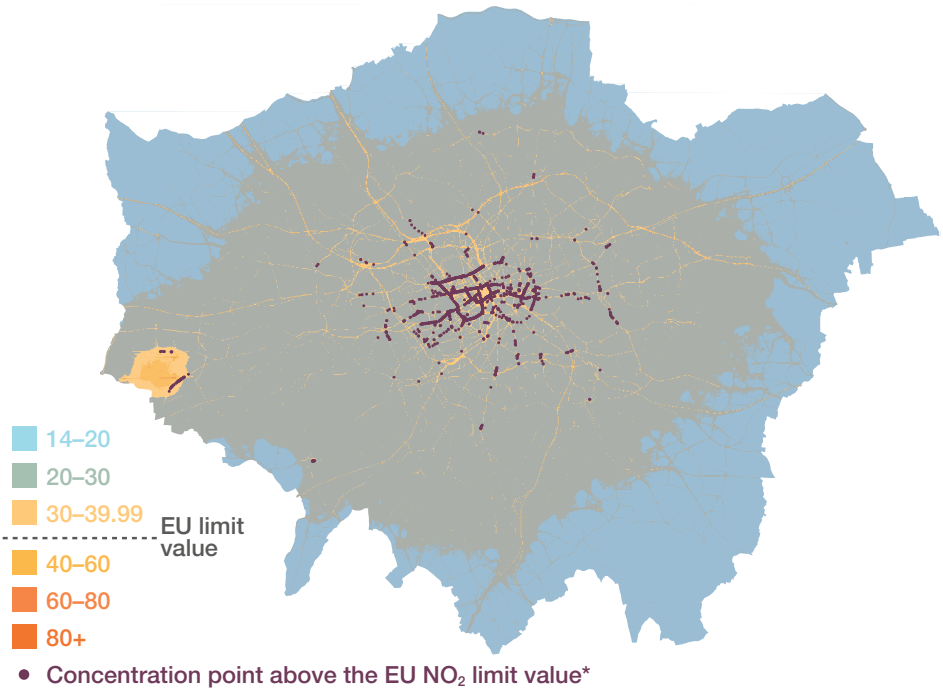
Base case: annual mean concentration levels of NO_2 in 2025 ($\mu g\ m^{-3}$) under existing policies



Sources: adapted from Howard 2015; data from GLA 2010

FIGURE 3.2

New modelling: annual mean concentration levels of NO_2 in 2025 ($\mu g\ m^{-3}$) under new policies to reduce the number of diesels



Source: Courtesy of King's College London; data from GLA 2010
*Note: excludes points on roads and railways, and within Heathrow airport site.

3.2 POLICY IMPLICATIONS

The implications of this are significant. Policymakers will have to show even more ambition if they wish to meet legal limits on air pollution. This will ultimately mean the phasing out of diesel cars in the capital entirely, as well as a range of complementary policies to address pollution from buses, taxis, lorries and vans.

This would be a substantial achievement given current levels of diesel car ownership in the capital (see table 3.1). It took 20 years to get from 1995 levels of diesel ownership, at 10 per cent of London's car fleet, to where we find ourselves today – 57 per cent. Our modelling assumes a reversal of this trend across the capital in just eight years, between now and 2025.

TABLE 3.1

Share of petrol vs diesel cars on London's roads with and without new policy interventions

	Petrol	Diesel	Other
Current	42%	57%	1%
2025 (forecast – no policy change)	46%	54%	-
2025 (modelled)	90%	10%	-

Source: 'Current share' provided by TfL in correspondence with IPPR, January 2016; 'no policy change' scenario from Howard 2015.

However, such a shift is not impossible. There are a range of policy levers available to policymakers to attempt to achieve legal compliance, including the ultimate phasing out of diesel cars. Stronger policy is likely to be needed at all three levels of government – European, national and local. The following sections set out a menu of available policies.

European policy

The car industry as a whole is regulated at the EU level. This will continue to be true even if the UK leaves the European Union, since the cars sold in the UK will remain the same as those sold in the EU single market. This means EU policy will remain a significant driver of local air pollution levels, helping to determine the proportions of diesel, petrol, hybrid and electric vehicles. It does this in two main ways.

1. Through laws on the emissions standards, which all new cars are expected to achieve, and the testing regime under which these standards are set.
2. Through the Ambient Air Quality and National Emissions Ceilings Directives, which set limits on local pollution concentration levels and national emission levels with which member states have to comply.

The former requires car producers directly to reduce emissions, while the latter puts pressure on member states to introduce policies to reduce air pollution – such as through vehicle tax rates and local clean air zones – which in turn helps drive manufactures to produce cleaner cars that are compliant with these policies. The EU will be able to use at least the first of these levers to drive further progress in air pollution in London even if the UK leaves the EU. Its ability to use the second lever is highly uncertain.

For emissions standards for car producers, action could be taken to toughen the testing regime and enforce greater conformity with the existing standards, combating the failures of the laboratory test and the infractions of producers described in chapter 1. In this regard, the EU is currently planning to introduce a new on-road 'real driving emissions' (RDE) test by 2017. However, the EU has so far agreed to introduce it in stages, thus allowing any cars with less than a conformity factor of 2.1 times – that is, those whose emissions differ from laboratory tests by a factor of 2.1 – to be sold from 2019 onwards, falling to 1.5 times the standard from 2021 onwards. These dates could be brought forward, encouraging car manufacturers to either deliver on their promise of 'clean diesel' or shift production (and sales) towards alternative petrol, electric or hybrid alternatives.

At the same time, the EU could adopt tighter emissions standards for ambient air quality. This could be achieved by going beyond WHO guidelines on safe concentrations of NO_2 and by matching WHO guidelines on PM emission concentrations.

National policy

National policymakers could also make a range of policy decisions that would help address London's air pollution crisis. As discussed earlier in this paper, the shift towards diesel cars since 1995 was partially driven by reform of vehicle tax policy to tackle climate change by reducing carbon emissions. In particular, vehicle excise duty (VED) was linked to CO_2 emissions, meaning that diesel cars became cheaper to buy and run than petrol cars.

The government could take a step in the right direction by progressively reforming the VED regime to disincentivise diesel cars relative to petrol ones. Behavioural modelling would be needed to establish the size of the differential required, but to achieve a significant decline in diesel sales and use it would likely have to be substantial. If the government decided it was not willing to go far enough in terms of reforming VED in order to reach compliance in places with acute air quality problems such as London, it could devolve VED rates to places like London so that they could go further and faster.

Tax policies could contribute to the reduction in diesels on the road. But the process of cleaning up the car fleet could be accelerated by the reintroduction of a national 'scrappage' scheme, providing owners of older diesel cars with a cash incentive to scrap their vehicles. This was last tried in 2009/10 for vehicles older than 10 years old as a way of stimulating economic growth in the wake of the financial crash. A similar scheme could be set up now with a more specific environmental objective of taking older and more polluting diesel cars off the road. Such schemes are expensive and involve some 'deadweight' (giving financial support to car owners who were anyway planning to sell their vehicles), but experience from 2009/10 suggests they are effective in bringing forward sales decisions.

Local policy

Finally, the shift away from diesel will require action at the local level. Indeed, because of the scale of the problem in London, local policy is likely to have to go further and faster than elsewhere. This will become

even more important if strong action is not taken at the EU or national level. Thus far, the UK government has not made the reduction of air pollution a priority and has been accused of obstructing moves to tighten regulation at the EU level (Boffey 2016).

This means that the mayor of London is likely to need to introduce a radical package of measures if he is to make a significant impact on air pollution in the next few years. IPPR will publish a report in the autumn that will set out a possible policy package in more detail, alongside more extensive and detailed modelling by King's College London.

However, in the interim, some potential policy measures can be identified.

- The introduction of an expanded ULEZ across the whole of inner London (bounded by the north and south circular roads), potentially by 2019. The key variables that will need to be determined are the standards which will be applied to different vehicles, the charges and fines to be levied, and the timetable under which the standards may be increased in the future. Any move to penalise large numbers of diesel vehicles in the short term may impact negatively on poorer households; those who have recently bought a non-compliant car; and small businesses (vans in particular may require a discount or exemption from regulation in the short term as there are very few non-diesel vans available to purchase). There is a clear need for TfL to conduct a full socioeconomic impact assessment, and the speed of introduction is likely to be a determining factor in public acceptance. However, in the longer term the ULEZ could be used to completely phase out diesel cars by including Euro 6 in the regulation and increasing the charge associated with non-compliance.
- The tightening of standards for vans, HGVs, buses and coaches within the low emissions zone. At the moment this regulation requires vans to meet Euro 3 and other vehicles to meet Euro 4. This could be progressively tightened over time, so that ultimately all vehicles will have to meet Euro 6 standards. For buses and taxis, where the technologies are available and the mayor has more regulatory control, the ultimate objective could be the phasing out of diesel vehicles altogether. It may also be possible to work with the business sector to help reduce freight transport, particularly at peak hours.
- The introduction of new policies to promote alternative forms of transport including the expansion of car sharing schemes across London, acceleration of the electric vehicle charging network, further investment in new walkways and cycle super-highways, and significant investment in the public transport network.

ANNEX

BACKGROUND ASSUMPTIONS

	Base	Year modelled	Traffic**	Fleet composition
Basecase	LAEI2010 + ULEZ*	2020 & 2025	2020 & 2025	2020 & 2025
New modelling	LAEI2010 + ULEZ1	2025	2020***	2025

*The model scenario builds upon GLA and TfL's ULEZ Scenario C (ULEZ ScC), which is based upon the revised London Atmospheric Emissions Inventory 2010 (LAEI2010).
**Road transport TRAFFIC assumptions.
***Traffic is assumed not to grow post-2020, based on policies designed to encourage alternative methods of transport such as car sharing, investment in public transport and creation of new public walk and cycle ways.

PETROL/DIESEL SPLIT AND HYBRID, LPG AND ELECTRIC VEHICLE (EV) ASSUMPTIONS

	Car petrol/ diesel split*	LGV petrol/ diesel split*	Hybrid	LPG	EV
Basecase 2025	CCZ: 50/50 Outside CCZ: 47/53	CCZ: 2/98 Outside CCZ: 2/98	Petrol car: 13%	-	-
New modelling	All London: 90/103	All London: 38/62**	Petrol car: 13%***	-	-

*Petrol/diesel ratio in the congestion charging zone (CCZ) and outside of the CCZ (inner, outer and external zone up to the M25).
**For scenario, we shifted the diesel/petrol ratio to 1995 levels in every zone in Greater London (ULEZ, IRR, inner, outer, external).
***Scenario assumes the same fleet composition as basecase 2025.

EMISSION FACTORS (EF) ASSUMPTIONS

Unit in g/km*	Euro 6 diesel car	Euro 6 diesel LGV class 1	Euro 6 diesel LGV class 2	Euro 6 diesel LGV class 3
Basecase 2025	0.24	0.24	0.34	0.34
New modelling* **	0.08**	0.08**	0.105**	0.125**

*The EF are given at average London speed.
**Assume a conformity factor of 1 (there would need to be a European- and UK-wide policy to deliver the CF=1).
***All Euro 6 assume EF = 0.08 g/km.

ADDITIONAL ASSUMPTIONS

	Background	Diesel cars	LT buses	Taxis
Basecase 2025	-	-	-	-
New modelling	UK background*: -1.61 µg/m^3*	-	-	-

*Rural NO_x background: Changing the diesel/petrol split in London implies a UK-wide policy, and when coupled with the new Euro 6 standard (applied in Europe), it is reasonable to assume that there would be improvements in NO_x emissions throughout the UK. We have adjusted the contribution to NO_x in London from outside the city, based upon how the forecast road emissions changes in 2020, due to the new modelling, influences NAEI total ground level emissions. From this we have estimated a further drop of rural NO_x in 2020 of -1.61 µg/m3 compared with our business as usual assumptions.
**All LT buses are Euro6/Euro6 hybrid/EV in CCZ area

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