



Transport Emissions Roadmap!

Cleaner transport for a cleaner London

September 2014

MAYOR OF LONDON



**TRANSPORT
FOR LONDON**
EVERY JOURNEY MATTERS

Mayoral Foreword

Dear Londoner,

London's air is no longer clogged with the industrial effluent that caused its infamous pea-soupers, and I am proud to say we have made great progress through the most ambitious and comprehensive set of measures to improve air quality this city has ever seen. The aim is simple – to keep improving quality of life and make London's air the cleanest of any major world city.



As Mayor, I have already cut nitrogen oxides (NO_x) emissions by 20 per cent, halving the number of Londoners living in areas exceeding legal limits and the emissions of PM₁₀ by 15 per cent by:

- Tightening the standards for the Low Emission Zone
- Retiring 3,000 of the oldest, most polluting taxis
- Cleaning up the bus fleet
- Retrofitting more than 400,000 buildings to reduce their emissions and requiring new developments to be air quality neutral
- Creating a new £20m Air Quality Fund to help boroughs tackle local hotspots

However, there's still more to be done. Improving London's air quality is an urgent challenge – it affects the health and well-being of all Londoners, and it simply cannot be put on hold. Here at City Hall we are doing everything in our power to address it. At the heart of this are my plans for the world's first Ultra Low Emission Zone in central London from 2020. This will be a game changer for air quality.

But we need a little more energy, ambition and action from the Government and EU, if London is to meet the EU limits for NO₂ by 2020. It is possible, and together we can make it happen. This roadmap calls on the levels of government – local boroughs, central Government and the EU to commit to doing their part. We need to work constructively together to make London's air ever cleaner and sweeter.

A handwritten signature in black ink, which appears to read 'Boris Johnson'.

Boris Johnson
Mayor of London

Executive Summary

- E.1 In 2010 the Mayor published his Air Quality Strategy – ‘Clearing the air’, and in 2011 he published his Climate Change Mitigation and Energy Strategy – Delivering London’s Energy Future’. Together these contain a range of transport and non-transport measures to reduce emissions to mitigate climate change and improve London’s air quality. Since then significant progress has been made in delivering these improvements and building on the wide ranging measures set out in these strategies.
- E.2 This Transport Emissions Roadmap (TERM) focuses on how to reduce emissions from ground-based transport in London. Chapter 1 provides some background and our vision and objectives regarding transport emissions, with the challenges and opportunities associated with reducing them outlined in Chapter 2.
- E.3 Reflecting on the need for action by everyone and at all levels of government, this plan includes an ‘Action by All’ tool kit in Chapter 3, which links the various types of measures in this document with those who can help deliver them. This can be used to better understand how different people can play their part in helping London (and the UK) reach compliance with EU limit values for air pollution and our broader climate change mitigation obligations.
- E.4 Chapter 4 reports on established actions and the potential to extend the scope of these and Chapter 5 provides a range of possible new measures that the Mayor, TfL, the London boroughs, the Government, EU and other third parties should consider to help meet the challenge of reducing air pollutants and CO₂ emissions in London. The measures are grouped into the following top ten list, which are described in more detail in Chapter 5 with an estimation of their potential impacts provided in Chapter 6.

Top Ten Measures

- 1) Implementing an Ultra Low Emission Zone (ULEZ) in central London
- 2) Tightening the Low Emission Zone
- 3) Making traffic management and regulation smarter
- 4) Helping Londoners tackle air pollution and climate change
- 5) Driving the uptake of Low Emission Vehicles
- 6) Cleaning up electricity for London's transport
- 7) Transforming London's bus fleet
- 8) Delivering zero emissions taxi and private hire fleets
- 9) Transforming London's public and commercial fleets
- 10) Developing Low Emission Neighbourhoods

- E.5 The EU Ambient Air Quality Directive (2008/50/EC) set limits for concentrations of pollutants in outdoor air. These were passed into English law by the Air Quality Standards Regulations 2010. One of the largest failings in legislation over recent years has been the inadequacy of the Euro emission standards to deliver the predicted emission reductions,

because the testing of vehicles did not properly reflect real world urban driving conditions. The measures put forward in this Roadmap reflect the legal responsibilities of all public bodies to take appropriate action to ensure compliance with EU legal air quality requirements as soon as possible.

E.6 The scale of change required to cut London emissions cannot be underestimated and tough choices will need to be made by all about how we achieve this change. Many of the identified measures will need to be progressed and delivered by others and many of the ideas presented in the Roadmap require further development to understand their feasibility. It should be noted that, even for those actions within our control, TfL does not have the additional funding needed to take forward most of the measures identified. Resources must be sought from central Government, boroughs, other key stakeholders and the private sector. In some cases, the measures themselves fall outside the Mayor's own area of responsibility and would need to be entirely undertaken by these other parties.

E.7 Input, both financial and political, is needed from all levels of government, as well as from businesses and Londoners. This document provides an ambitious yet viable roadmap to compliance and demonstrates that we are planning every reasonable action to reduce emissions and improve air quality as quickly as possible. The reality is that the European Commission and the UK's central Government also need to provide much more funding, support and action if NO₂ legal limits and CO₂ reduction targets are to be achieved in an acceptable timeframe.

E.8 Examples of action needed by the European Commission include:

- Verify and assure the performance of the new Euro 6 engine emission standard and use it to address vehicle emissions under real world conditions
- Make it easier to get EU funding to tackle pollution and create an Urban Clean Air Fund for European cities

E.9 Examples of action needed by UK central Government include:

- Encourage and promote the cleanest vehicles through financial incentives that incorporate both carbon and air pollutant emission standards
- Update the Clean Air Act to give councils the right powers to deal with pollution and address emissions from construction
- Support a local approach to air quality in London with extra cash for pollution hotspots
- Help London's public transport go ultra-low emission by 2020 with funds for hybrid/electric buses and zero emission capable taxis where air quality is worst
- Tackle building emissions by considering air quality alongside CO₂ in the Department for Energy and Climate Change's priorities
- Put air quality at the heart of health working with Public Health England to help tackle exposure to air pollution

- E.10 The Office for Low Emission Vehicles (OLEV) has funding to help progress the uptake of ultra low emission vehicles from 2015 – 2020, and we are working with it to develop proposals for how some of this could be spent in London to deliver our shared objectives. This Roadmap deliberately goes further than simply showing what we have already done and are still doing, and instead seeks to encourage debate and focus minds on developing and implementing solutions to deliver further emissions reductions in London.
- E.11 Although there are significant challenges to overcome in reducing transport emissions, there are real opportunities, such as contributing to the green economy and helping to create more jobs while maintaining and improving quality of life for Londoners. The ideas and proposals that we develop will maximise these benefits and position London and the UK at the forefront of the emerging low emission economy.
- E.12 TERM is not intended to be a finalised plan but part of an on-going discussion. We will be continuing with stakeholder engagement beyond the publication of this document to generate further viable solutions, secure support for their implementation and begin the process of securing funding for them. Working together, we can ensure London meets its obligations, promote sustainability, secure investment and economic growth and ensure that London has the best air quality it deserves.

Contents Page

- 1 Background, vision and objectives 1
- 2 Challenges and opportunities 7
- 3 Toolkit: ‘Action by All’ 10
- 4 What are we already doing?..... 11
- 5 Future focus..... 17
- 6 Roadmap to compliance..... 33

Appendix A – Further detail on what action we are already taking

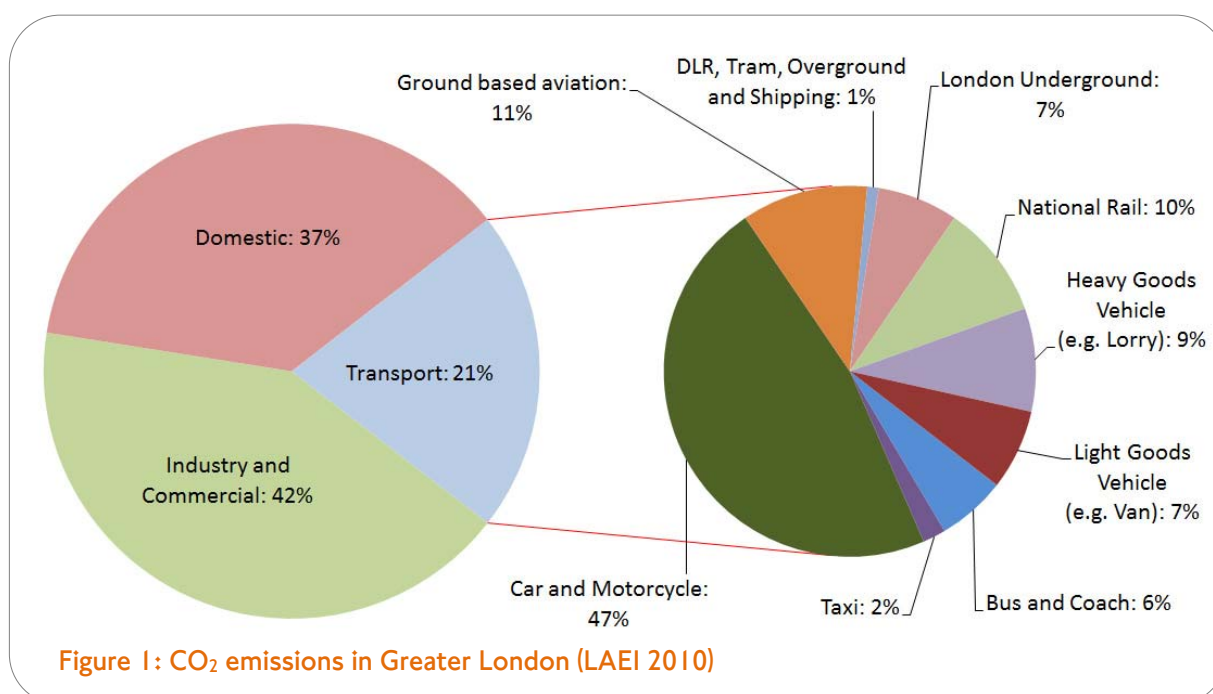
Appendix B – Glossary and acronyms

I Background, vision and objectives

- I.1 Emissions of air pollutants and greenhouse gases are among the most pressing environmental challenges faced by London. While these emissions share a common main cause – the combustion of fossil fuels – their impacts differ in nature and distribution.

Carbon Dioxide

- I.2 Carbon dioxide (CO₂) is considered to be the principal greenhouse gas related to climate change. If global emissions of greenhouse gases are left unchecked, average global temperatures could rise by up to 4.8 Celsius by the end of the century, which could cause extreme climate change¹.
- I.3 Transport is a key contributor to London's CO₂ emissions. Figure 1 below shows 21 per cent of CO₂ emissions in London are from transport.



- I.4 In the Climate Change Mitigation and Energy Strategy the Mayor committed London to reducing CO₂ emissions across all sectors to 60 per cent below 1990 levels by 2025. This translates into a projection for reducing London's transport CO₂ emissions by between 4.6 and 5.3 Mt CO₂ by 2025 (which is approximately 48 per cent from 1990 levels).
- I.5 Other emissions can also contribute to climate change. For example, black carbon particulate matter, which is emitted from diesel vehicles, acts in a similar way to CO₂ but on a faster timescale per tonne of pollutant emitted².

¹Intergovernmental panel on Climate Change 5th Report: <http://goo.gl/EzaLvp>

²Journal of Geophysical Research: Atmospheres Volume 118, Issue 11, pages 5380–5552, 16 June 2013

Air pollution

- 1.6 Air pollutants are substances in the air that can harm human health. The World Health Organisation (WHO) has identified a number of air pollutants of major public health concern³. Among these, the two of principal concern within London are Particulate Matter (PM) and Nitrogen Dioxide (NO₂)⁴.
- 1.7 Transport is a major contributor to NO_x and PM₁₀⁵ emissions in Greater London, accounting for 63 per cent and 52 per cent of emissions of these pollutants respectively in 2010, as can be seen in Figures 2 and 3 below.

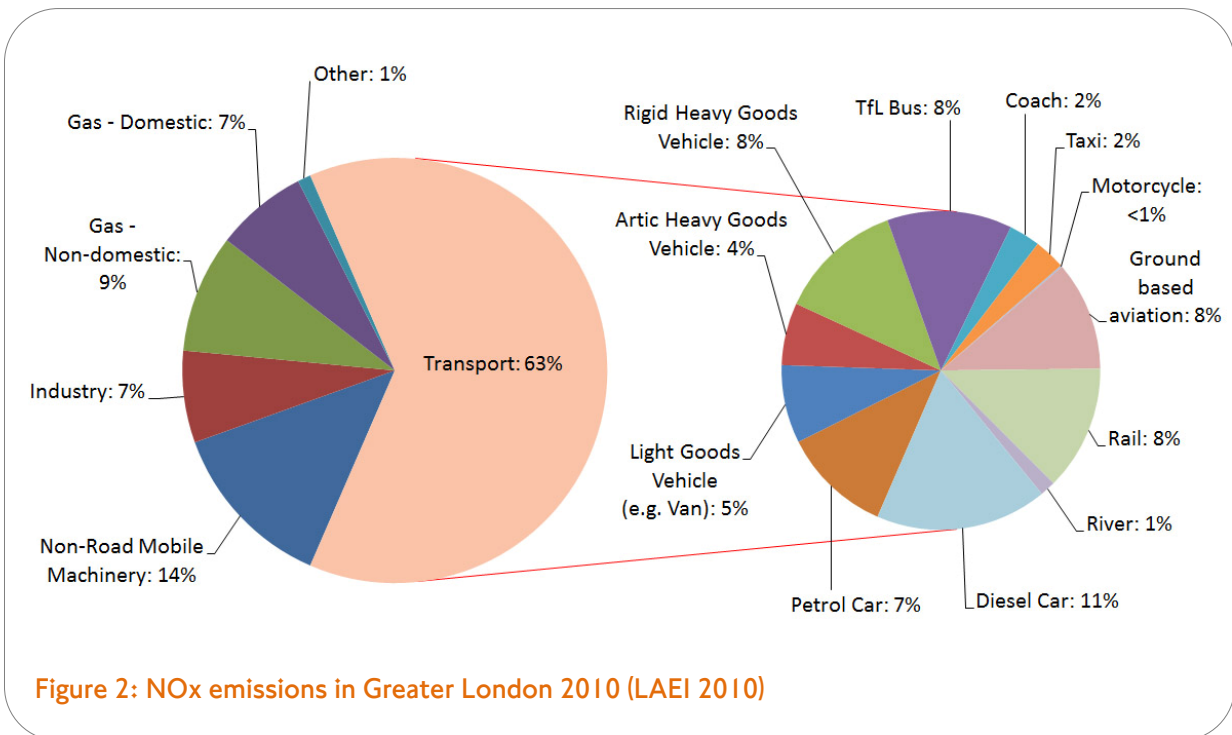


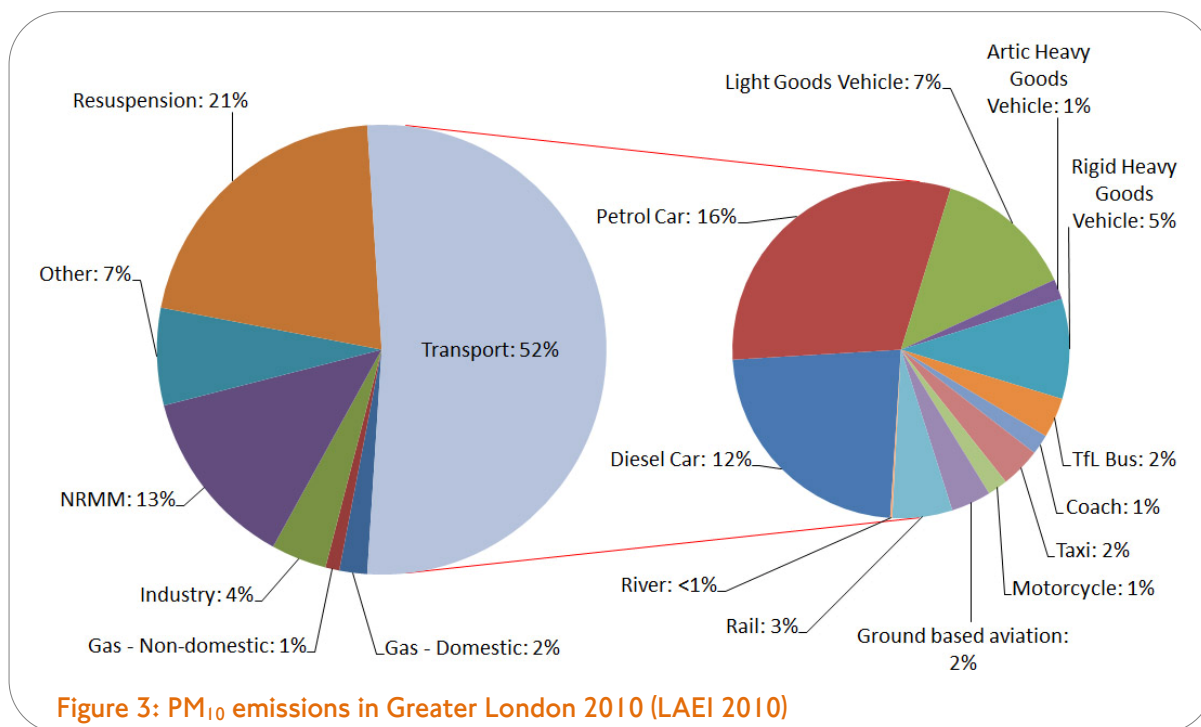
Figure 2: NO_x emissions in Greater London 2010 (LAEI 2010)

³ World Health Organisation (WHO) Air quality guidelines global update 2005: <http://goo.gl/UW8zvl>

⁴ When addressing NO₂ concentrations caused by transport, it is essential to consider emissions of oxides of nitrogen (NO_x). NO_x comprises of primary NO₂ and Nitric Oxide (NO), which is harmless but easily converts to NO₂ in the air. To reduce NO₂ concentrations it is essential to control NO_x emissions

⁵ PM₁₀ are particles of less than 10 microns in diameter which are injurious to human health as they can be inhaled into the respiratory tract.

- I.8 The concentrations and exposure of people to the pollutants is a key issue. This is why the EU has set limit values for air pollutant concentrations⁶.
- I.9 Levels of PM₁₀ in London have consistently fallen over recent years. In its most recent report to the EU, The Department for Environment, Food and Rural Affairs (Defra) reported that the UK, including London met the legal requirement relating to the EU limit values for PM₁₀. However, across the London air quality monitoring network there remain sites which record unacceptably high levels of PM₁₀ concentrations. Furthermore, there is no safe level of exposure to particulate matter so additional reductions in concentrations of this pollutant would deliver commensurate health benefits.



- I.10 Monitoring of PM_{2.5}⁷ demonstrates London meets the limit values for this pollutant, although the European exposure reduction target for PM_{2.5} is yet to be assessed. As noted in the national Air Quality Strategy, there is no safe level of particulate matter⁸. Continued reductions to emissions are therefore important.
- I.11 The EU compliance date for meeting NO₂ limit values was January 2010 but, as with much of Europe, most UK cities are not currently expected to comply until well after this date. The Government has recently published revised forecasts suggesting that without further action of the type set out in this document London, along with Birmingham and Leeds, will not meet the legal limits until after 2030⁹. This is partly a result of the increasing popularity

⁶ National Air Quality Objectives: <http://goo.gl/DzMxub>

⁷ PM_{2.5} is PM less than 2.5 microns in diameter, meaning it can be inhaled deeper into the respiratory tract and can cause significant damage to human health

⁸ Air Quality Strategy for England, Scotland, Wales and Northern Ireland, paragraph 621

⁹ Defra NO₂ projection tables: <http://goo.gl/rfpwlk>

of diesel engines. But also, crucially, the European emission standards¹⁰ set for vehicles have not performed as well as expected. Had these standards worked effectively, London may have been able to meet EU limit values for NO₂ by 2015.

Progress to date in reducing transport emissions

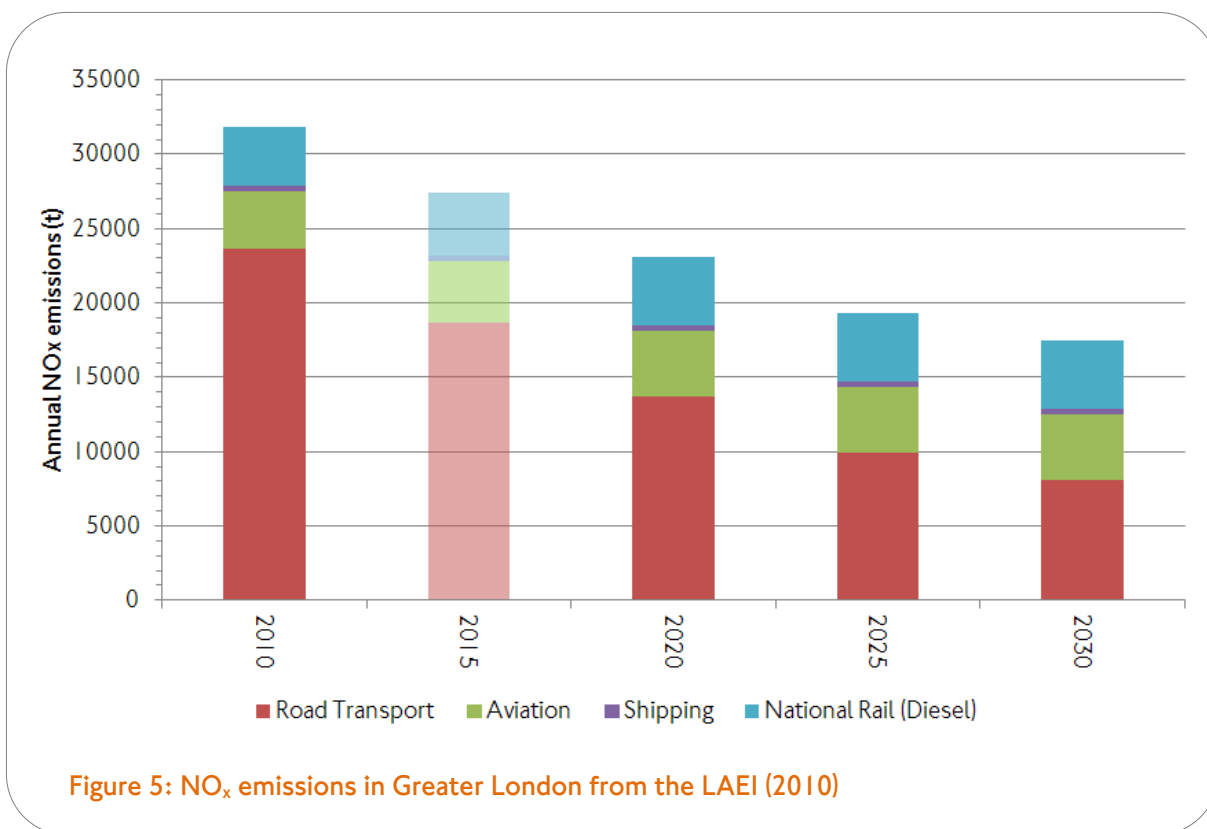
- I.12 Although there is still a lot to do to meet NO₂ limit values and CO₂ targets, and to continue to lower PM, significant progress has been made. The forecast future year emissions are shown below for 2020, 2025 and 2030, with an interpolated figure for 2015. These calculations include the impact of existing and new schemes which have already secured funding for implementation.



- I.13 Although the graph above shows the fall in annual CO₂ emissions from transport, this is not occurring fast enough to meet the target (5.9Mt per year) due to the difficulty in achieving absolute reductions in CO₂ due to increasing population. However the efficiency and mode shift of transport systems is improving, as can be seen in the reduction in CO₂ per capita. Since 2005 average CO₂ emissions per passenger km travelled on public transport have also reduced from 77 grams to 61 grams in 2012-13, a 21 percent reduction.
- I.14 Compared to the rest of the country, CO₂ emissions from transport in London are low. In 2011 they accounted for only 21 percent of London's emissions, compared to the national average of around 29 percent. They have been on a general downward trend since 1990, reducing by nine percent by 2011. This is particularly significant in the light of a growing

¹⁰ EU emissions standards: <http://goo.gl/zEX948>

population. Due to faster than expected growth, the number of journeys taken by all forms of transport has increased, increasing energy demand, and provision of public transport has increased to cater for this growth. CO₂ emissions per person are expected to reduce at a faster rate



- I.15 Figure 5 shows the general trend in overall reduction in NO_x emissions. The legal limits are based on concentrations of NO₂ and the figure simply gives a London-wide indication of trend. In general, the more London-wide NO_x emissions are reduced the less people are exposed to high concentrations of NO₂.
- I.16 As shown by Figure 4 and 5, current funded measures show progress towards meeting air pollution limit values and CO₂ reduction targets, however much more action is required.

Non-transport emissions

- I.17 The scope of TERM includes road and rail based transport, but excludes aviation and non-transport machinery (such as non-road mobile machinery used on construction sites) or other non-transport sources of emissions. This is being addressed separately by the Mayor and will be reported in updates to his Climate Change Mitigation and Energy Strategy and the Mayor's Air Quality Strategy. A summary of non-transport action to reduce emissions is provided below.

Non-transport action to reduce emissions

Although this plan focuses on ground transport emissions (which in 2010 accounted for 63 per cent of NO_x emissions and 21 per cent of CO₂ emissions in London), the GLA is coordinating efforts to address the remaining non-transport sources.

The GLA has recently introduced new minimum emission standards for boiler systems (combined heat and power; biomass) and construction plant (non-road mobile machinery) in London. This will help address emissions from these sources. This complements a general requirement for all new developments to be 'air quality neutral'. The Mayor's new construction machinery Low Emission Zone is expected to help reduce emissions from construction machinery by 40 per cent by 2020 (compared to a 2010 baseline).

Retrofitting London's homes requires activity by a range of bodies including the Mayor, Government, energy suppliers, private sector and social landlords, homeowners and the wider energy efficiency market. From 2008 to 2012, over 400,000 homes were visited and retrofitted in London through Mayoral and wider market schemes, exceeding the Mayor's target to retrofit 200,000 homes by the end of 2012. RE:FIT, the Mayor's scheme to retrofit public buildings, has retrofitted 250 public buildings (including 36 schools) and is firmly on track to meet its targets to enable a minimum of £66m of retrofit of London's public workplaces. The Mayor's RE:NEW programme to retrofit London's homes has already installed or is installing energy efficiency measures in 90,000 homes. RE:NEW is being extended with a further £2.8 million investment to retrofit 175,000 homes and save 93,000 annual tonnes of carbon by 2017.

We have a 10 year energy efficiency plan for operational buildings and infrastructure to reduce CO₂ emissions by 30 per cent from 2011/12. It is estimated that energy saving opportunities identified under the plan could save 17,330 tonnes of CO₂ plus associated energy costs by 2021/22. Several energy saving projects are proposed including upgrading pier lighting to LED, the introduction of a central management system for street lighting and the replacement of street lighting, tram stops and traffic signal lamps with LED lamps.

2 Challenges and opportunities

- 2.1 Transforming London into a world leading city with low emissions and clean air is an exciting challenge. It is also an opportunity that will lead to a resource efficient, resilient and greener economy that is healthier for Londoners.

Health

- 2.2 Scientific research has shown air pollution has a great impact on our health. Children, the elderly and people already suffering from pulmonary or cardiovascular disease are particularly vulnerable. Lifelong exposure to the current concentration of particulates in the air in London has been calculated to reduce average life expectancy by about nine months (based on children born in 2008)¹¹.
- 2.3 We have recently published our Health Improvement Action Plan for Transport¹². This sets out further evidence of air quality relationship to health, including its impact on cardiovascular disease, respiratory disease including asthma, increased sensitivity to allergens and evidence that pre-natal exposure to air pollution results in low birth weight and increased risk of chronic diseases in later life.
- 2.4 Further action identified herein will provide an opportunity to help improve Londoners' health, lengthen lives and reduce suffering from respiratory and cardiovascular illnesses, while generally improving wellbeing and quality of life.



¹¹ The Committee on the Medical Effects of Air Pollutants. The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom, 2010

¹² Improving the Health of Londoners: Transport Action Plan: <http://goo.gl/kzlHiK>

Jobs and growth

- 2.5 Stimulating the market for low emission vehicles and technologies presents an opportunity for new jobs and growth. As more people adopt these new technologies more manufacturing, sales and aftercare (including repair and maintenance) will be required. London's new status as a cleaner, resource efficient and greener city will attract more businesses as its global reputation is enhanced. Recent work for the GLA¹³ indicated London's thriving green economy has bucked national trends and continued to grow over the last five years with over 9,200 green businesses employing over 163,500 people. The value of London's Low Carbon and Environmental Goods and Services sector in 2011/12 was worth approximately £25.4bn to London's economy. This growth is predicted to continue at approximately six per cent per year, helping support the Mayor's goal of London becoming one of the world's most resource efficient, resilient and greener cities by 2020. The GLA's work showed the green economy grew robustly throughout the economic downturn.
- 2.6 At the same time, growth brings challenges. The population of London is expected to increase by over 1.5 million by 2031 with an additional 750,000 jobs. This is the equivalent of adding the population of Birmingham and Glasgow combined and is a larger increase than previously predicted. The additional trips generated by this could have a large impact on total emissions in London. This will intensify the challenge of meeting London's targets, despite anticipated reductions in per capita emissions from the increased efficiency of the transport system or improvements in vehicle emissions technology.



¹³London's Low Carbon Market Snapshot – 2013: <http://goo.gl/7Vjn3y>

Climate change

- 2.7 If global emissions of greenhouse gases, the most significant of which is CO₂, are left unchecked climate change could leave London vulnerable to floods, droughts and heat waves. Although London by itself cannot stop climate change, as a world city it has an important leadership role to play in reducing emissions and promoting best practice.
- 2.8 The Stern Review of 2006 estimated the costs of uncontrolled climate change could be between five and 20 per cent of global gross domestic product (GDP) per year¹⁴. By acting now to reduce greenhouse gas emissions, we will help mitigate climate change and save money we would have spent on adaptation.

Equality

- 2.9 People living in deprived areas are disproportionately affected by air pollution as they tend to be located nearer to its sources, with the poorest areas having poorer than average air quality¹⁵. An improvement in air quality will provide benefits for deprived areas with high exposure to pollutants.
- 2.10 Improving air quality will also benefit many of London's vulnerable groups of people such as older people who may be more susceptible due to existing illnesses; young people whose lung development may be adversely affected by long term exposure to NO₂; those with cardiovascular and respiratory illnesses, such as asthma, and pregnant women.

Biodiversity and built environment

- 2.11 Air pollution has also been shown to adversely affect the growth of vegetation and certain plants and trees, with more severe effects at roadside sites. Reducing air pollution will help to increase London's biodiversity and protect natural habitats within London.
- 2.12 Improving air quality will also benefit the built environment and will help reduce cleaning and maintenance costs. Particulates can cause discolouration of buildings and NO_x deposits leave some building materials more vulnerable to weathering.

¹⁴ Stern Review on the Economics of Climate Change, 2006

¹⁵ Mitchell and Dorling (2003): <http://goo.gl/90UyoE>

3 Toolkit: 'Action by All'

- 3.1 To reduce emissions and address the challenges set out in Chapter 2, a wide range of actions are needed and everyone must contribute. Figure 6 below shows the relationship between the measures in this document with those who can deliver them, creating a toolkit for people to understand how they can play their part. Example measures are also shown. This is developed further in Chapters 4 and 5.







	Regulation 	Infrastructure 	Innovation 	Lobbying 	Fleet 	Education & Awareness 
EU	Emissions Standards	Urban clean air fund				
Central Government	Reform VED	Develop alternative fuel infrastructure	Invest in technology research	Lobby EU for funding	National incentive scheme for LEVs	National campaigns to cut car use
GLA & TfL	Low Emission Zones	Rapid Charging Network	Inductive charging & Geofencing	Lobby to revise Vehicle Excise Duty	Cleaner buses and taxis	Provide guidance for cleaner fleets
Boroughs	Differential parking charges	Improved cycling facilities	Mayors Air Quality Fund schemes	Lobby for central Government funding	Use LEVs in support fleet	Encourage more sustainable travel
Businesses & Institutions			New low emission technology	Go Ultra Low campaign	Switch fleet to LEVs	Develop travel plans
Individuals					Switch to LEV	Walk and cycle more

Figure 6: Toolkit to reduce transport emission

4 What are we already doing?

4.1 The Mayor's Climate Change Mitigation and Energy Strategy and Mayor's Air Quality Strategy set out a wide range of measures to reduce transport related emissions. This section summarises what has been done in recent years (further detail is provided in **Appendix A**). Action is ongoing on many of these measures and expanding their scale and scope would further reduce emissions.

4.2 Methods taken to reduce emissions can generally be categorised into four types:

- promoting shift towards more sustainable travel choices
- environmentally efficient use of existing vehicles and technology
- development and uptake of low emission vehicles and technologies
- tackling local air pollution focus areas

Promoting a shift towards more sustainable travel choices

4.3 The first type of measure aims to reduce emissions by reducing overall travel and encouraging a shift towards more sustainable modes of travel. It includes measures which use the planning system, providing infrastructure and other incentives, along with strong and powerful financial measures such as congestion charging.

Promoting shift towards more sustainable travel choices

Land use planning



We permit greater density of development in areas which have better levels of public transport, in order to encourage public transport use. In addition:

- We have included requirements for electric charging provision at parking spaces in the London Plan
- Some London boroughs have applied differential rates for parking permits according to CO₂ emissions. This could be expanded to other boroughs, extended to include visitor parking and adjusted to capture air pollutants
- The most recent update to the London Plan, consulted on in January 2014, increased the minimum cycle parking standards
- The GLA has developed Supplementary Planning Guidance on sustainable design and construction, including the control of dust and emissions during construction
- Opportunity Area Planning Frameworks (OAPFs) and work on developing specific Growth Areas secured investment in sustainable transport provision (eg Northern Line extension)
- Car Lite and Car Free developments have been specified in planning agreements

New rail & underground infrastructure





We continue to develop our public transport infrastructure through upgrades, new extensions and increased frequencies, as well as new rail lines including Crossrail, new trams and longer platforms on National Rail.

Bus stop and bus accessibility 	<p>We have made improvements to bus stops, as well as to the buses themselves, to enable people to get on and off easily to allow more people to make bus journeys.</p>
Walking improvements  	<p>We have taken forward the Better Streets programme, a range of measures to encourage walking trips, and developed the Walk London Network. We are expanding Legible London with a target of 3,000 signs by 2021, and Pedestrian Countdown at traffic signals to 400 sites by 2016. The Mayor has set a target to increase walking trips by one million by 2031.</p>
Cycling improvements 	<p>We have launched the Mayor's Cycle Vision, an ambitious programme of improved cycling infrastructure and promotion with close to £1 bn of funding up until 2020 to help to double cycling's mode share. This includes a central London cycle grid, quietways, mini-Hollands, further cycle superhighways, cycle hire scheme and cycle parking.</p>
Smarter Travel, Car Clubs and Travel Demand Management 	<p>We are encouraging sustainable travel through business engagement and school travel plans (via STARS accreditation), the Cleaner Air 4 Schools pilot and Smarter Travel Sutton/Richmond. This includes the promotion and investment in car clubs and encouraging their use of low emission vehicles.</p> <p>The success of the travel demand management campaign during the London 2012 Olympics shows the benefits of travel demand management with an average reduction in background travel of five per cent per day. More recently, in response to the Roads Task Force report, we are seeking to reduce car trips as part of a demand management strategy.</p>
Smarter Freight    	<p>Safeguarded wharves, a cycle freight trial in Camden, Delivery and Servicing plans, Construction and Logistics Plans and the Fleet Operators Recognition Scheme have all been used to encourage more sustainable freight operation.</p>
Congestion Charging 	<p>We have significantly reduced traffic in central London due to the congestion charge and have recently announced an increase in the charge level to maintain the effectiveness of this charge.</p>

Environmentally efficient use of existing vehicles


- 4.4 This can include ways to optimise the use of engines, both mechanically and by behaviour change, as well as reducing congestion to minimise driving time.

Environmentally efficient use of existing vehicles and technology	
Smarter Driving 	<p>We have introduced smarter driving as part of the bus drivers' training course and licensed taxi drivers' test. This encourages more efficient driving, which reduces emissions.</p>
Traffic signal optimisation (SCOOT) 	<p>We have introduced SCOOT¹⁶ at around 3,000 of the 6,000 traffic junctions in London, leading to a reduction in delays and less stop and start traffic (which increases air pollution). SCOOT is being expanded to a further 1,500 sites by 2019, to help reduce delays further and ease congestion which may arise from the delivery of the Roads Modernisation Plan.</p>
Lane rental for roadworks 	<p>We have introduced lane rental for roadworks at key congestion hotspots on the TLRN. This aims to reduce the amount of time roadworks disturb the road network.</p>
Reduced engine idling 	<p>We launched a No Engine Idling campaign in early 2012 with a second phase launched in September 2012. Results indicated a five per cent fall in engine idling overall at monitored locations, with larger reductions in the taxi sector.</p>
Freight Operators Recognition Scheme 	<p>We operate the Fleet Operators Recognition Scheme (FORS), a voluntary scheme which fleet operators can join. It encourages sustainable best practice for fleet operators who deliver or service in London. There are four key areas to the FORS standard: Management, Vehicles, Drivers and Operations. For example, FORS operators can reduce operational costs to the business and risk to all road users by managing route and vehicle choice. Among other incentives FORS offers driver profiling (tracking and real time monitoring of driver performance) to allow fleet managers to assess and improve the performance of their drivers. In the future, we are considering developing a green fleet standard where operators would be required to meet environmental standards and driver training.</p>
Out of hours delivery 	<p>In partnership with the industry through the London Freight Forum, we are trialling out of hours deliveries, making deliveries more efficient and reducing fuel consumption. We are also considering the noise impacts of these deliveries.</p>

¹⁶ Split Cycle Offset Optimisation Technique

Development and uptake of low emission vehicles and technologies

- 4.5 There is a huge variety of measures within this category, including the low emission zone, cleaner buses, taxis and river services.

Development and uptake of low emission vehicles and technologies	
Low Emission Zone 	<p>We initiated the London Low Emission Zone (LEZ) in 2008. The scheme was expanded to cover larger vans and minibuses and introduced tighter emission standards for lorries, buses and coaches in 2012. The LEZ covers almost all of the Greater London area and operates continuously.</p>
Congestion Charging Ultra Low Emission Discount 	<p>We introduced the Ultra Low Emission Discount, a 100 per cent Congestion Charge discount for cleaner vehicles encouraging a switch to lower emission vehicles.</p>
Zero emission vehicles and charge points 	<p>We encourage the uptake of zero emission vehicles through many avenues: the Mayor's Electric Vehicle Delivery Plan; the installation of over 1,400 electric vehicle charge points in the Source London network; providing information and support via the Source London website; and engaging with businesses and the taxi industry. Other measures include the Energy Saving Trust's Plugged in Fleets initiative and demonstrating hydrogen fuelled transport through HyTEC (Hydrogen Transport in European Cities)</p>
Freight schemes 	<p>We are involved in joint European projects to encourage low emission freight operation, including Clean Fleets FREVUE, CAPIRE and LaMiLo¹⁷.</p>
Cleaner TfL Buses 	<p>We have added particulate filters and selective catalytic reduction to our fleet and are also accelerating the roll out of Euro VI buses, retiring the oldest, most polluting buses. We are expanding our fleet of hybrid buses and new Routemasters with 1,700 due to be introduced by 2016. We have also recently begun piloting the use of biodiesel on 120 buses and are trialling electric and range extended hybrid buses to test operational suitability.</p>

¹⁷ FREVUE involves supporting use of electric freight vehicles in urban Europe.

CAPIRE involves developing roadmaps to foster road transport electrification, including clean city logistics.

LaMiLo has been set up to develop innovative solutions to make Last Mile Logistics operations more effective, sustainable and easier for private companies and end users.

<p>Cleaner Taxis and PHVs</p> 	<p>We have introduced age and emission limits for taxis and PHVs, retiring the most polluting vehicles from the roads.</p> <p>The Mayor has also proposed (subject to consultation) that from 2018 all new taxis will need to be zero emission capable¹⁸, and several taxi manufacturers are bringing such vehicles to the market in the next few years.</p> <p>We are currently developing a package of incentives to encourage early uptake of the new cleaner vehicles.</p> <p>As part of the HyTEC project, a trial of five taxis powered by hydrogen fuel cells was launched during the Olympics.</p>
<p>Powered Two Wheelers</p> 	<p>We have enabled powered two wheelers to use bus lanes on the TfL Road Network (TLRN) which has decreased their journey time and lowered powered two wheeler emissions.</p>
<p>LU energy reduction</p> 	<p>We are embarking on a programme to minimise the energy used by the tube network through implementing regenerative braking and automatic train operation as lines are upgraded. Additionally we are introducing low carbon technology such as low energy lighting, heat and cooling capture systems and automated lighting systems at stations. We are also seeking to diversify our supply of electricity and use electricity generated from lower carbon sources.</p> <p>These measures will ensure we minimise carbon emissions from London Underground as the network expands.</p>
<p>Rail electrification</p> 	<p>We have successfully lobbied for the conversion of the Gospel Oak to Barking Line from diesel operation to electric in 2017/18. Work is also ongoing to electrify the Great Western Main Line, which would reduce the diesel rolling stock used on longer-distance services. As electric rail is zero emissions at point of source there will be savings in NOx and PM emissions, as well as CO₂.</p>
<p>River services</p> 	<p>We have introduced ultra low sulphur diesel in Thames Clipper services and fitted a diesel particulate filter on a Woolwich Ferry vessel to significantly reduce particulates emitted.</p>

¹⁸ As a proposal, this policy will be subject to consultation.

Tackling local air pollution focus areas

- 4.6 Along with the Mayor we continuously work closely with boroughs, providing direct funding, support or guidance, and through influencing and joint local projects.

Tackling local air pollution focus areas

Clean Air Fund



Between 2011 and 2013, we implemented a range of measures at PM hotspots with support from the DfT. Trials included green walls and dust suppressants, use of Diesel Particulate Filters on buses, and vehicle anti-idling campaigns.

Clear Zones



We provided support and funding for Clear Zones where specific measures were implemented to give spot treatments (implemented in Camden, Westminster and Tower Hamlets).

Mayors Air Quality Fund



The Mayor's Air Quality Fund (MAQF) provides match funding for boroughs to deliver innovative air quality improvement projects. A number of area-specific air quality schemes are emerging from London boroughs, many encouraged by the MAQF. (More details can be found in Appendix A).

Airport Surface Access Strategies and Air Quality Strategies



All London airports have surface access strategies to set out how they will encourage more sustainable access to their airports. London City Airport has a three year Air Quality Action Plan (to 2015). Heathrow also has an Air Quality Strategy, to specifically look at how it can reduce air pollutant emissions, such as reducing pollution from airside vehicles and aircraft, and encouraging more staff to take public transport to work.

Access restrictions



We have supported ongoing street access restrictions such as pedestrianisation, giving road space to cyclists or bus lanes, restricting traffic and therefore emissions in that area.

5 Future focus

5.1 There are a number of new and innovative ideas which could be implemented in London in the future along with strengthening of existing actions. A long list of measures has been assessed according to their potential impact on emission reductions, costs, technical feasibility and overall alignment with wider transport objectives. This assessment used evidence gathered from practice elsewhere, experience from similar schemes within London, and an initial assessment of the associated benefits and risks. Some measures were grouped together to increase the overall impact, forming the top 10 list set out below.

- 1) Ultra Low Emission Zone
- 2) The future of the Low Emission Zone
- 3) Making traffic management and regulation smarter
- 4) Helping Londoners tackle air pollution and climate
- 5) Driving the uptake of low emission vehicles
- 6) Cleaner electricity for London's transport
- 7) Transforming London's bus fleet
- 8) Delivering a zero emission taxi and PHV fleet
- 9) Transforming London's public and commercial fleets
- 10) Low Emission Neighbourhoods

5.2 These measures reflect a broad range of types of intervention, covering regulation, infrastructure, innovation, lobbying, fleet-specific changes and education and awareness campaigns to encourage behaviour change and more sustainable travel. This illustrates how a wide variety of approaches will be necessary to tackle transport emissions effectively with action in a number of areas.

5.3 Chapter 6, Roadmap to Compliance, sets out an ambitious package of measures on what could be possible by 2020 and 2025 with further funding, helping London achieve compliance with the EU limit values for NO₂ by 2025. Additional investment from central Government would be required. The measures could also potentially reduce emissions of CO₂ and particulate matter (PM), bringing about further benefits for the environment and public health.

5.4 These ten measures will need to be developed to understand their feasibility, impact and funding requirements. TERM is intended to be a platform document with which to engage stakeholders and the public to help build consensus and drive action as well as to encourage central Government and the EU to provide further support.

1. Ultra Low Emission Zone



- 5.5 We are developing a proposal for an Ultra Low Emission Zone (ULEZ) in Central London. The operational area of the ULEZ would cover the Congestion Charging Zone and come into effect from 2020. Subject to public consultation, ULEZ would set an emissions requirement for all types of vehicles entering central London with charges for non-compliance, discouraging all but the cleanest vehicles.
- 5.6 While the impact of the ULEZ will primarily be in central London, it will have wider benefits across London from vehicle replacement. As low emission vehicle technology and markets develop in the future, it may become feasible and practical to introduce more stringent requirements for the ULEZ, and to potentially expand the zone into other areas.
- 5.7 The ULEZ proposal will be subject to public consultation, to commence at the end of October 2014. The scheme has three elements:
- **Emissions-based vehicle charging:** a daily ULEZ charge for road users to encourage the uptake of lower emission vehicles. It is proposed those that do not comply with the most modern exhaust emission standards will be required to pay to enter central London
 - **TfL buses:** a new procurement requirement to increase the total number of hybrid double-decker buses operating in central London and zero emission single-decker buses
 - **Taxis & PHVs:** revised licensing requirements to reduce emissions and accelerate the uptake of zero emission capable vehicles
- 5.8 Further detail on ULEZ will be available with the public consultation material in October.



Spotlight on diesel

While there are some measures that can provide benefits in lowering both air quality pollutant and CO₂ emissions, it is important to ensure that measures to improve one do not adversely impact the other. For example, diesel powered cars are more fuel efficient, producing less CO₂ for the same class of vehicle, and were thus encouraged through the Vehicle Excise Duty (VED) and company car tax bandings. Partly due to these tax incentives, new diesel car sales in the UK dramatically increased, from an approximate 14 per cent share in 2000 to 50 per cent in 2012. However they can produce up to 20 times as much PM₁₀ and NO_x emissions as a petrol equivalent, and their increased uptake has contributed to poor air quality in London.

Recent research (Cames and Helmers, 2013) reported that the expected greenhouse gas savings initiated by the shift to diesel cars have been overestimated. About one tenth of overall energy efficiency improvements of passenger cars can be attributed to it. These savings are also overshadowed by a significant increase of supply chain CO₂ emissions for diesel fuel and black carbon emissions from diesel cars, especially those without a particulate filter fitted.

Black carbon is the most strongly light-absorbing component of particulate matter (PM), and is formed by the incomplete combustion of fossil fuels, biofuels, and biomass. It is emitted directly into the atmosphere in the form of fine particles (PM_{2.5}) and is now known to have a powerful atmospheric warming effect.

Similar incentives for diesel have been put in place in other European countries, including fuel tax incentives, which means diesel costs between 10 per cent and 50 per cent less than petrol. The overall package of incentives adopted at both European and national level now appears inappropriate and helps explain the differential in air pollution performance compared to other major developed nations such as the US and Japan, where there are much lower levels of diesel penetration. It is estimated that there are now an additional 45 million diesel cars in Europe as a result of the multiple incentives for these type of vehicles. Consequently the Mayor is actively calling on the European Commission and UK central Government to unwind existing incentives and to take further steps to accelerate the introduction of Euro VI and other ultra low emission vehicles, including by establishing a national scrappage scheme to accelerate the introduction of Euro 6 vehicles by retiring the oldest most polluting diesel vehicles.

- 5.9 If introduced as proposed, ULEZ could reduce NO_x emissions in 2020 by as much as 51 per cent in central London. There would be some wider benefits due to cleaner vehicles also travelling in inner and outer London with an estimated reduction of 16 per cent and 10 per cent respectively.
- 5.10 ULEZ could be tightened further in the future, in 2025 for example, with a standard for cars and vans to include a CO₂ emissions standard (for example in line with the Government's Ultra Low Emission Vehicle campaign or – dependent on appropriate technologies being widely available – even zero emission). Consideration could also be given to expanding the geography of ULEZ in the future, to cover inner London and outer London as well for example.
- 5.11 It should be noted that, to support an emissions-based vehicle charging scheme such as ULEZ, the government and EU could introduce legislation and standards to reduce the CO₂ and air pollution impact of vehicles, and introduce financial measures to encourage their uptake. Euro emission standards have failed to deliver the predicted emission reductions under real world urban driving conditions. This is anticipated to improve significantly with the introduction of Euro VI/6. However, pressure needs to be maintained, and by all parties involved, including the EU, in developing vehicle emission standards, to ensure emission reductions are delivered in realistic urban driving conditions for all vehicle types.

2. The Future of the Low Emission Zone



- 5.12 The London-wide Low Emission Zone (LEZ) is the largest such zone in the world and covers almost all of the Greater London area, setting standards for maximum emissions of PM10 for commercial vehicles including vans, trucks, buses and coaches. The high daily charges are an important deterrent for the highest polluting vehicles.
- 5.13 Further tightening of the LEZ by 2020 has been considered. However, given vehicle availability and cost of compliance over the whole of London, tightening LEZ significantly in the short term would be difficult. Moreover, a modest change of Euro IV to Euro V, which would be more acceptable, would only yield improvement reduction in emissions of less than one per cent.
- 5.14 Tightening LEZ after 2020 would be more feasible and effective, given the wider availability of suitable vehicles and additional compliance time for people and businesses. If LEZ standards were adapted to more closely match ULEZ standards in 2025. This would result in as much as a 19 per cent reduction in NO_x outside central London in addition to the saving achieved by ULEZ in central London. Any London wide standards would need to reflect the condition of the market in terms of the availability of compliant vehicles at the time tighter standards were introduced.

- 5.15 At a national or European level, a LEZ framework could encourage a consistency in low emission zones in the UK and across Europe, particularly for more specialist vehicle types affected by a LEZ. Putting in place a national certification scheme which certifies high quality retrofitted emissions abatement equipment, could offer an economic alternative to purchasing a new vehicle.. A national certification scheme for PM and NO_x emissions as well as the existing CO₂ certification, based on a robust urban drive cycle test, is also required to better target measures at the most polluting vehicles.

3. Making traffic management and regulation smarter



- 5.16 Changing our approach to traffic management can help to mitigate congestion and related emissions. More sophisticated use of London's intelligent traffic light system can help to keep delays to a minimum. Improved information, through more channels to road users, gives drivers options to avoid queues and disrupted areas. Targeted measures such as these are being taken forward as part of our response to the Roads Task Force report.
- 5.17 Reducing speed limits reduces the power demand on engines and can reduce vehicle emissions for NO_x, PM and CO₂. The Highways Agency has recently discussed introducing 60mph speed limits to reduce emissions on parts of the motorway network, although it has confirmed this will be a last-resort measure. Further investigation into its potential benefits for London's roads should be undertaken, although speed limit changes in urban environments are expected to have less of an impact. There are also other regulatory measures which could be used to mitigate environmental impact, such as the London Lorry Control Scheme (LLCS), which was designed to restrict the movement of heavy goods vehicles during the night and at weekends.
- 5.18 With new river crossings being planned for London, there is an opportunity to explore the use of differential charging on the crossings, for example to encourage uptake and use of lower emitting vehicles and deter the use of higher polluting vehicles. Potential standards could be set according to NO_x or CO₂ emissions or a combination of both.

Changing the way road use is paid for

- 5.19 More radical approaches in the future might consider changing the way we pay for road use. By rethinking Vehicle Excise Duty (VED) and fuel tax, payment for use of the roads could be charged at point of use, and discounts could be made for ultra low emission or zero emission vehicles. This would need to be supported by central Government action and funding. Careful consideration of the costs and benefits would be needed, including ensuring user groups are not unfairly affected. New, innovative solutions may also be required to meet the needs of London in a future where fewer vehicle kilometres are driven. More radical measures such as this may be needed to bring forward the date of compliance for NO₂ emissions and to significantly tackle vehicle emission levels. This would require sustained capital investment in the transport system as well as change to national legislation.

- 5.20 If funding and support was available from central Government to take forward a more radical approach to traffic management, emissions of NO_x in 2025 could be cut by 10 per cent in Central London (in addition to savings from ULEZ), 20 per cent across the rest of London and further reductions could be achieved at pollution hot spots. In this scenario, junctions would be optimised, access would be restricted to some streets to disperse traffic and its associated pollution, and the way of paying for road use would be revised to be charged at the point of use.

4. Helping Londoners tackle air pollution and climate change



- 5.21 All Londoners have a role to play in reducing emissions from transport, through choosing more sustainable forms of transport and more effective ways to travel. While substituting an existing vehicle for a lower emission equivalent helps to reduce emissions, linking journeys to reduce travel, or switching to walking and cycling can significantly reduce an individual's emissions impact. TfL, London boroughs, central Government as well as businesses, schools and other organisations can support this in a variety of ways.
- 5.22 Measures to help Londoners have included behaviour change campaigns to promote sustainable travel such as walking and cycling, with information on infrastructure, route planning and events. Personalised travel plans, delivered through community groups, businesses and for interested individuals can complement these. There are also good examples of actions delivered through schools and workplaces.
- 5.23 Further research to gain a fuller understanding of behaviour patterns relating to air quality pollution and CO₂ emissions, and how it affects peoples' modal choice, would be highly beneficial. This will support the development of a travel choices campaign to encourage further modal shift away from more polluting transport.
- 5.24 As part of this measure, we would like to review travel information at key decision points. Many visitors to London are unfamiliar with our transport network and could be better informed to help them get around the city more efficiently. We already provide maps at most tube stations to help people with their onward journey by foot. There is potential to provide a more integrated approach to promoting travel options at key decision points in the system, helping people make a the most sustainable mode choice for longer distance journeys. We will focus on key interchanges, working with key stakeholders to explore options, with a view to trialling some potential solutions.
- 5.25 By 2020, should sufficient funding and support be provided by central Government, a large media campaign with incentives for choosing sustainable travel could contribute further to the NO_x emission reductions (approximately one per cent more in central London and some two per cent across the rest of London). Comparable to campaigns against drink-driving and smoking, these can complement and enhance the impact of other measures. They may take some time to take effect but tend to have much more impact than can be estimated from an individual measure.

5.26 In the short term, central Government can help to reduce emissions by providing better information on existing vehicle emissions. Information on air pollution emissions of vehicles at point of sale, similar to the current CO₂ rating label, would promote the messages around air quality and allow consumers to make a more informed choice. Further awareness-raising activities on the benefits of low emission vehicles, similar to the current 'go ultra low' campaign¹⁹ run by OLEV in partnership with the private sector, would also help promote the benefits to the public. Increasing familiarity of these technologies by supporting initiatives which allow people to try the vehicles out, would also help address a key barrier to large scale uptake.

5. Driving the uptake of low emission vehicles



5.27 Increasing the use of low emission vehicles, including electric vehicles and a range of low emission vehicle technologies for heavier vehicles, would have a major impact on emissions of air pollutants and CO₂ if achieved on a significant scale. This could be met by developing the refuelling and recharging infrastructure to support these vehicles, complemented by promoting and incentivising the use of these vehicles.



¹⁹ goultralow.com

Low emission vehicles in London

TfL commissioned research to explore a low emission vehicle vision for London. This independent work investigated the whole lifecycle costs and emissions impact of fuel and powertrain combinations for all vehicle types from the present until 2050. It explored the likely emissions impacts of a high, medium and low uptake scenario for low emission vehicles and the infrastructure and other conditions required to achieve this uptake.

The lifecycle analysis concluded vehicles with increasingly electrified means of providing power to the wheels offer the greatest benefits in reducing greenhouse gases (including CO₂), NO_x and PM on a lifecycle basis. It also confirmed that even using the current grid mix with high fossil fuel usage, electric vehicles produced CO₂ savings over the lifecycle of the vehicle. These savings will increase as battery technology becomes more efficient and the CO₂ output of electricity generation reduces. It concluded the total cost of ownership for alternatively powered low emission vehicles would be comparable to that of conventional petrol and diesel fuelled vehicles between 2020 and 2030.

The study looked at high, medium and low scenarios for vehicle uptake, based on what would be required to meet emissions reduction targets solely through low emission vehicles, without reducing travel or mode shift. The high scenario indicated by 2025, London would need around 19 per cent of the entire vehicle fleet to be plug-in hybrid or fully electric with some two per cent hydrogen vehicles. For heavy duty vehicles, where technology options are fewer, approximately 20 per cent of the fleet would need to be natural gas and some 12 per cent operating on higher blend (20 per cent) sustainable biodiesel. (For comparison in 2012 just 0.01 per cent of the total vehicle fleet in London was electric or plug in hybrid).

The consultants concluded the high scenario was at the limit of what is possible, if funding was unlimited and the market responded rapidly to produce additional vehicles, and substantial infrastructure for electric, hydrogen and natural gas powered vehicles would be required. However, the low and medium scenarios, while still requiring decisive action, offered significant savings in CO₂, NO_x and PM. Although investing in low emission vehicles is a large part of the solution, it is clear that we cannot rely on this alone to solve our air pollution and CO₂ problem.

- 5.28 To support public adoption of electric and hybrid plug in vehicles, we have signed a deal with a private sector operator to manage and develop the Source London network of standard charging points. The operator (IER²⁰) plan to expand the number of points from the current 1,400 to 6,000 by 2018 and to introduce a new electric car sharing scheme. In addition, a network of rapid charge points will be essential to support the deployment of zero emission capable taxis from 2018 and other high mileage fleets. To establish a network of 350 rapid charge points for use by specific fleets by 2020, TfL has requested funding from the Office for Low Emission Vehicles (OLEV).

²⁰ IER <http://goo.gl/QZxPzR>

- 5.29 Promotion of low emission vehicles is important in raising awareness and encouraging their uptake. London will be hosting a race in the Formula E championship for electric vehicles in 2015 and there is the opportunity to use this to further promote electric vehicles. TfL and the GLA are considering other ways of promoting awareness such as the setting up of low emission vehicle demonstration centres and education for school children and other groups.
- 5.30 There are a number of future technologies such as wireless inductive charging, which need to be investigated further. This uses electromagnetic fields to transfer energy to charge batteries while a vehicle is in a particular location. It could potentially allow for vehicles to operate with smaller batteries as they will be able to be recharged en route. A trial is taking place on four buses in London funded by the EU, to investigate this further. Dynamic wireless charging is being trialled in some South Korean buses, where vehicles do not need to stop to be charged. Investment in future vehicle technology and creation of a nationwide alternative fuelling infrastructure will be needed at a national level to encourage uptake of alternatively fuelled vehicles. Investment in rapid charging, inductive charging, hydrogen and natural gas networks across the UK will be needed for any significant shift to alternatively fuelled vehicles to occur.
- 5.31 Investment in upgrading the national electricity grid to support the installation of charging infrastructure (particularly rapid charging) will be needed to support the surge in electricity use in some areas at certain times of day. This would entail increasing the capacity and number of substations and demand-side management systems. The end user and/or network operator of charging infrastructure cannot be left with the risk of reinforcing the grid ahead of any immediate request for a connection. Making the case to Government, Ofgem and the District Network Operator of the need for strategic investment before any increase in capacity is actually needed, and avoiding stranded assets and the financial contribution of the private sector to these upgrades, are key issues to be resolved. The Mayor's High Level Electricity Working Group and his Spatial Energy Infrastructure Plan (to be published in 2015) will set out the case.
- 5.32 There are other issues to overcome with charging infrastructure. Reliability of public charge points needs to be assessed, and compatibility for different vehicles can also be a problem. This is particularly the case for electric motorbikes where some inconsistency exists in terms of compliance with EU charging point standards. This makes it harder for users to adopt electric motorbikes.
- 5.33 Reducing the total cost of ownership for alternatively fuelled low emission vehicles compared to conventional vehicles would be necessary to achieve the high LEV uptake suggested in the consultants' study. Significant investment, market availability of LEVs and sufficient infrastructure will be required, but if by 2020 we could achieve a 'medium' scenario, we could expect a two per cent reduction in NOx emissions in central London, a three per cent reduction in inner London and a four per cent reduction in outer London. Without other measures such as ULEZ, these changes are very modest.

- 5.34 Central Government could further incentivise this by altering legislation and taxation. Vehicle Excise Duty and company car tax incentives only consider CO₂ emissions resulting in a shift towards diesel vehicles, which have slightly lower tailpipe CO₂ emissions compared to petrol. This has caused large increases in emissions of PM and NO_x, and may not even have an overall greenhouse gas benefit, when the effect of black carbon is taken into account. Bandings should be altered over a reasonable length of time, so that air pollutants are considered as well as CO₂, and the full benefits of ultra low emission vehicles are fully recognised. The capital allowance deductions for vehicles should be treated similarly, to encourage lower polluting vehicles in business usage.
- 5.35 Average CO₂ emission limits on new cars and vans have encouraged manufacturers to introduce alternatively fuelled vehicles to meet the targets. The government needs to push the EU to further reduce the CO₂ limit for new cars. This will further encourage manufacturers to widen the range of alternatively fuelled zero emission capable cars and vans, increasing the supply and reducing the cost to consumers.
- 5.36 As a further incentive, the introduction of a new compensation scheme at a national level for removing older, high polluting cars and vans from the road (potentially focussed on diesel), would also help to renew the vehicle fleet and stimulate the motor manufacturing industry. Financial compensation could be offered towards car club memberships, rail season tickets or bicycles when selling cars and not replacing them. The government should also consider specific incentives to encourage early up take of lower emission taxis, HGVs and buses.
- 5.37 In the longer term we would encourage central Government to continue to fund research for low emission vehicle technologies as it currently does through the Technology Strategy Board.

6. Cleaner electricity for London's transport



- 5.38 In order to maximise the benefits of reducing air pollution and greenhouse gases, the increased use of electricity to power vehicles and the increased energy use associated with higher levels of rail and Underground provision in London must be complemented with the decarbonisation of electricity supply. It is also important to ensure this does not negatively impact on London's air quality.
- 5.39 The Mayor's low carbon energy supply policies and programmes for London aim to reduce carbon emissions and provide greater energy security. Twenty five per cent of London's energy are planned to come from decentralised low carbon energy by 2025. This, along with the roll out of installed energy efficiency measures, installation of low carbon energy supply and demand-side 'smart grid' technologies will support the delivery of a low carbon grid transition in London. The Mayor's Spatial Energy Infrastructure Plan for London (to be published in 2015) will set out what energy infrastructure is required to deliver a secure, safe, low-carbon and affordable energy transition.

- 5.40 London is the first authority in the country to apply to the Office of Gas and Electricity Markets (Ofgem) for a new type of electricity supply licence. The Mayor is working to enable the capital's small electricity producers to sell power to the market at a better rate. Initially, the 'Licence Lite' scheme will allow the Greater London Authority to buy excess electricity produced by London's boroughs and public bodies before selling it on, at cost price, to other public sector organisations, such as TfL, the Met Police and NHS hospitals. If the scheme proves successful the Mayor plans to extend it to include private sector energy producers in London as well.
- 5.41 As the largest electricity consumer in London, there is an opportunity for us to utilise our buying power to stimulate the development of low carbon energy. TfL and the GLA are investigating this in relation to the use of Greenwich Power Station. By adding new, low carbon generation units, TfL could reduce its energy use and costs, and could even sell heat as well to help meet the Mayor's decentralised energy targets.
- 5.42 Alongside this, central Government is undertaking work to reduce the carbon intensity of the national grid by 2030. We support and encourage the Government to achieve a grid emissions intensity of 100g CO₂/kWh in 2030, but also recognise the UK should aspire to the level of 50g/KWh in 2030, proposed by the Committee on Climate Change (CCC). This would significantly support our transport emissions reduction plans for London, and we wish to work with Government to best achieve this target. A significant level of further investment at a national level is required to meet either of these projections, as well as political will.

7. Transforming London's bus fleet



- 5.43 If sufficient additional funding is provided by central Government, there is potential for TfL's buses to get even cleaner. We have already funded a further 1,400 hybrid buses since 2012 so we will have a fleet of 1,700 by 2016. To support the ULEZ proposal we require additional funding to roll out a further 1,600 hybrid double-decker and 300 electric single-decker buses. There is also an opportunity to convert our Dial-a-Ride fleet (the on-demand minibus service for those who are unable to use mainstream public transport) into ultra low emission vehicles.
- 5.44 Funding is not the only limiting factor. The number of new buses that can be purchased is limited by the capacity of manufacturers. In theory, if central Government provided sufficient funding, manufacturers could be paid to quickly increase capacity and production and provide new hybrid buses for a London-wide ULEZ by 2020. However, this would not be cost effective in the long term because it would commit us to current technology for most of the bus fleet for over a decade. The current approach is for a steady turnover of vehicles over time, making use of new technology as it becomes available.

8. Delivering a zero emission taxi and PHV fleet



- 5.45 Taxis produce a large proportion of transport's NO_x emissions, as well as significant emissions of particulate matter, due to their size, engine type and long hours of operation. As part of ULEZ it is proposed that from 2018 (subject to consultation) all new taxis and PHVs will be licensed if they are zero emissions capable. In addition, supporting measures such as promotions, grants and other incentives could be used to encourage early uptake and support the taxi and private hire industry moving over to the new requirement. We have already requested additional funding from Government (via OLEV) to support this. The impact of such changes proposed as part of ULEZ for taxi and PHVs alone, would be an eight per cent reduction in NO_x in central London with wider benefits (a two per cent reduction) in the rest of London.
- 5.46 Further action could be taken, for example from 2025, for all new taxis to be fully electric or hydrogen (effectively zero emissions at tailpipe). The emissions savings from this policy would be realised over time from 2025 onward and would require advances in technology as well as additional funding.

9. Transforming London's public and commercial fleets



- 5.47 There is an opportunity to upgrade many of the public sector's support fleets and suppliers' fleets to meet ULEZ standards, allowing the public sector to lead by example. This would require direct action and funding from national Government. In addition to the direct emissions savings this will bring, it could encourage a wider uptake of ultra low emission vehicles. This could go so far as to include sub contractors, depending on feasibility. We would also propose to develop the existing FORS accreditation scheme to reflect emissions standards, and/or creating a new vehicle badging scheme for private fleets to demonstrate compliance.
- 5.48 Providing a relatively high profile example to businesses on how ultra low emission fleets can be run and promoting the uptake of vehicles through on-vehicle advertising could help encourage a wider shift towards ultra low emission vehicles.
- 5.49 Schemes could include Metropolitan Police, London Fire Brigade and TfL's support fleets being ULEZ compliant throughout Greater London. Guidance could be considered to require all new transport related contracts and sub-contracts to be ULEZ compliant. It is likely that such a measure would focus on guidance and encouraging uptake through an accreditation scheme rather than regulation, which would be more difficult and expensive.
- 5.50 The overall impact would vary depending on the level of investment promoting such initiatives. The likely overall contribution to NO_x reduction from this measure would probably only be in the order of one per cent in 2020, but it would be an important complementary measure to ULEZ.

- 5.51 Accelerating the uptake of low emission vehicles will improve emissions of nitrogen dioxide and many other pollutants, but it should be noted that emissions from tyre and brake wear are a significant source of particulates in London, and this has not been adequately addressed to date. This is an international problem, and limited action has been taken at the EU level to address particulates from these sources. The EU must provide more significant funding and regulation to push this forward. Government has a critical role to play in undertaking additional research to further understand this issue, and subsequently putting in place appropriate steps to reduce this emissions source.

10. Low Emission Neighbourhoods (LENs)



- 5.52 There is opportunity to apply the principles of the ULEZ in other areas of London. This could be in the form of Low Emission Neighbourhoods (LENs), which would be targeted in local hotspot areas of poor air quality. Local political will and funding from sources external to TfL would be required for the measures outlined below as many are outside of our control.



- 5.53 In order to become a LEN, a number of measures would need to be adopted for an area, from a package supported by us, through to advice and incentives. The most appropriate measures will vary between the different LENs depending on their unique characteristics and local requirements. Examples are included in the table below.

Potential measures for a typical Low Emission Neighbourhood (LEN)

Parking and charging infrastructure	<ul style="list-style-type: none"> • Workplace parking levies • Workplace charging facilities, including mobile charging units • Preferential parking for LEVs • Emissions based parking charges (parking permits, public on street, and/or public car parks) • Additional charging infrastructure (eg on street, at home) • Inductive charging networks
Low emission vehicles	<ul style="list-style-type: none"> • Geofencing 'hard' or 'soft' zone • LEV loans (similar to existing travelcard or bicycle loans) • LEV in car clubs (including vans for businesses) • 'Try before you buy' schemes for LEV • Neighbourhood ULEZ • Micro-ULEZ (eg key shopping roads at certain times) – potentially zero emission
Efficient operation	<ul style="list-style-type: none"> • Freight Management Plan (with survey) and use of microconsolidation through cycle freight or electric freight deliveries • Local implementation of Green Fleet scheme (eg amended FORS, ULEZ badging or ECOStars) • Anti-idling campaign • Optimising traffic signals to reduce emissions • Geofencing technology to switch on zero emissions mode of hybrid buses and taxis within hotspot areas (see box below)
Engagement	<ul style="list-style-type: none"> • Schools engagement, eg Clean Air for Schools (CA4S) • School cycling training and events • Community engagement • Business engagement, eg CityAir • Workplace cycle challenge
Procurement	<ul style="list-style-type: none"> • Including emission standards and/or efficient operation in contracts let by the LA and a large proportion of local businesses
Smarter travel initiatives (with minimum numbers)	<ul style="list-style-type: none"> • Personalised travel plans • Corporate and Community travel plans • Installing cycling infrastructure • Smarter driving training • Encouraging cycling, through cycle training, Dr Bike, etc. • Travel Campaign (where cars are a major source), eg Colchester and Kendal • Free car club membership • Car free days

- 5.54 There are 187 designated Air Quality Focus Areas in London identified by us, which are based on locations that greatly exceed the NO₂ limit values. Some of these zones are small and focused on major roads and junctions which have a large amount of through traffic. These will be more effectively addressed by London-wide measures or schemes to significantly reduce traffic, which may not be feasible if problems are simply created elsewhere. However, if either end of the journey is in a LEN, any improvements in vehicle emissions and operation in the LEN should lead to improvements in the wider area. Therefore, key destinations with high air pollution levels also have the potential to be effective LENs. A LEN would need to include a reasonable number of residents or businesses, rather than just roads, in order to be effective. There may be opportunities to combine these elements when developing a LEN. For example, by grouping together Air Quality Focus Zones with the surrounding urban centres. Other areas which could be of interest include growth areas or Housing Zones, where these coincide with areas of high pollution.

Geofencing

We are investigating the possible use of geofencing technology. This uses GPS systems to create a virtual zone around a particular location which activates the electric mode of TfL a hybrid vehicle buses with extended zero emission capability and other hybrid vehicles when they enter the ultra low emission zone or other zones. TfL are trialling this on hybrid buses. This can be configured to allow 'hard zones', where buses certain vehicles/taxis must always run in electric mode and 'soft zones' where they run in electric mode if there is enough battery charge remaining.

Geofencing will enable us to target high pollution, difficult to treat areas. Where blanket London-wide measures are insufficient to tackle these special cases geofencing will allow us to manage pollution more effectively.

The technology could also be used in LENs and other roads with high concentrations of NO_x and high levels of pedestrian activity such as Oxford Street. However, this will require the roll out of buses with extended zero emission range. In addition there are carbon dioxide emission benefits, and it would enable better control of emission output by buses.

The technology could also extend to taxis although the lack of planned routeing introduces difficulties in knowing when charging will be needed. Further research into the feasibility of taxis using geofencing is needed.

- 5.55 The impact of LENs will depend on their area, the main cause of pollution, and the extent of the measures selected for that neighbourhood. Most LENs are likely to need to be promoted and developed by boroughs. Many of the suggested measures described in the table would not have a significant individual impact on emissions (although there are many other benefits associated with measures such as public realm improvements), but collectively they could have more significant local impacts. In reality, measures such as

geofencing and traffic reduction are more likely to have a significant impact on local emissions. However, care will need to be taken to ensure the scheme does not simply displace traffic onto surrounding roads, creating problems elsewhere.

- 5.56 Caution must be taken when estimating the contribution that LENs could have on the overall reduction in London-wide emissions, but it could be up to a one per cent reduction in emissions. LENs are, however, primarily about addressing areas with particularly high emissions coupled with population exposure. They could play a vital role in dealing with the remaining problem locations following the implementation of London-wide measures, such as tightening LEZ.



6 Roadmap to compliance

6.1 Although significant progress has been made in improving air quality more needs to be done if London is to have the air quality it deserves, meet its climate change obligations and meet EU legal limits for nitrogen dioxide (NO₂).

6.2 The Department for Environment, Food and Rural Affairs (Defra) recently stated²¹ that London, Birmingham and Leeds would not be compliant with EU limit values until after 2030, based on business as usual. Defra's assessment does not take account of any possible further measures, such as ULEZ, as described in this Roadmap. These are essentially about bringing forward the date of achieving compliance by accelerating the turnover of London's total vehicle fleet through incentives and regulation as well as reducing traffic in problem locations. Bringing forward the compliance date would have significant cost implications which are not currently provided for.

London's NO₂ compliance targets

6.3 We have made some preliminary calculations regarding what percentage of NO_x emission reductions would be required to achieve limit value compliance by 2020 and 2025. These calculations will be refined using more detailed modelling work. The table below shows the approximate percentage reductions required in 2020 and 2025 for 99 per cent and 100 per cent compliance in terms of roads located in central, inner and outer London. Less reduction is required in 2025, compared to 2020 because of the natural turnover and improvements to the total vehicle fleet composition.

	Central	Inner	Outer
99% compliance in 2020	50%	40%	20%
100% compliance in 2020	70%	65%	60%
99% compliance in 2025	35%	15%	5%
100% compliance in 2025	60%	50%	40%

Table 6.1: Estimated preliminary percentage reduction in NO_x to achieve compliance with EU legal limits on 99% and 100% of the road network in 2020 and 2025

6.4 The greatest reductions will be required in central London where emissions are currently highest. The most effective way of achieving compliance will be a combination of blanket measures that achieve compliance on 99 per cent of the road network and then some targeted measures on the remaining one per cent of the road network that is currently the most problematic. These targeted measures are likely to require strong traffic reduction as the only remaining option for achieving NO₂ limit value compliance.

²¹ Defra, 2014 <http://goo.gl/rPLrd0>

Measures by 2020

- 6.5 Using the measures in the previous chapter, we have compiled an ambitious package which, by 2020, could potentially bring London towards NO₂ limit value compliance. Reaching full compliance will only be possible if further action is taken at the national and European level, including the use of enhanced financial incentives, national scrappage schemes and measures to support more sustainable forms of transport.
- 6.6 The headline scheme is the proposed Ultra Low Emission Zone to be implemented in central London (Measure 1) by 2020. ULEZ alone could achieve as much as a 51 per cent reduction in NO_x in central London, as well as knock on impacts to inner and outer London (reducing NO_x by 16 per cent and 10 per cent in those areas respectively). Roughly this takes us two-thirds of the way to compliance with EU legal limits for NO₂ in central London.
- 6.7 By 2020, further tightening of the Low Emission Zone (Measure 2) could be delivered. However, this measure can only be taken so far by 2020 because of the lack of available vehicles in the market and increasing cost of compliance. Therefore any tightening of LEZ in the short term could only be relatively modest so it is better to consider tightening LEZ for 2025, when much tougher emissions standards can be achieved.
- 6.8 Traffic management (Measure 3), such as using new technology, on the scale of what might be possible by 2020, along with publicity campaigns to use more ultra low emission vehicles, would reduce NO_x further by one to two per cent across London, (assuming further spending by central Government by 2020). However, this is still an important additional reduction.
- 6.9 Local measures, such as those outlined in Measure 10 (Developing Low Emission Neighbourhoods) would tackle specific problem areas by 2020, with some of the more stringent aspects, such as mini ULEZ enforcement areas, geofencing, or area wide reconfiguration of traffic management, being developed for 2025.
- 6.10 This ambitious package for 2020 (set out in the table below) would amount to a 54 per cent reduction in NO_x in central London (mostly owing to ULEZ); 28 per cent in inner London and 20 per cent in outer London. It is considered ambitious but achievable, provided additional funding is made available by central Government. It is also estimated it will reduce PM₁₀ by 66 per cent in central London, largely due to ULEZ, and 25 per cent and 12 per cent in inner and central London respectively.
- 6.11 The package is estimated to reduce CO₂ emissions by 17 per cent from transport in central London if the electricity supply used to power the Overground and Underground network is included, with this contributing to the Mayor's commitment to reduce London's transport CO₂ emissions by approximately 48 per cent below 1990 levels by 2025.

Summary of ambitious possible measures in 2020	Per cent NO _x reduction		
	Central	Inner	Outer
Measure 1: ULEZ	51%	16%	10%
Measure 2: Future LEZ – tightening to Euro IV standard for both NO _x and PM, for HGVs and coaches	0%	1%	0%
Measure 3: Making traffic management and regulation smarter – small scale traffic management measures	<i>Savings from Measure 3 are captured in Measure 4 below.</i>		
Measure 4: Helping Londoners tackle air pollution and climate change – including behaviour change campaigns, no vehicle idling regulation and mass publicity	1%	2%	2%
Measure 5: Driving the uptake of low emission vehicles – significantly reducing cost of ownership to make LEVs more attractive and providing further infrastructure where required	1%	2%	2%
Measure 6: Cleaner electricity (action directed at reducing CO ₂ emissions)	<i>NO_x not applicable for Measure 6. Savings from Measures 7 through to 9 are captured in measures 1 and 2 above.</i>		
Measure 7: Transforming London's bus fleet – ULEZ standards for all buses in central London			
Measure 8: Delivering a zero emissions taxi fleet			
Measure 9: Transforming London's public and private fleets – Promoting ULEZ standards for all public fleets across Greater London			
Measure 10: Low Emission Neighbourhoods – targeted area-based measures including local ULEZ enforcement and geofencing for zero emissions capable buses and taxis	1%	1%	1%
TOTAL IMPACT:	54%	28%	20%
<i>Required for 99% compliance in 2020 by road length:</i>	50%	40%	20%
<i>Required for 100% compliance in 2020 by road length:</i>	70%	65%	60%

Table 6.2: Summary of ambitious possible measures in 2020

Action by Government and the European Commission

- 6.12 On 29 July 2014 the Mayor called on Government and the European Commission to match his bold action and imagination and put in place a package of stand alone and supporting measures which will bridge the remaining compliance gap in London by 2020.
- 6.13 It is clear from the analysis above that the Mayor alone cannot achieve compliance using the options available to him. Action is required at all levels of Government. In recent years

the efficacy of financial incentives has been demonstrated and it is important that further support is provided at the European level to accelerate the uptake of new Euro VI/6 vehicles. Recognising the particular challenge faced at the city level, a new Urban Clean Air Fund should be established. This would support additional measures, pilots and the exchange of best practice to tackle air pollution by the significant increase in the purchase of diesel cars as a result of company car tax benefits and through vehicle excise duty discounts. A national scrappage scheme for diesel vehicles is now needed as a priority in order to compensate people who have bought polluting diesel vehicles in good faith as well as to drive forward air quality improvements. Further national support to promote more sustainable modes of transport, such as the Mayor has done with his near £1bn investment in cycling, is also needed.

- 6.14 The European Commission also has a crucial role to play. It is the guardian of the Euro engine emission standards, which are central to effective local, regional and national policies to address emissions. An appropriate and effective testing regime for Euro VI/6 must be introduced as soon as possible, and no later than 2017. Further harmonisation between vehicle standards for carbon and air pollutants will ensure that the mistakes of dieselisation are not repeated.
- 6.15 Recognising the efforts that many national, regional and local governments have taken to incentivise the uptake of Euro 4 and 5, it is important that further support is provided at the European level to accelerate the uptake of new Euro VI/6 vehicles. Recognising the particular challenge faced at the city level, a new national Urban Clean Air Fund should be established to support additional measures, pilots and the exchange of best practice to tackle air pollution.



Compliance by 2025

- 6.16 The Mayor has also considered what steps he could take, using the options within his control, to deliver full compliance in London by 2025. This package would require considerable financial support from central Government to be viable. With significant sustained investment and commitment by central Government and the EU, a roadmap for NO₂ limit value compliance by 2025 is set out in Table 6.1 below. By 2025 the percentage of NO_x reduction to achieve compliance is lower than for 2020. Further work will be required to understand the feasibility and affordability of these measures.

Summary of measures required for 99% compliance in 2025	Per cent NO _x reduction		
	Central	Inner	Outer
Measure 1: ULEZ - implemented in 2020, with a tightening of the standard to near zero for cars by 2025 ²²	34%	8%	8%
Measure 2: Future LEZ - expanding ULEZ standards across Greater London for all modes (overlap with Action 1 in central London)	0%	11%	11%
Measure 3: Making traffic management and regulation smarter - including changing the way road use is priced	10%	20%	20%
Measure 4: Helping Londoners tackle air pollution and climate change - including behaviour change campaigns, no vehicle idling regulation and mass publicity	1%	2%	2%
Measure 5: Driving the uptake of low emission vehicles - significantly reducing cost of ownership to make LEVs more attractive and providing further infrastructure where required	7%	12%	13%
Measure 6: Cleaner electricity (action directed at reducing CO ₂ emissions)	<i>NO_x not applicable for Measure 6 and savings from Measures 7 through to 9 are captured in measures 1 and 2 above.</i>		
Measure 7: Transforming London's bus fleet - ULEZ standards for all buses in Greater London			
Measure 8: Delivering a zero emissions taxi fleet			
Measure 9: Transforming London's public and private fleets - Promoting ULEZ standards for all public fleets across Greater London			
Measure 10: Low Emission Neighbourhoods - targeted area-based measured including local ULEZ enforcement and geofencing for zero emissions capable buses and taxis	1%	1%	1%
TOTAL IMPACT:	51%	53%	54%
<i>Required for 99% compliance by road length in 2025:</i>	<i>35%</i>	<i>15%</i>	<i>5%</i>
<i>Required for 100% compliance by road length in 2025:</i>	<i>60%</i>	<i>50%</i>	<i>40%</i>

Table 6.3: Summary of measures required for 99% compliance in 2025

²² Note the NO_x savings of ULEZ shown in the table are less in 2025, compared to 2020, due to the natural turnover of vehicles five years later, although the scheme would be implemented in 2020 and tightened in 2025 with a standard for new zero cars.

- 6.17 This package would achieve 99 per cent compliance by road length in 2025 with measures that bring about blanket reductions. Targeted measures (such as the Low Emission Neighbourhoods) would be used to address the remaining one per cent of the road network. The package could also reduce exhaust PM by 60 per cent in central London and 54 per cent elsewhere, and CO₂ emissions by 45 per cent in London.

Next steps

- 6.18 The publication of TERM is not intended to be a final say on the roadmap. It is intended to be the start of a discussion with key stakeholders on how we can deliver the measures outlined here and what more can be done. We wish to work with stakeholders to develop the ideas maximising action wherever possible. We will assess the impacts and costs of proposals and continue to seek ways to fund their implementation. We will explore funding opportunities with central Government and financial support could be sought from private sector companies such as the Green Investment Bank and the European Investment Bank.
- 6.19 The first measure, implementing the proposed ULEZ in central London, has already undergone substantial detailed feasibility work and stakeholder engagement. It is intended that the detailed proposals will be consulted on at the end of October 2014, with a view to seeking the Mayor's confirmation of the proposal by Easter 2015. This would give people and businesses five years notice before the scheme starts, allowing time to influence decision-making in vehicle purchases in time for the implementation date.
- 6.20 TfL, the GLA and others must continue to lobby central Government and the EU to help encourage the development of new technology, to promote ways of reducing emissions and to send clear messages by introducing new legislation and standards. Above all, we must lobby them to provide additional funding, to help maintain the momentum towards improving emissions and achieving compliance with EU limit values for NO₂ as soon as possible.



Appendix A: Further detail on what we are already doing

Promoting shift towards more sustainable travel choices

- A.1 **Land use planning:** The London Plan states the Mayor supports developments that are located in areas of high public transport accessibility and capacity and allows for use of planning obligations to improve accessibility in areas where this is lacking. Greater density and mixed use development also helps to promote lower emission modes of transport.
- The London Plan provides maximum car parking standards and minimum cycle parking standards
 - Some boroughs have implemented emissions related resident permit charges, based on CO₂ emissions.
 - The GLA has drafted supplementary planning guidance on sustainable design and construction and the control of dust and emissions during construction and demolition
 - Opportunity Area Planning Frameworks (OAPFs) are planning documents which are being written to support the sustainable development of key growth areas in London, such as the Battersea Nine Elms area
 - Depending on the level of accessibility of the specific sites, car-free developments (which can be encouraged via borough Local Development Frameworks), or very restricted parking allowances can reduce the proportion of car travel
- A.2 **New Rail infrastructure:** Rail infrastructure has been upgraded to provide additional capacity and new connections in order to encourage modal shift. Several rail projects have been completed since the publication of the Mayor's Air Quality Strategy and his Climate Change Mitigation and Energy Strategy. For example, the East London Line Extension Phase 1 to Highbury and Islington (completed 2011), Phase 2 extension from Surrey Quays to Clapham Junction (completed 2012), and line upgrades on the Victoria and Jubilee Lines to increase the frequency of trains on these lines. On the DLR, the extension from Stratford International to Canning Town was completed in 2011.
- A.3 **Bus stop accessibility:** Being able to make bus journeys easily and comfortably is important to all bus passengers. London's bus fleet has been 100 per cent accessible for many years. Being able to get on and off the bus easily, making full use of this modern, accessible bus fleet, is just as important and helps ensure the bus is available as a transport option to all Londoners.
- A.4 **Walking Improvements:** We and the London boroughs have introduced and continue to introduce a range of measures to encourage more walking trips; these being centred on the themes of infrastructure, information and promotion.
- A.5 Across the TLRN and borough Roads, the Mayor's Better Streets programme and our key walking route programme are delivering substantial pedestrian and urban realm enhancements to make walking more accessible and convenient while increasing levels of walking. Pedestrian countdown timers at traffic signals have been trialled and have proved popular with

pedestrians in reducing uncertainty around crossings. These innovative signals are now being rolled out across London at 200 identified sites.

- A.6 The Legible London wayfinding system, designed to encourage walking with clear and relevant directional information and walking times to key destinations is expanding across the Capital
- A.7 We have invested over £9m in the Walk London Network of seven walking routes that span London. These routes provide high quality walking experiences for everyday journeys such as to work, school, or the shops, as well as opportunities to simply walk for fun and relaxation.
- A.8 **Cycling improvements:** We and the Mayor have invested heavily in cycling. The Barclays Cycle Hire Scheme was launched to members in July 2010 and to general users in December 2010. It was expanded in March 2012 to East London and Shepherd's Bush with 8,000 bicycles. Since its launch there have been over 30 million hires.
- A.9 Cycle Superhighways were also launched in summer 2010. These aim to provide fast, direct safe routes for cyclists from outer London to central London. Investment has continued in developing cycling infrastructure on the TLRN and funding the provision of cycling on borough roads and in parks and open spaces through the LIP programme.
- A.10 Cycle parking has also been expanded across London with a rolling programme to deliver on street cycle parking and secure parking at rail interchanges. We have also offered free cycle stands for employers to install on their premises to encourage and facilitate the growth in cycling to work. The mayor launched his Cycling Vision in 2013 to build on this work and further encourage modal shift.
- A.11 **Smarter travel, car clubs and travel demand management:** We and the boroughs continue to engage with schools and businesses through smarter travel planning to promote less polluting forms of transport. TfL STARS[1] (Sustainable Travel: Active, Responsible, Safe) is the school travel plan accreditation programme that rewards schools for adopting safer and more active travel behaviour, as well as reducing car use as part of the school journey. Over 40 per cent of London's schools are accredited. To support schools in their delivery of initiatives, STARS offers a range of ready to use campaign and activity toolkits including Park & Stride, Biker's Breakfasts, cycle training, walking incentive schemes and independent travel skills training.
- A.12 We ran a 'Cleaner Air 4 Schools' pilot with three primary schools in the City of Westminster to raise awareness of air pollution in and around their schools and to discourage engine idling. This resulted in a GLA funded toolkit, schools can use to educate their communities about reducing their impact and to protect themselves from the health risks caused by pollution. This is now used as part of the STARS scheme.
- A.13 Schools that are part of the STARS scheme have seen an average eight per cent reduction in car use as part of the school journey. The scheme allows us to monitor this activity and the modes of travel to school by pupils and staff and the initiatives delivered.
- A.14 We engage with businesses to promote sustainable travel as well. Using part of the £5m awarded by the Department for Transport's Clean Air Fund, we launched an engagement programme with businesses in 2011 near PM₁₀ action areas to raise awareness of air quality

issues. Measures included promotion of electric pool bikes, promoting delivery and servicing plans, publishing best practice guidance for businesses promoting measures to improve air quality, providing electric vehicle charging points and tools to encourage more walking trips..

- A.15 We are also helping the London boroughs to promote car clubs. Over £1m was allocated in 2011/12 and 2012/13 to 23 London boroughs to deliver additional infrastructure for car clubs. On average car club members reduce their mileage by up to 57 per cent. Recently, electric car clubs have been established which not only encourages sustainable travel but also the use of low emission vehicles.
- A.16 In October 2013, the first all electric car club was launched in East London, in the London Borough of Tower Hamlets and in partnership with social landlord Poplar HARCA.
- A.17 The success of the Travel Demand Management campaign during the London 2012 Olympics shows the benefits smarter travel campaigns can have in encouraging modal shift with reductions in traffic of up to ten percent for some central London locations. The business engagement programme developed for the Games is ongoing and can potentially be used to further reduce both levels of traffic and emissions from traffic.
- A.18 **Smarter freight:** We are also promoting modal shift for freight. The London Plan has safeguarded wharves on the River Thames for waterborne freight and is continuing to safeguard sites suitable for rail freight handling. Working with partners we are aiming to further improve awareness of the potential to use the canal network.
- A.19 The London Borough of Camden launched a cycle freight trial that used a micro-consolidation centre and a fleet of electric cargocycles to deliver small packages around central London. We are continuing to promote construction and logistics plans to ensure new developments reduce the emissions impact of freight trips. We are also promoting delivery and servicing plans which aim to ensure freight movements associated with a building are as efficient as possible.
- A.20 The Fleet Operators Recognition Scheme (FORS) is a funded, voluntary certification scheme aimed at ensuring fleet operators work lawfully and to best practice by meeting the FORS standard. Subsidised by us, it provides techniques, toolkits, workshops and best practice examples to help and guide the freight industry, promoting safe, green and efficient practice. Approximately 40 per cent of the industry is accredited. Operators benefit from knowledge sharing and advice on how to improve efficiency as well as discounts on equipment and training.
- A.21 Operators have to meet standards in safety, legal compliance, efficiency and environmental performance in order to achieve accreditation at the Bronze Standard. Silver and Gold operators have more stringent criteria, including requirements to monitor and reduce fuel consumption and emissions and appoint environmental champions.
- A.22 We are considering developing a green fleet standard based on the environmental elements of the FORS model. Operators would be required to meet specific environmental standards for

vehicles and driver training. Special green fleet branding could be used to promote the message.

- A.23 We have previously used procurement as a lever to reduce emissions from freight. Several contracts that involve delivery to TfL premises or sites specify that deliveries must be undertaken by operators who are members of, or working towards membership of FORS. Encouraging boroughs and other large organisations to adopt these principles could further increase the uptake of FORS among the freight industry and bring about the associated benefits. Specifying operators must meet the new Green Fleet standards could potentially promote the further uptake of Low Emission Vehicles.
- A.24 **Congestion Charge Zone:** This zone is another key driver for modal shift in London. While the primary objective is reduction in congestion, there are associated benefits in reducing emissions by reducing overall motorised transport within the zone and encouraging a shift to less polluting forms of transport.

Environmentally efficient use of existing vehicles and technology

- A.25 **Smarter driving:** We are promoting eco-driving as a way to reduce vehicular emissions. Bus drivers are required to undertake an eco-driving course as part of the BTEC. Bus Operators are also providing eco-driver training and monitoring performance using telematics systems. An average fuel saving of 4.8 percent across operators was reported through application of eco-driving techniques, equating to a saving of 30,000 tonnes of CO₂. Monitoring found that incentives for drivers and provision of feedback could potentially produce further reductions in CO₂.
- A.26 All newly licensed taxi drivers are required to pass the Driver Standards Agency (DSA) taxi driving test which includes an eco-driving module. PHV operators are being encouraged to provide training for their drivers. We are encouraging eco-driving for commercial vehicle drivers and fleet operators through FORS. Marketing campaigns aimed at private car drivers have also been rolled out to encourage eco-driving.
- A.27 The financial benefits of eco-driving to the driver through reduced fuel consumption meant this can be heavily promoted and taken up by private and fleet drivers.
- A.28 In partnership with the CPT, we are running professional development courses for coach drivers, which include best practice on eco-driving and reducing idling. This will allow smaller operators without the access to in house training to enjoy the benefits of driver training.
- A.29 **Traffic signal optimisation:** Congestion on the road network can cause additional problems with emissions. Vehicles travelling slowly in stop start conditions emit more CO₂ and air pollutants. Recent work has taken place to improve the efficiency of the road network. The use of Split Cycle and Offset Optimisation Technique (SCOOT) for traffic signals has been rolled out to improve journey time reliability. As of 2013, around 3,000 of the 6,000 traffic signal sites operate SCOOT, leading to a reduction in delays of around 12 per cent at local junctions.

- A.30 **Lane rental for roadworks:** Lane rental charges for undertaking roadworks at the busiest road locations have been introduced. This has encouraged utilities companies to undertake more works outside of the busy peak periods, helping to reduce congestion and thus reduce emissions.
- A.31 **Reduced engine idling:** A No Idling campaign was launched in early 2012 including poster and radio adverts targeted at car drivers and a more targeted approach for engaging with professional drivers. Results indicated a five percent fall in engine idling overall at monitored locations, with larger reductions in the taxi sector.
- A.32 **Low carbon stations initiative:** London Underground is implementing several measures to reduce the energy consumption and thus the carbon emissions of TfL assets. Leicester Square and Sloane Square stations were chosen for trials of new technology to reduce energy and thus CO₂. Initiatives have included use of low energy lighting, centralised heat recovery systems and automated lighting systems designed to switch off when not needed. Initial results showed a 25 per cent reduction in energy usage at Leicester Square and associated carbon savings.
- A.33 **Out of hours delivery:** In partnership with the industry through the London Freight forum, out of hours deliveries are being trialled helping to reduce exposure to pollutants and offering potential reductions in fuel consumption of three to six per cent and in overall emissions as deliveries become more efficient.

Environmentally efficient use of existing vehicles and technology

- A.34 **Low Emission Zone:** The London Low Emission Zone (LEZ) is one of the key drivers in encouraging a shift to lower emitting vehicles, especially regarding local air quality pollutants. LEZ was launched in February 2008 and required lorries over 12 tonnes entering the zone to be of Euro III standard for particulate matter. This was expanded to cover buses, coaches and lorries over 3.5 tonnes in July 2008. In 2012, the scheme was expanded to cover larger vans and minibuses, which were required to meet a Euro 3 standard for PM. Standards were also tightened for HGVs buses and coaches with a new requirement to meet a Euro IV standard for PM.
- A.35 **The Ultra Low Emission Discount:** The congestion charging zone also encourages a shift to lower emission vehicles through the Ultra Low Emission Discount. Electric vehicles or cars and vans emitting less than 75g of CO₂ per km and meeting Euro 5 standards qualify for a 100 per cent discount from the Congestion Charge. This replaced the earlier Electric Vehicle Discount and Greener Vehicle Discount, which had less stringent requirements of less than 100g of CO₂ per km and had the unintended effect of encouraging greater numbers of diesel vehicles.
- A.36 **Zero emission vehicles:** There have been several measures to promote the use of zero emission vehicles, particularly electric and hydrogen vehicles and ensuring that London is a global centre for the development, deployment and use of fuel cell technologies and hydrogen as an energy source. Measures taken so far to realise this include:
- The Source London network of over 1,400 electric charging points for vehicles

- The Plugged in Fleets Initiative with the Energy Savings Trust to provide free advice to businesses who could introduce EVs into their fleets
- Ongoing engagement with partners, businesses and stakeholders, for example through the Mayor's Electric 20 group and Low Emission Vehicle Partnership
- Planning to increase the number of EVs in our own fleet to 120, as part of the Mayor's aspiration to have 1,000 low emission vehicles in the GLA fleet
- Commissioning a feasibility study into rapid charging infrastructure for taxi and private hire vehicle operators, to determine suitable locations and understand the operational viability of such a scheme
- The launch of hydrogen fuelling stations and demonstrator projects as part of the HyFive and HyTEC projects

- A.37 **Freight schemes:** We are currently involved in a number of European funded projects to share best practice and support the development of vehicle technology and freight solutions across the EU. These projects include ICVUE, FREVUE, which involves supporting use of electric freight vehicles in urban Europe; CAPIRE, which involves developing roadmaps to foster road transport electrification, and LaMiLo, which will develop innovative solutions to make Last Mile Logistics operations more effective, sustainable and easier for private companies and end users.
- A.38 **Cleaner buses:** There are several initiatives to reduce the emissions of our bus fleet through the use of lower emission vehicles which have been summarised below:
- A.39 **Particulate filters:** We installed diesel particulate filters on 120 buses on six routes running through the PM₁₀ priority areas. This led to a 77 per cent reduction in PM emissions per bus.
- A.40 **Selective Catalytic reduction:** We are introducing NO_x abatement equipment on older Euro III standard buses. Priority has been given to buses operating in Air Quality Focus Areas with high levels of NO_x, and long contract life to maximise the benefits. Reductions of around 88 per cent on standard EURO III emissions have been achieved where SCR has been applied.
- A.41 **Hybrid buses:** Both the Mayor's Air Quality Strategy and Climate Change Mitigation and Energy Strategy committed TfL to an expansion in the use of hybrid buses with a target of 300 hybrids by the end of 2012, and to work with manufacturers and operators to reduce costs of new low carbon buses to maximise the number entering service in London after 2012. At present there are around 600 hybrid buses operating in the city with 1,700 set to operate by 2016, including New Routemasters
- A.42 **Hydrogen buses:** Hydrogen buses have also been trialled in London with hydrogen fuel cell buses launched on route RV1 as a demonstrator. In Winter 2013 operation of the whole of Route RV1 was converted to hydrogen fuel cell vehicles, with a total of eight buses on street.
- A.43 **Electric buses:** As part of the Green Bus Fund round in 2013, we agreed to purchase four electric buses for operation in spring 2014. Two electric single-decker buses entered service in winter 2013 on central London Routes 507 and 521 as a trial and demonstration project and

will help inform future development and roll out of the vehicles where operationally suitable. We have also launched successful bids for trials of Plug in Hybrid or Range Extended Hybrid buses and for an additional two smaller electric buses for further trials in 2014.

- A.44 **Biodiesel:** We have tested biodiesel sourced from used cooking oils on the Dial-a-ride fleet and it is currently being trialled on 120 buses over 10 routes at the Barking depot.
- A.45 **Cleaner taxis and PHVs:** A trial of five taxis powered by hydrogen fuel cells was launched during the Olympics as part of the Hydrogen Transport in European Cities (HyTEC) project, further promoting the uptake of zero emission vehicles in the industry. The trials will continue in 2013 and 2014.
- A.46 Age and emission limits have been introduced for taxis and PHVs. A 15 year age limit for taxis has been introduced and all newly licensed taxis must meet the Euro V emissions standards as a minimum. A 10 year age limit for PHVs has been introduced and all newly licensed vehicles must be no older than five years and meet the Euro IV emissions standards as a minimum.
- A.47 Support continues to be provided to existing and potential taxi vehicle manufacturers to encourage them to develop low emission vehicles that can be used as taxis in London.
- A.48 **Powered Two Wheelers:** We commissioned a study 'Evaluation of Journey Time and Emissions of P2Ws in Bus Lanes' in 2011, which conclude petrol cars of a comparable size to P2Ws emit on average two to six times more CO₂ than P2W using bus lanes, and 1.5 to 6.5 times more NO_x than P2W using bus lanes. This contributed towards the case for allowing P2W to use bus lanes.
- A.49 **River Services:** As part of the River Services Concordat, we are working with operators to improve the energy efficiency of the river fleet including the use of ultra low sulphur diesel in Thames Clipper services.

Tackling local air pollution focus areas

- A.50 **Clean Air Fund:** Through the Clean Air Fund several measures were implemented to reduce PM emissions. We are promoting green walls to help trap particulate in areas of high concentration and have created our own on Edgware Road tube station. Plants can act as a sink for NO₂, as they absorb it through their stomata to aid their growth and development. The benefits of green walls through the seasons, with variable meteorological conditions and concentrations, are still not well understood, warranting further investigation to assess benefits and their cost-effectiveness.
- A.51 Dust suppressants were also trialled at construction and at roadside priority corridors for PM₁₀. It was found this can be effective in areas where there is high dust generating activity nearby, such as construction sites. With the GLA we have produced a cleaner air for schools toolkit, which suggests measures that can be undertaken by schools to reduce PM₁₀ and NO_x emissions from the school run, reduce exposure of children to NO_x and generally promote awareness of air quality issues to children as part of the curriculum.

- A.52 **Clear Zones:** The Clear Zones initiative was set up in 2001 and used partnership working between Central London Authorities to reduce congestion, air and noise pollution and improve the urban realm. A Clear Zone was identified in a number of boroughs, including Camden, Westminster and Tower Hamlets, where initiatives and schemes were concentrated to give spot treatment. Tower Hamlet's Clear Zone includes intensification of electric vehicle charging points, including a mini hub of charging points in a smaller area. Tower Hamlets also pledges to work with car clubs to offer electric vehicles for hire. A pilot scheme for installing paving that helps remove nitrogen dioxide (NO₂) from the atmosphere was also described.
- A.53 **Mayor's Air Quality Fund schemes:** The Mayor's Air Quality Fund will provide match funding for boroughs to deliver innovative air quality improvement projects. A number of area specific air quality schemes are emerging from London boroughs, many encouraged by the fund, which include:
- Green Zones and the Zero emissions network in the London Borough of Hackney
 - Barts Health NHS Trust Cleaner Air Project
 - London boroughs' Freight Consolidation Centres
 - Anti Idling campaign at Tower Bridge
 - Several school specific initiatives to educate on air quality
- A.54 **Airport surface access strategies and air quality strategies:** All London airports have surface access strategies to set out how they will encourage more sustainable access to their airports. London City Airport has a three year Air Quality Action Plan (to 2015). Heathrow also has an Air Quality Strategy, to specifically look at how it can reduce air pollutant emissions, such as reducing pollution from airside vehicles and aircraft, and encouraging more staff to take public transport to work. As part of its plans for expansion, Heathrow airport has proposed introducing a congestion charge. Along with the Mayor we are encouraging Heathrow to introduce additional measures to improve air quality, through encouraging early adoption of zero emission taxis and buses, and introducing emissions related charging for parking.
- A.55 **Access restrictions:** We have supported access restrictions in several locations in London, notably the Narrow Way in Hackney where access has been restricted to pedestrians and cyclists, and Venn St in Clapham which provides pedestrian only access at weekends. We are also backing plans by Camden to restrict vehicular access to Tottenham Court Road. We support boroughs making timed or permanent closures to through traffic in appropriate locations.

Appendix B: Glossary and acronyms

Air pollutants – Generic term for substances emitted that have adverse effects on humans and the ecosystem

CAF – Clean Air Fund: £5m of DfT funding in 2011 to introduce measures to tackle PM emissions

CO₂ – Carbon Dioxide. Principal greenhouse gas related to climate change

CCMES – Mayor's Climate Change Mitigation and Energy Strategy. Statutory document outlining the Mayoral plans to reduce CO₂ emissions and encourage renewable energy

DfT – Department for Transport. Central government department responsible for transport in England

DVLA – Driver and Vehicle Licensing Agency: Organisation of UK government responsible for keeping a database of drivers and vehicles

Euro Standards – Standards set by the European Union for maximum emissions of air pollutants for new vehicles sold within EU member states. Range from Euro I-6 for light vehicles, with 6 the most recent and Euro I – VI for heavy vehicles.

EV – Electric vehicle: Vehicle which uses electric motor for propulsion. Includes both pure electric vehicles that run solely from batteries and plug in hybrid electrics that have an attached petrol or diesel engine to power the battery engine

FORS – Fleet Operator Recognition Scheme: A TfL led scheme to promote best practice amongst freight and fleet operators.

Greenhouse Gas – Gases that absorb heat, contributing to climate change. The most significant of which is CO₂

LIP – Local Implementation Plan: Documents produced by London Boroughs outlining how they will implement the Mayor's Transport Strategy

LGV – Light Goods Vehicle: Commercial vehicle weighing <3.5T

LAEI – London Atmospheric Emissions Inventory. Database of emissions sources and information about rates of emissions for air pollutants emitted within and around the Greater London area.

LEZ – Londonwide Low Emission Zone: Charging zone across Greater London for vehicles that do not meet emissions standards for Particulate Matter

Limit Values – Legal maximum levels of atmospheric concentrations of air pollutants

HGV – Heavy Goods Vehicle: type of truck weighing >3.5T

MAQS – Mayor’s Air Quality Strategy. Statutory document outlining the mayors plan to reduce air pollution.

NO_x – Nitrogen oxides. A generic term for Nitrogen Dioxide (NO₂) and Nitrogen Monoxide (NO), which can form NO₂ in the atmosphere. Euro standards set limits for vehicles emissions of NO_x

NO₂ – Nitrogen Dioxide: A gas formed by combustion, identified as an air pollutant harmful to human health. The European limit values measure concentrations of NO₂ in the air.

OLEV – Office for Low Emission Vehicles. Cross governmental office set up to support the development of the low emission vehicle sector.

Particulate filter – An exhaust filter that traps PM

PHV – Private Hire Vehicle: Licensed vehicles that are available for hire on a pre-booked basis. Also known as minicabs.

PM – Particulate matter. A mixture of various solid and liquid particles of various chemical compositions suspended in the air.

PM₁₀ – Particulate matter <10 microns in diameter. Particulate matter that is harmful to human health and subject to EU limit values

PM_{2.5} – Particulate matter <2.5 microns in diameter: The smallest and most harmful form of Particulate matter. Also subject to EU limit values

Selective Catalytic Reduction – An exhaust retrofit system that reduces NO_x emissions from buses and HGVs

TLRN – Transport for London Road Network: A network of 580km of roads within Greater London which TfL has highway authority powers for.

ULEZ – Ultra Low Emission Zone : A package of measures in central London, including new standard for TfL buses, Taxis, Private Hire Vehicles and a proposed charging zone for all other types of vehicles within Central London for vehicles that do not meet set emission standards.

VED – Vehicle Excise Duty: Annual charge levied for vehicles to use the public highway. Banded according to engine size or CO₂ emissions.