



Ultra Low Emission Zone consultation

Supplementary information

October 2014

MAYOR OF LONDON



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About this document

To tackle poor air quality and reduce greenhouse gas emissions the Mayor and Transport for London (TfL) have developed a proposal for an Ultra Low Emission Zone (ULEZ) in central London. This would require all vehicles travelling in the zone to meet specified exhaust emissions standards.

This complements several other initiatives identified in the Mayor's Transport Strategy (MTS) to address challenges concerning air quality, CO₂ emissions, traffic congestion and public health. These are also set out in his Air Quality Strategy (MAQS, 2010) and the Climate Change and Energy Mitigation Strategy (CCMES, 2011). This year, TfL published a Transport Emissions Roadmap (TERM), a framework of proposed measures to be undertaken by all, including TfL, the boroughs and the Government, to reduce harmful emissions of pollutants and meet CO₂ targets.

In the past decade, TfL has delivered a greener bus fleet, increased public transport patronage, and enabled a huge increase in cycling. The Londonwide Low Emission Zone (LEZ) has been very successful in reducing air pollutant emissions from heavy vehicles. These and other initiatives have improved London's air quality but the challenge of meeting legal limits for one particular air pollutant, Nitrogen Dioxide (NO₂), remains.

Last year, the Mayor's Roads Task Force announced its vision to support a healthier city and reduce emissions from London's road network. This included the ambition for an 'ultra-low emissions environment'¹ in central London. In this context TfL has developed the ULEZ proposal. The ULEZ is defined as the area of central London covered by the Congestion Charge Zone where air pollution is particularly bad and where it can be tackled most effectively.

This document outlines the recommended ULEZ proposal taken forward for public consultation, the option development process and the potential impact of the proposals on emissions, air quality and cost to vehicle owners.

¹ Roads Task Force Executive Summary, p12

Structure of this document

This document is in three parts. The first part provides a summary description of the proposal and the rationale for addressing road transport emissions in London in order to improve air quality and public health. It introduces the three elements of the proposal: new exhaust emission standards in central London; changes to taxi and PHV licensing and the procurement strategy for TfL buses.

Part 2 contains detailed information on the development of potential options and how these were assessed in order to reach the proposal for consultation. It describes in detail the options for reducing emissions from each vehicle type and the effects of changing the parameters of the scheme. In conclusion, Part 3 sets out the costs, likely impacts and next steps for the scheme. A glossary for the terms used in this document is available in the appendices, as is further information about the scheme. There is an 'at-a-glance' summary infographic of the ULEZ proposal at Appendix 7.

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Part 1: Introduction and background

1. Description of the ULEZ proposal

1.1. Introduction and objectives

London's air quality has improved significantly in recent years and is now considered compliant for all but one air pollutant for which the European Union has set legal limits. This pollutant is nitrogen dioxide (NO₂), which has impacts on public health. An equivalent of 4,300 deaths in London is attributed to air quality related illness. The Capital also faces challenging targets to mitigate the effects of climate change.

This means further action is needed to reduce air pollutant and carbon dioxide (CO₂) emissions from transport to improve quality of life and public health. In recognition of this, the Mayor and Transport for London (TfL) have developed a proposal for an Ultra Low Emission Zone (ULEZ) in central London.

The ULEZ would require all vehicles driving in central London to meet new exhaust emissions standards (ULEZ standards). The ULEZ would take effect from 7 September 2020, and apply 24 hours a day, 7 days a week. A vehicle that does not meet the ULEZ standards could still be driven in central London but a daily charge would have to have been paid to do so.

The ULEZ would include additional requirements for TfL buses, taxis (black cabs) and private hire vehicles (PHVs):

- A requirement that all taxis and new PHVs presented for licensing from 1 January 2018 would need to be zero emission capable²;
- A reduction in the age limit for all non zero emission capable taxis from 7 September 2020 from 15 to 10 years (irrespective of date of licensing); and
- Investment in the TfL bus fleet so that all double deck buses operating in central London will be hybrid and all single deck buses will be zero emission (at tailpipe) by September 2020.

² See sections 13.2 and 14.2 for a definition of zero emission capable

The objectives of the ULEZ are as follows:

- **Reduce air pollutant emissions from road transport**, particularly those with greatest health impacts, to support Mayoral strategies and contribute to achieving compliance with EU limit values (see section 2.4)
- **Reduce CO₂ emissions from road transport**, to support Mayoral strategies and contribute to a London-wide reduction
- **Promote sustainable travel and stimulate the low emission vehicle economy**, by increasing the proportion of low emission vehicles in London

A public and stakeholder consultation on the proposal runs from 27 October 2014 to 9 January 2015.

1.2. The ULEZ geographical area

It is proposed the ULEZ will be the same geographical area and within the same boundaries as the central London Congestion Charge (CC) (Figure 2). This covers the area where air pollution levels are consistently the highest in London and where people experience the greatest exposure to them. As can be seen in Figure 1 the background concentrations in central London are consistently above the EU limit value of 40 $\mu\text{g}/\text{m}^3$ and 63 per cent of the population live in areas of NO₂ exceedence.

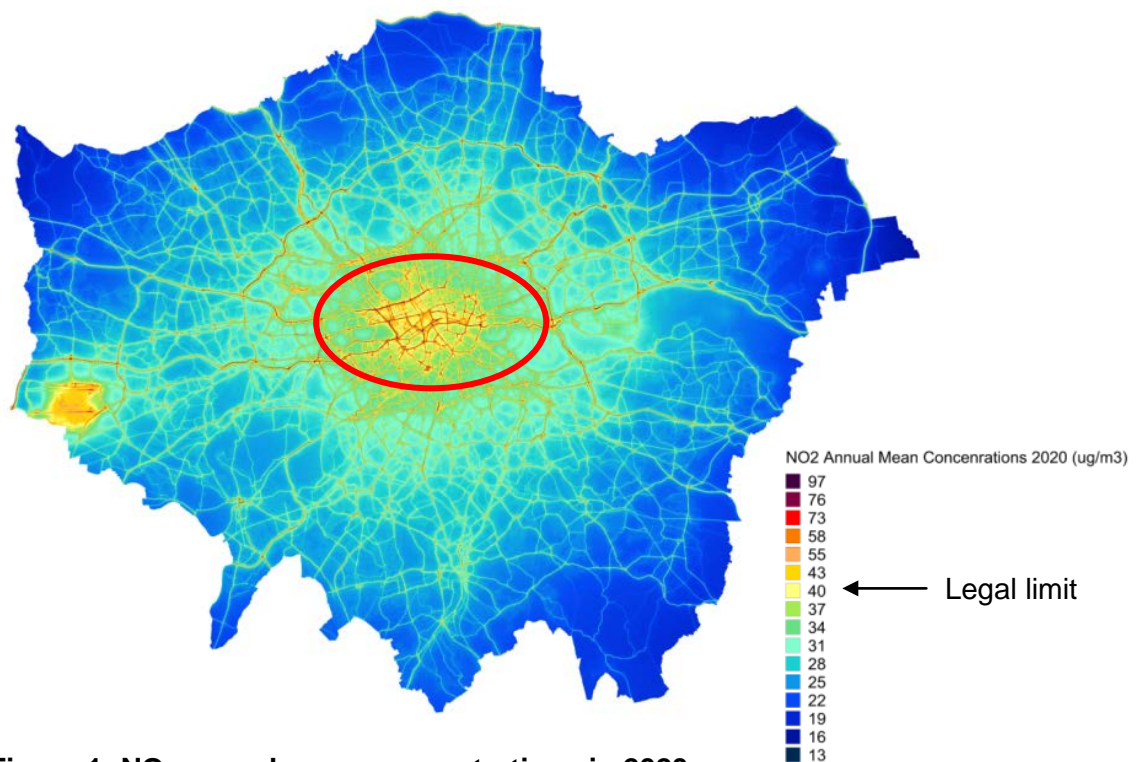


Figure 1: NO₂ annual mean concentrations in 2020

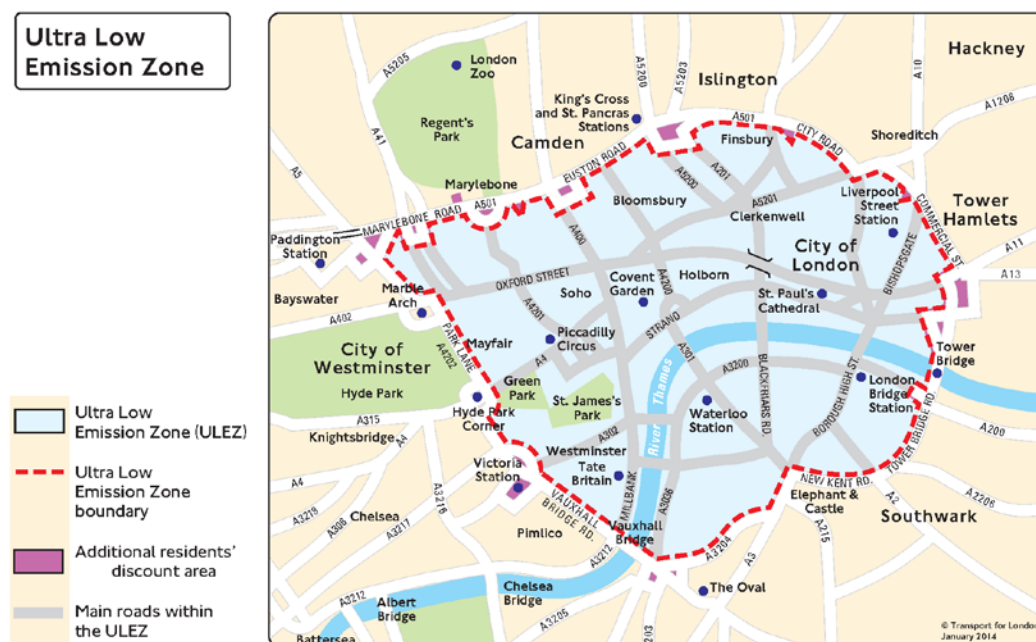


Figure 2: Proposed Ultra Low Emission Zone using existing Congestion Charging zone boundary

It is recognised that other parts of London experience poor air quality and have areas which exceed legal limits for NO₂. TfL has recently published its Transport Emissions Roadmap (TERM), which sets out a range of other measures separate from ULEZ which could reduce emissions, protect public health and help London to achieve compliance with legal limits. Funding is also available to London boroughs³ to help them explore options to reduce emissions at local air quality hotspots, develop low emission neighbourhoods or take forward other policy measures to improve air quality.

Central London only is the area with the greatest exposure to poor air quality and the area in which road transport emissions may be most effectively tackled. As described later in this chapter, central London also has the advantage of already being established and understood for a road user charging scheme owing to the Congestion Charge, and much of the infrastructure is already in place. In this way costs are managed and users would find the zone easier to understand than a different ULEZ boundary.

³ For example from the Mayor's Air Quality Fund and Local Implementation Plan (LIP) funding

That aside, the ULEZ will have benefits across the whole of London. It will not only reduce emissions in the ULEZ area but also reduce them in inner and outer London (where the number of people exposed to NO₂ exceedence will be halved in inner London and reduced by over two fifths in outer London).

1.3. Proposed ULEZ standards

The ULEZ will require all vehicles driving in central London to meet new exhaust emissions standards (ULEZ standards). These are proposed to reflect vehicle size, fuel and contribution to emissions on an individual basis.

It is proposed the ULEZ standards would be based on 'Euro standards', which are used in the Londonwide LEZ. These are European standards that define the limits for exhaust emissions for new vehicles sold in EU member states. From specified dates onwards, vehicle manufacturers may only sell new vehicles that comply with these standards. Table 1 sets out the proposed minimum Euro standards for different vehicle types and the mandatory date from which newly sold vehicles need to meet this standard.

The age of a vehicle can be used as a way to determine its Euro standard. It is possible to find out the age of a vehicle by checking its V5C certificate ('log book') for the date of first registration.

A small number of vehicles that comply with the most recent Euro standard will have been sold before it became mandatory for vehicles off the production line. These are referred to as 'early adopters'. These vehicles may have been registered up to a year earlier and so may be compliant for up to a year longer than is shown in Table 1. Early adopters will need to register their vehicle with TfL to avoid incurring a charge under the ULEZ scheme.

If approved by the Mayor, the ULEZ standards would be introduced from 7 September 2020 and by this time it is expected many vehicles will already be compliant. This timeframe provides five years notice and also allows people five at least four years to arrange to upgrade or switch to a compliant vehicle.

Vehicles which did not comply with the relevant ULEZ standard would incur a daily charge for this non-compliance. This has been set at a differential level for different vehicle types as set out below in Table 1.

It is proposed those wishing to drive in the ULEZ in cars, minibuses, vans and motorcycles that do not meet the ULEZ standards must pay a daily charge of £12.50. Cars, minibuses, vans and motorcycles make up the majority of traffic but contribute less to pollution on a per-vehicle basis. This charge has been set at a level that enables those people making very infrequent trips to continue to do so if they do not want to change their vehicle.

It is proposed that those wishing to drive in the ULEZ in HGVs, coaches and buses that do not meet the ULEZ standards must pay a daily charge of £100. This has been set at a level to reflect the large contribution each vehicle makes on a per-vehicle basis to air pollution and is intended to deter older, more polluting vehicles.

Table 1: Proposed ULEZ emissions standards according to vehicle category

Vehicle name	Vehicle type approval ⁴	Description	Proposed emissions standard ⁵	Date when manufacturers must sell new vehicles meeting the emissions standards ⁶	Charge level if not compliant
Motorcycle, moped etc	L	Any motorcycle or moped, (tricycle or quadricycle).	Euro 3	From 1 July 2007	£12.50
Car and small van ⁷	M1	A passenger vehicle with no more than 8 seats in addition to the driver's seat. A goods vehicle with weight when empty less than 1205 kg.	Euro 4 (petrol)	From 1 January 2006	£12.50
	N1 (i)		Euro 6 (diesel)	From 1 September 2015	
Large van and minibus	N1 (ii,iii) M2	Goods vehicle with a gross weight of 3.5 tonnes or less. Passenger vehicle with more than 8 passenger seats & gross vehicle weight of 5 tonnes or less.	Euro 4 (petrol)	From 1 January 2007	£12.50
			Euro 6 (diesel)	From 1 September 2016	
HGV	N2, N3	Lorries and specialist vehicles of more than 3.5 tonnes gross vehicle weight	Euro VI	From 1 January 2014	£100
Bus/coach ⁸	M3	Passenger vehicles with more than 8 passenger seats of more than 5 tonnes gross vehicle weight	Euro VI	From 1 January 2014	£100

⁴ <http://www.dft.gov.uk/vca/vehicletype/definition-of-vehicle-categories.asp>

⁵ Euro standards for heavy-duty diesel engines use Roman numerals and for light-duty vehicle standards use Arabic numerals.

⁶ These are usually a year earlier for early adopters.

⁷ Car-derived van

⁸ Technically some New Routemasters are Euro V but perform close to Euro VI (see Chapter 12)

1.4. Future ULEZ standards

While the standards set out in Table 1 constitute the current proposal for these vehicles in 2020, it is possible that, as low emission vehicle technology and markets develop, a further strengthening of the ULEZ standards could be proposed at a later date. The Mayor is considering the introduction of a tighter ‘zero emission capable’ standard from 2025. This could achieve further emissions reductions, position London as a leader in this field and support the UK in this rapidly developing economic sector.

Any such change would be subject to statutory processes including another public and stakeholder consultation and it will be informed by an appraisal of compliance costs, availability of vehicles on the market and the air quality impacts.

Section 1.8 below sets out the approach for taxis, PHVs and TfL buses proposed for 2020, which includes a ‘zero emission capable’ requirement from 2018. This is considered right for these vehicles owing to their contribution to emissions and the current and expected availability of suitable vehicles. Government support to help owners and drivers will nevertheless be critical (see Chapters 13 and 14 for more information).

As will be seen in Chapters 11 and 15, TfL also considered the potential for a ‘zero emission capable’ standard for cars and other light vehicles in its development of the ULEZ proposal. In light of the availability of vehicles, their cost and the current barriers to widespread adoption, there is no proposal to include a ‘zero emission capable’ requirement for every vehicle at this time. Instead, taxis, PHVs and TfL buses are proposed to help lead on this requirement. However, the Mayor has stated his ambition to achieve a step-change in the uptake of electric vehicles in London and, if the ULEZ is approved by the Mayor, TfL would monitor its impacts and could consult on ‘zero emission capable’ standards in the future.

1.5. Low Emission Zone and the Congestion Charge

The ULEZ standards are intended to be in addition to the LEZ requirements (24 hours, 365 days across Greater London) and the Congestion Charge (CC), which will continue to apply to vehicles entering the zone 07:00-18:00 Monday to Friday. It is in principle possible that for a vehicle which is not compliant with LEZ and / or ULEZ emissions standards and which is driven during CC hours, three charges would have

to be paid in one day (see Table 2 and Figure 3). Although the number of times this is expected to be the case is likely to be very small.

Table 2: Daily charges according to vehicle type*

	LEZ	CC Mon-Fri 07.00- 18.00	ULEZ Proposed charge
Motorcycle, moped etc	n/a	n/a	£12.50 If not Euro 3 compliant
Car / small van	n/a	£11.50	£12.50 If not Euro 6 compliant (diesel) or Euro 4 compliant (petrol)
Large van / minibus	£100 If not Euro 3 for PM ₁₀ compliant	£11.50	£12.50 If not Euro 6 compliant (diesel) or Euro 4 compliant (petrol)
Bus/coach	£200 If not Euro IV for PM ₁₀ compliant	n/a	£100 If not Euro VI compliant
HGV	£200 If not Euro IV compliant	£11.50	£100 If not Euro VI compliant

** At today's prices. Discounts and exemptions may apply for specific vehicles and/or drivers in each of the three schemes. Please see section 15.7 for proposed ULEZ exemptions and TfL's website for details of CC and LEZ exemptions and discounts.*

A vehicle being subject to all three charges is in reality likely to happen very infrequently. The LEZ already has a very high compliance rate (meaning that few vehicles actually pay the charge, which is intended to act as a deterrent) and both the CCZ and the ULEZ apply only to central London, with the CCZ in operation only at certain times. As already stated, many vehicles will already be compliant with the ULEZ standards and will not be required to pay the ULEZ charge.

By 2020, the oldest Euro VI HGV will be six years old, whilst the oldest Euro diesel 6 car will be five years old (or older if manufactures start producing and selling approved Euro 6/VI standard vehicles before they are required to). The oldest Euro 4 petrol car would be fourteen years old. This means that even without the ULEZ, it is estimated there will be a substantial number of Euro VI/6 (diesel) or Euro 4 (petrol)

vehicles driven in central London— approximately 77 per cent of HGV, 73 per cent of car, 67 per cent of coach and 44 per cent of vans driven on an average day in 2020. These vehicles would not be charged under the ULEZ proposals.

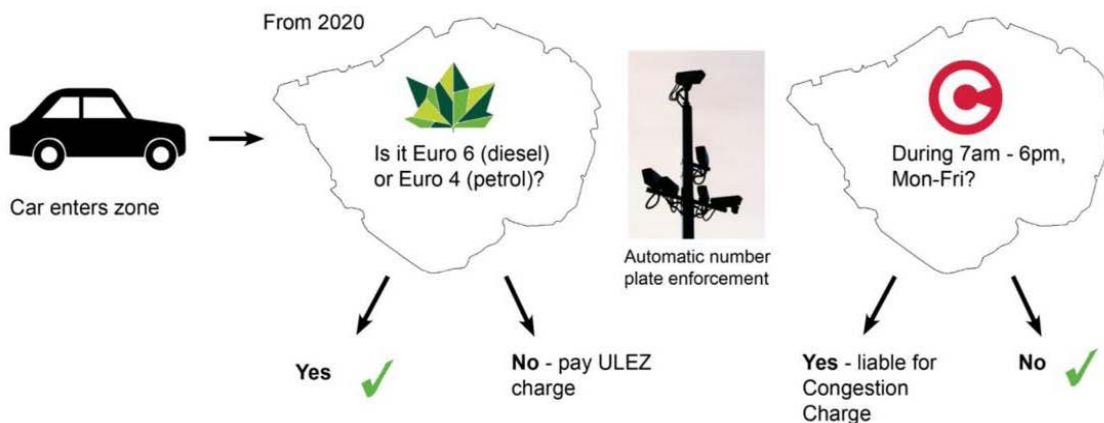


Figure 3: Example scenario

1.6. Discounts and exemptions to the ULEZ standards

It is proposed the small number of vehicle types that are currently exempt from the LEZ would also be exempt from the ULEZ standards. These include agricultural vehicles, military vehicles, historic vehicles, non-road going vehicles which are allowed to drive on the highway (for example excavators) and certain types of mobile crane. The rationale for these proposed exemptions, and how emissions from these vehicles will be addressed in other ways, is described in section 15.7.

Taxis and Private Hire Vehicles (PHV)

In light of the proposed changes to taxi vehicle licensing requirements and the proposed reduction in the taxi age limit for all taxis across London (see Chapter 13), it is proposed all taxis licensed with TfL will be exempt from the ULEZ charge (irrespective of being zero emission capable or not). PHVs would not be exempt and must pay the charge unless they meet the ULEZ emission standards of Euro 6 diesel, Euro 4 petrol (just like other cars, vans etc.).

Residents of the zone

It is proposed that all residents living in the ULEZ will be granted a 100% discount for the first three years the ULEZ is in operation (a 'sunset period'), with a time-limited 100% discount to recognise that they are unable to avoid the ULEZ and so may not have the options of, for example, re-routing their journeys. For this reason, it is proposed that residents be given more time to change their vehicle for one which

meets the ULEZ standards. The vehicles of all residents within ULEZ would therefore need to be compliant with applicable ULEZ standards from 7 September 2023 (instead of 2020). After that point residents must pay 100% of the daily charge to drive a non-compliant vehicle in the ULEZ. This provides residents with eight years advance notice of the ULEZ standards.

Not all vehicles will be liable for the daily charge. Petrol cars registered with the DVLA from 2006 (which will be Euro 4) will meet the ULEZ standard and not be subject to the charge. Diesel cars registered from September 2015 will also meet the ULEZ standards and not be subject to the charge.

Residents' vehicles registered for the CC residents' discount will automatically be registered for the ULEZ residents' discount (until the discount ceases in 2023). Residents not registered for the CC Residents' discount will have to register with TfL (£10 registration fee) to receive the ULEZ residents' discount for their registered vehicle (regardless of when they started living in the zone). The ULEZ residents' discount will be available to residents within the zone and in designated areas next to the zone (which will be the same areas as applies to the CC residents' discount). A resident who moves out of the ULEZ area would no longer be eligible for this discount.

1.7. Enforcing the ULEZ standards

It is proposed the ULEZ standards would be enforced using the existing Automatic Number Plate Recognition (ANPR) cameras – both fixed and mobile – already installed within the ULEZ area, which are also used for CC enforcement. The cameras would capture the number plates of vehicles and check vehicle details against a database of vehicles that met and didn't meet the required emissions standards and for which the daily charge had been paid.

If a vehicle did not meet the emissions standards and the daily charge had not been paid by the specified time, a Penalty Charge Notice (PCN) would be issued to the registered keeper of the vehicle. It is proposed this would be £1,000 (reduced to £500 if paid within 14 days) for heavy vehicles and £130 (reduced to £65 if paid within 14

days) for light vehicles (cars, vans, motorcycles and other L1⁹ vehicles). Unpaid penalty charges would be recovered by TfL.

Drivers using the CCZ can already register with TfL for CC AutoPay and be automatically billed for their use of the CCZ each month, with the added benefit of not needing to remember to pay the charge and so removing the risk of a PCN. For these drivers, the combination of Congestion and ULEZ charges would be automatically calculated and billed (this does not include any penalty charges for which a separate procedure exists).

For drivers who are not registered but are paying the CC, a daily ULEZ charge would automatically be added if applicable and itemised accordingly. Anyone who is not registered and is driving in the ULEZ would need to remember to pay the daily ULEZ charge if their vehicle is not compliant with the ULEZ standards (unless an exemption or discount applies).

For non-registered users, it is expected that the payment channels for the ULEZ daily charge will be in line with those available for the Congestion Charge and include for example online payments and payments by phone. Options to pay a daily charge, a weekly charge and to pay next day would be available. Further information would be made available and publicised closer to the launch of the scheme.

1.8. The approach for TfL buses, taxis and PHVs in the ULEZ and beyond

The proposed approach for these vehicles builds on the approach proposed for private and commercial vehicles outlined earlier in this chapter. For private and commercial vehicles including buses, a charging scheme is the most appropriate way to encourage the use of lower emission vehicles in the ULEZ, because this enables TfL to influence purchasing and driving behaviour in this sector. Other approaches, such as a ban on certain vehicles, would have significant adverse economic and social impacts.

For TfL buses, taxis and PHVs, there are more direct ways to raise the emissions standards of vehicles on London's roads, namely via TfL's procurement programme for buses (although the proposed Variation Order also requires TfL buses to meet the

⁹ <http://www.dft.gov.uk/vca/vehicletype/definition-of-vehicle-categories.asp>

relevant emissions standards); and for taxis and PHVs, by using its role as the licensing authority for taxi and private hire services in London. Detailed information on the proposals for buses is given in chapter 12; for taxis and PHVs please see chapters 13 and 14. Information on proposed financial support for taxi and PHV drivers is also set out in those chapters; TfL would engage with representatives from the taxi and PHV trades on the appropriate ways to apply this support.

A further difference between the ULEZ standards and bus procurement approach on the one hand, and the licensing approach on the other, is that the former would apply only within the ULEZ in central London. The taxi and PHV licensing proposals would apply Londonwide, reflecting both the existing operation of licensing for these vehicles and the relatively high mileage and emissions contribution of these vehicles. Although the charging scheme and the bus standards will only apply in the central London zone, the benefits will be spread beyond this zone as cleaner vehicles are used for journeys that start or end outside this zone; relatively few trips will take place exclusively within central London. A summary of the proposals for buses, taxis and PHVs is provided below, with detailed information later in this document.

TfL buses

The TfL bus fleet is the youngest of any major European or world city with an average age of six years. It is proposed in the ULEZ, double-decker TfL buses will meet Euro VI emissions standards (either using a retrofit solution or an accelerated procurement of new buses) and be hybrid (diesel-electric) and all single-decker TfL buses will be zero emission (at tailpipe)¹⁰. TfL will progressively increase the number of these buses to the point that from 2020 only buses of this type will be operated on routes that enter the ULEZ. This means nearly all double deck buses in inner London will be hybrid.

Taxis and PHVs overview

TfL is able to influence the emissions standards of both taxis and PHVs via the licensing regime, which is a more direct approach and allows us to apply standards appropriate to these vehicles. The proposal also reflects the emissions contribution of these vehicles compared with other vehicles; for taxis the contribution is much

¹⁰ See Glossary (Appendix 1) for definitions.

greater due to their high mileage within the ULEZ. It has also been tailored to reflect the different types of vehicles used as taxis and PHVs and their associated cost.

For these reasons the requirement for taxis and PHVs differs in some ways from those for private cars; additionally in some respects the proposals for PHVs differ from the proposals for taxis. For both PHVs and taxis the intention is to incentivise the development and take-up of zero emission capable vehicles while removing the oldest and most polluting vehicles from the fleet. The proposed approach is considered to be the most appropriate way to achieve this for each sector.

It is worth concluding this section with a brief description of taxis and PHVs, since their differing vehicle types, uses and operating rules have also informed the development of the proposal.

The London taxi is a vehicle licensed by TfL to ply for hire in London. Unlike PHVs, taxis are permitted to pick up passengers on street (as well as accept pre-booked trips). Taxis are specialist vehicles which must comply with requirements concerning disabled accessibility; only a few models are available, they are relatively expensive and are built for a long service life.

By contrast, PHVs are a highly diverse fleet and not specialised in design, being showroom models from many different manufacturers. As such there is a much broader range and cheaper models than taxis available and they may be more frequently replaced. Unlike taxis, PHV trips must be pre-booked. For both taxis and PHVs, the proposals seek to encourage the development of a zero emission capable fleet at the same time as removing the oldest and most polluting vehicles from the roads.

Taxis licensed in London (black cabs)

It is proposed from 1 January 2018 all newly licensed taxis must be zero emission capable and have a maximum age limit of 15 years. A zero emission capable taxi is considered to be:

- Minimum zero emissions range 30 miles
- Maximum CO₂ emissions of 50g/km

Since 2012, a 15 year age limit has removed over 6,000 of the oldest and most polluting taxis. TfL proposes to exempt all taxis licensed in London from the ULEZ emissions standards (and daily charge). Instead, it is proposed to reduce the taxi age limit from 15 years to 10 years from 7 September 2020 to reduce NO_x and PM₁₀ exhaust emissions from the Londonwide taxi fleet by 45 per cent and 70 per cent respectively and encourage the uptake of zero emission capable taxis (which would continue to be subject to a 15 year age limit to recognise they are far less polluting).

PHVs licensed in London

The PHV fleet comprises a very diverse range of vehicle models (as described above, unlike the London taxi), which provide a variety of different services in London such as minicab, chauffeur and executive cars, patient transport and school support services. However, there is a much broader range of models available on the market, many of which can be purchased today, which would be compliant with the proposed ULEZ standards.

Unlike the taxi industry, the majority of vehicles presented for licensing as PHVs for the first time have already been used as private vehicles (approximately 65% of newly licensed PHVs). Furthermore, there is a far higher turnover of vehicles each year (around 14,500 PHVs newly licensed per year) Therefore, a distinction has been made between the requirement for newly manufactured PHVs and second-hand vehicles being used to trade for the first time.

It is proposed that a broadly similar requirement is introduced to taxis whereby from 1 January 2018, all new (newly manufactured¹¹) PHVs must be zero emission capable. A zero emission capable PHV is considered to be:

- Minimum zero emissions range 30 miles
- Maximum CO₂ emissions of 50g/km

From 1 January 2018, second-hand¹² PHVs presented for licensing for the first time must meet the ULEZ standards, which are dependent on its vehicle type (Euro 4 petrol, Euro 6/VI diesel).

¹¹ 18 months or younger from date of first registration

¹² Older than 18 months old from date of first registration

PHVs will not be exempt from the ULEZ standards in central London. From 7 September 2020, PHVs that do not meet the ULEZ standards must pay the daily charge when driving in the zone. A reduction in the Londonwide age limit would have affected many drivers that do not operate in central London (approximately 40% of the fleet are not observed driving in central London), so it is proposed that this remains unchanged at 10 years. Requiring PHVs to meet the ULEZ standards is considered to be fair and reasonable as it impacts only those that trade in this area and also accounts for the fact that many drivers use their own vehicle privately when it is not operated as a PHV,

Table 3: Summary of combined proposed requirements for taxis and PHVs

Year	Taxis	PHVs
2018	<p>All newly licensed taxis from 1 January 2018 must be zero emissions capable</p> <p>Zero emission capable taxi:</p> <p>Minimum zero emission range 30 miles.</p> <p>Maximum 50 g/km CO₂.</p> <p>Zero emission capable taxi to retain a 15 year age limit</p>	<p>All newly licensed new (newly manufactured) PHVs from 1 January 2018 must be zero emission capable.</p> <p>Zero emission capable PHV:</p> <p>Minimum zero emission range 30 miles.</p> <p>Maximum 50 g/km CO₂</p> <p>Second hand newly licensed, PHVs must be not less than 18 months of age and meet ULEZ standards: Euro 4 petrol or Euro 6 diesel.</p> <p>Five year introductory age limit discontinued</p>
2020	10 year age limit for all non zero emission taxis.	10 year age limit (no change)

2. The case for intervention

2.1. Progress to date

Significant steps have been taken over recent years to improve air quality and reduce CO₂ emissions in London. Despite this, London is projected to continue to exceed the legal limit for NO₂ beyond 2020. Additional measures are also needed to ensure the Capital is on the right trajectory to meet its ambitious CO₂ reduction target. It is for this reason the Mayor announced his proposals for an ULEZ for central London by 2020.

2.2. Air pollution and public health

The health impacts of the two pollutants of concern in London are listed below¹³.

- **Nitrogen dioxide (NO₂):**

At high concentrations, NO₂ causes inflammation of the airways. Long-term exposure is associated with an increase in symptoms of bronchitis in asthmatic children and reduced lung function growth.

- **Particulate matter (PM):**

Long term exposure to particulate matter contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer. Research shows that particles with a diameter of ten microns and smaller (PM₁₀) are likely to be inhaled deep into the respiratory tract. The health impacts of PM_{2.5} are especially significant as smaller particles can penetrate even deeper.

The extent of the negative effects of air pollution on health is dependent on each person's level of exposure and other diseases they may be vulnerable to or suffering from. Knowledge of the impacts of air quality on health is continually increasing as research in this area progresses.

It can be difficult to demonstrate a clear link between an individual's health and air quality. However, there are a number of studies that try to estimate the impacts at a population level. The Committee on the Medical Effects of Air Pollution has

¹³ <http://www.who.int/mediacentre/factsheets/fs313/en/>

recommended a relationship between concentration and mortality rates¹⁴. This demonstrated that in 2008 an equivalent of 4,300 deaths in the Capital were attributed to long-term exposure to fine particulate matter (PM_{2.5}) and a permanent reduction of 1µg/m³ would increase life expectancy equivalent to an average 3 weeks per member of the 2008 population, with the expected gains differing by age¹⁵.

In 2012, the World Health Organisation classified diesel engine exhaust as carcinogenic to humans, based on sufficient evidence that exposure is associated with an increased risk for lung cancer¹⁶.

Earlier in 2014, TfL ran an online Air Quality in London Survey¹⁷, to which 1,329 responses were received. Ninety-six per cent of respondents agreed that they were concerned about air quality in London. A similarly high figure (95 per cent) agreed that TfL should do more to limit pollution from road vehicles. Presented with seven options for achieving this, the most popular response was 'encourage people to walk and cycle more' (92 per cent), closely followed by 'encourage people to reduce their private car use' (89 per cent). The third most popular option was 'encourage people to use cleaner fuelled vehicles' (85 per cent), with 'encourage people to use vehicles powered by alternative fuels' (81 per cent) the next most chosen option.

¹⁴ for every 10 µg/m³ increases in average PM_{2.5} concentration there is an estimated 6% increase in annual all-cause death

¹⁵ http://www.london.gov.uk/sites/default/files/Health_Study_%20Report.pdf

¹⁶ http://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf

¹⁷ Air Quality in London, 3 March-13 April 2014

2.3. London’s policy framework

The diagram below illustrates the policy framework in relation to improving air quality and reducing greenhouse gas emissions. Policies and directives are agreed at the European Union (EU) level, which are then transposed into UK law and policy by the Government. The strategies and policies set by the Mayor must take these into consideration.

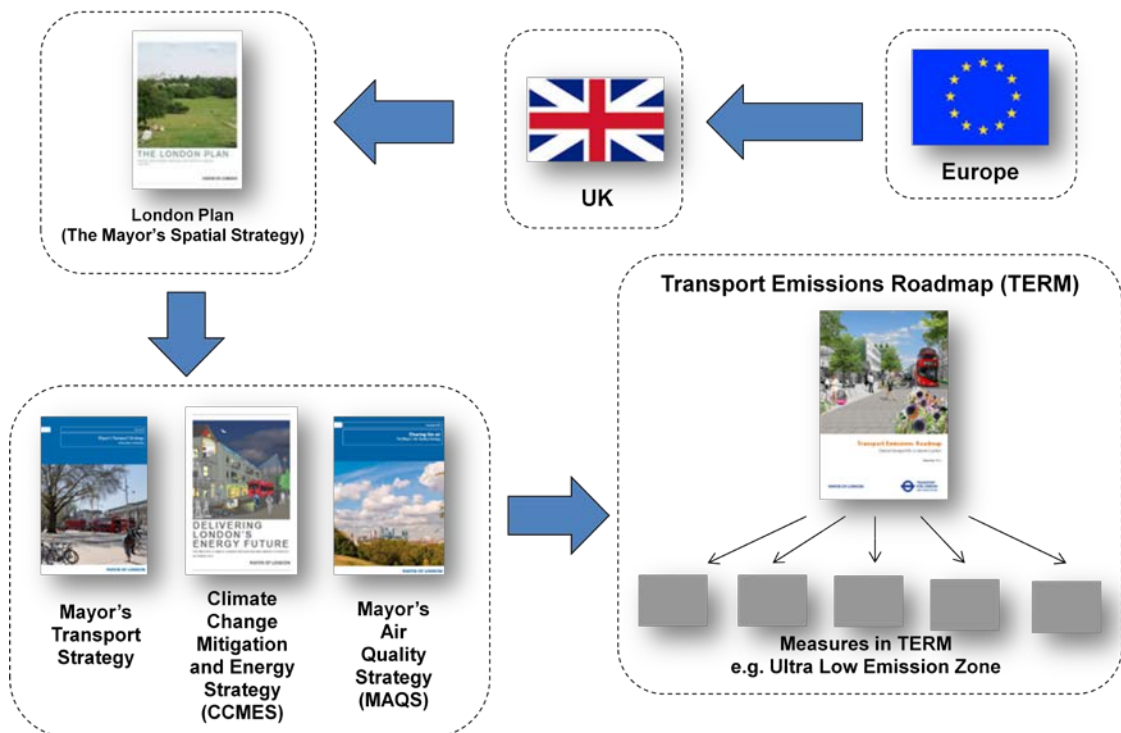


Figure 4: Overall policy framework

2.4. London’s responsibility – air quality

The EU Ambient Air Quality Directive (2008/50/EC) and Directive 2004/107/EC set legal limits (called ‘limit values’) for concentrations of pollutants in outdoor air, which have been transposed into English law by the Air Quality (Standards) Regulations 2010 (see Table 4).

Table 4: Legal limits for pollutants of most concern in London¹⁸

Pollutant	Concentration (limit value)	Averaging period	Legal nature	Permitted exceedence each year	Compliance assessment for 2012 in Greater London**
Fine particles (PM _{2.5})	25 µg/m ^{3*}	1 year	Target value entered into force 1.1.2010 Limit value enters into force 1.1.2015	n/a	Compliant
PM ₁₀	50 µg/m ³	24 hours	Limit value entered into force 1.1.2005 (time extension granted to June 2011)	35	Compliant***
	40 µg/m ³	1 year	Limit value entered into force 1.1.2005	n/a	Compliant
Nitrogen dioxide (NO ₂)	200 µg/m ³	1 hour	Limit value entered into force 1.1.2010	18	Not compliant
	40 µg/m ³	1 year	Limit value entered into force 1.1.2010	n/a	Not compliant

**an obligation to reduce exposure to concentrations of fine particles also comes into force from 2015*

*** Defra reports on compliance to the European Commission on behalf of the UK, in accordance with the Air Quality Directive. The most recent compliance assessment is for 2012¹⁹*

**** following the subtraction of natural sources in accordance with the directive*

The Department for Environment, Food and Rural Affairs (Defra) has reported compliance with particulate matter limits for 2013 across England and Wales with most non-reportable sites in London also falling below the legal limits. However, health evidence suggests that further reductions – especially for PM_{2.5} – will bring about improvements in health and quality of life for Londoners. Crucially, large sections of the Capital continue to exceed both the annual mean and hourly legal

¹⁸Taken from <http://ec.europa.eu/environment/air/quality/standards.htm>

¹⁹http://cdr.eionet.europa.eu/gb/eu/annualair/envukleya/air_pollution_uk_2012_Compliance_Assessment_Summary.pdf

limits for NO₂, which is likely to continue to occur beyond 2020 and this is why more action needs to be taken. Further information on pollutant concentrations in London is provided in Chapter 3

Improving air quality in the Capital is a shared responsibility. Under the Greater London Authority (GLA) Act 1999, the Mayor must prepare an Air Quality Strategy for London and he leads on the implementation of measures in the city to tackle pollution emissions, reduce exposure, raise awareness and integrate air quality and public health.

The Environment Act 1995 requires the London boroughs to designate and develop an action plan for areas where it appears that any air quality standards or objectives are not being achieved. They must take the Mayor's Air Quality Strategy into account when exercising their pollution control functions. The Mayor also has powers to require them to take action.

2.5. Greenhouse gas emissions and climate change

There is clear scientific evidence linking emissions of greenhouse gases to climate change.²⁰ If global emissions of greenhouse gases are left unchecked, average global temperatures could rise by up to 4.8 degrees celsius by the end of the century, which could cause extreme climate change²¹. This could leave London vulnerable to floods, droughts and heat waves. The Stern Review of 2006 estimated the costs of uncontrolled climate change could be between 5 and 20 per cent of global gross domestic product (GDP) per year. By acting now to instigate a step change to ultra low emission vehicles, we can help mitigate climate change and save money we would have spent on adaptation.

Tackling climate change requires global action. 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. Carbon dioxide (CO₂) is considered to be the principal greenhouse gas related to climate change and transport is a key contributor to London's CO₂ emissions with 21 per cent of CO₂ emissions in London coming from transport, 72 per cent of which comes from road transport.

²⁰ IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis.

²¹ Intergovernmental panel on Climate Change 5th Report: <http://goo.gl/EzaLvp>

Recent research has indicated that Black Carbon is the second most important contributor to climate change²². Black Carbon is one component of the pollutant PM_{2.5}, a major source of which is diesel combustion. Measures to tackle PM_{2.5} will therefore help mitigate climate change as well as improve public health.

2.6. London's responsibility – CO₂ emissions

The EU has committed to cutting its CO₂ emissions to 20 per cent below 1990 levels by 2020. It has also offered to increase its emissions reduction to 30 per cent by 2020 if other major emitting countries in the developed and developing worlds increase their commitment to reducing emissions. The Climate Change Act 2008 set the UK's emission reduction targets. The legally binding targets are a reduction of at least 80% by 2050 (against the 1990 baseline).

London has a target to reduce annual emissions of CO₂ by 60 per cent by 2025 on a 1990 base. All sectors must contribute to the overall reduction but the Mayor's Climate Change Mitigation and Energy Strategy (CCMES) suggested the transport sector contributes to the wider target by making a 48 per cent reduction in transport CO₂ emissions. However, this is dependent on the continuing ability of the industrial / commercial sector and domestic sector to reduce emissions in a more cost effective way than the transport sector. This is particularly challenging given that a million more people than originally envisaged are now forecast to be living in London by 2031.

2.7. Mayor's Transport Strategy

One of the six goals of the Mayor's Transport Strategy (MTS), published in 2010, is to *"Enhance the quality of life for all Londoners"* with the associated outcome of *"Reducing air pollutant emissions from ground-based transport, contributing to EU air quality targets"*. Proposal 95 of the MTS states that *"The Mayor will consider further tightening of the standards of the current LEZ, as well as the introduction of further emissions control schemes to encourage the use of cleaner vehicles in London."*

Further goals of the MTS which the ULEZ will assist in achieving include supporting economic development through stimulating the low emission vehicle market;

²² Journal of Geophysical Research: Atmospheres Volume 118, Issue 11, pages 5380–5552, 16 June 2013

improving transport opportunities for all through promotion of sustainable travel with increases in cycling, walking and public transport journeys and reduced congestion; and reducing transport's contribution to climate change through a reduction in CO₂ emissions from ground-based transport contributing to a London-wide 60% reduction target by 2025.

2.8. Mayor's Air Quality Strategy

The Mayor's Air Quality Strategy (2010) (MAQS)²³ sets out policies and proposals for improving London's air quality and therefore the health of Londoners. It was developed in conjunction with the MTS, London Plan, CCMES, Climate Change Adaptation Strategy and Municipal Waste Strategy.

Transport policies in the MAQS cover five categories: smarter choices and sustainable travel behaviour; technological change and cleaner vehicles; priority locations and local measures; public transport; and, emission control schemes, such as the Low Emission Zone (LEZ). Progress with the implementation of the policies and proposals in the Strategy was reported in July 2013²⁴, which included a substantial reduction in emissions from the TfL bus fleet.

The legislation, and the strategy itself, recognise that action by the Mayor alone is not sufficient to achieve compliance with legal limits. This is partly because London's air quality is affected by emissions from elsewhere but also a result of the limited powers the Mayor has to influence significant sources such as airports and industrial sources. Therefore, the strategy outlines action to be taken by others including the EU, the Government and London boroughs. The MAQS is taken into account by the boroughs in formulating their air quality action plans and the Mayor supports borough action to improve air quality through the Mayor's Air Quality Fund.

2.9. Transport Emissions Roadmap (TERM)

TfL continually considers options for meeting the objectives and targets of the MTS, MAQS and CCMES as well as all other legal requirements, such as legal limits for pollution. Our Transport Emissions Roadmap (TERM) was published in September

²³ MAQS forms part of the London Environment Strategy

²⁴ <http://www.london.gov.uk/sites/default/files/MAQS%20Progress%20Report%20-%20July%202013.pdf>

2014, and looks at how to reduce emissions from transport in London. It reports on what we have already done and what we could do in the future. It provides a range of possible new measures that the Mayor, TfL, the London boroughs, the Government, EU and other parties should consider to help meet the challenge of reducing air pollutants and CO₂ emissions in London. The proposed ULEZ is one of the key measures proposed in the TERM.

3. Update on London's air quality

3.1. Current reports on London's air quality

Significant improvements have been made over recent years and London is now broadly compliant with EU limits for PM, however, ongoing reductions are needed (especially PM_{2.5}) to further protect human health. However, London does not currently meet the legal limit for NO₂ (Figure 5).

Annual average PM₁₀ concentrations are considered within the legal limits, however modelling (see Figure 6) still predicts some hotspot locations where the daily average value for PM₁₀ is exceeded (for example kerbside at some junctions in central London, or within the road space itself). Annual mean concentrations of PM_{2.5} are also well within the legal limit value of 25ug/m³. Although compliance has officially been achieved, by further reducing particulate matter concentrations at any level, health benefits will still be realised – as illustrated by the inclusion of a target to reduce the average-exposure-indicator in the legal limits.

In contrast, annual average NO₂ concentrations still exceed the EU legal limit across much of Inner London, as well as in the vicinity of Heathrow and near major roads in outer London. Meeting the NO₂ limit poses a huge challenge for many cities in the UK and across Europe. One of the key reasons why ambient levels of NO₂ remain higher than had been previously expected is related to concerns over the performance of the Euro emissions standard 5/V, which has failed to reduce NO_x emissions from vehicles actually in service, despite tightening emission standards for NO_x.

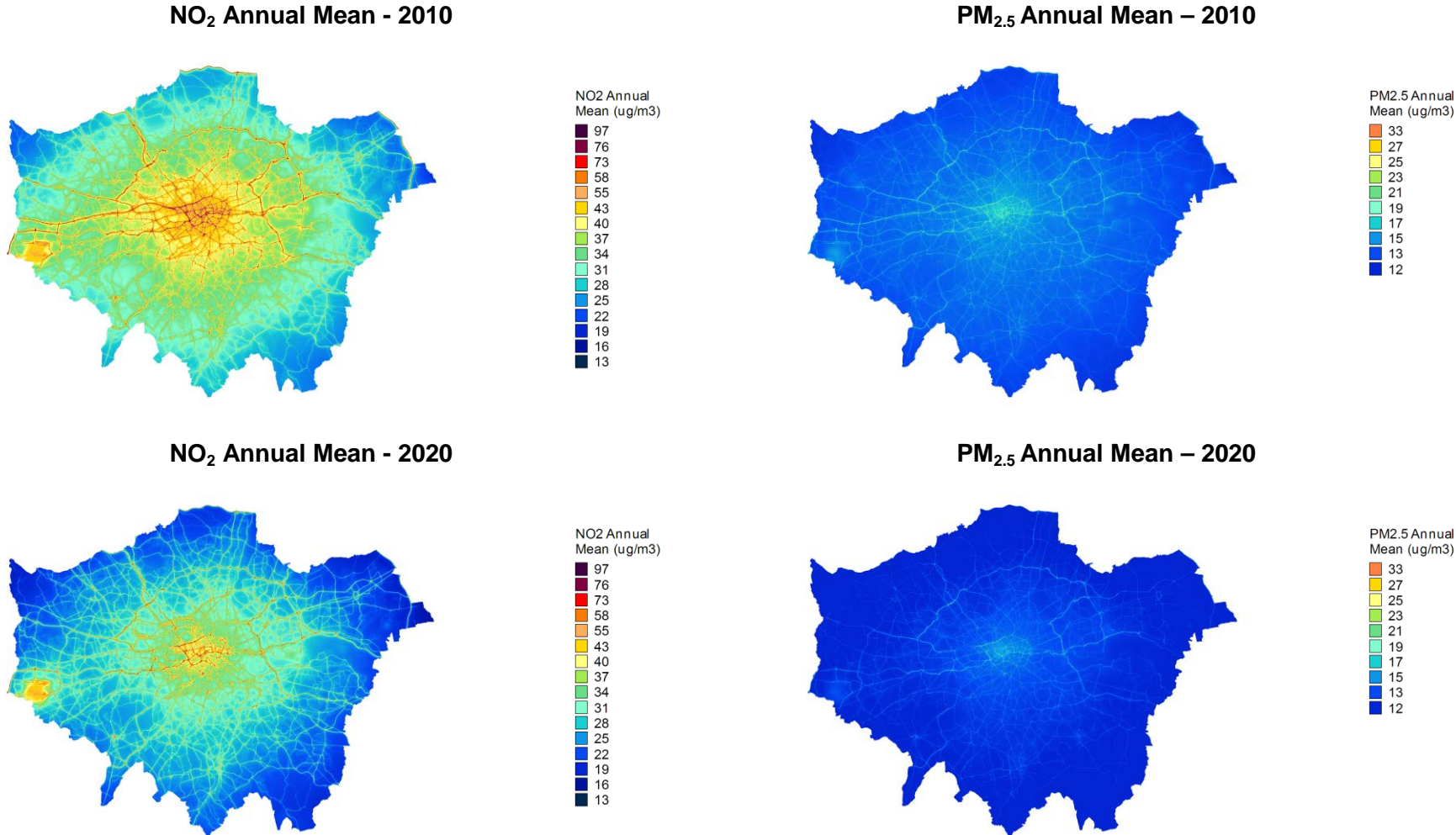


Figure 5: Concentrations of annual average NO₂ & PM_{2.5}, 2010 and 2020

3.2. Future year estimates of London's air quality

By 2020, air quality is expected to have improved (Figure 5). Emissions from all sources are projected to decrease owing to technological advances in vehicle design as well as policies and legislation already in place to reduce emissions across London, the UK and Europe. Specifically, the roll out of a new emission standard for vehicles (i.e. Euro 6/VI) is anticipated to be more successful at reducing pollutants in urban driving conditions than previous Euro standards. Although it is expected that PM emissions will remain within legal limits, levels of NO₂ will continue to exceed these limits in some areas, even with the ULEZ in place.

Further reductions in PM₁₀ and PM_{2.5} concentrations by 2020 mean that annual average concentrations should remain below the legal limits and there are no longer any hotspots where daily average PM_{2.5} concentrations are at risk of exceeding legal limits, although there will be some areas where PM₁₀ does. In the round, there remains a strong case to continue to reduce PM at any level to gain health benefits.

The proportion of London's area where annual average NO₂ concentrations exceed the legal limit is also expected to greatly reduce by 2020. However modelling indicates that, if nothing further is done, concentrations will continue to exceed the limit in central and inner London and in the vicinity of Heathrow airport, construction sites and near major roads in outer London. The European Commission has commenced the first stage of a legal process against the UK Government for not meeting these limits. This is partly because compliance with EU standards is estimated to only be achieved after 2030 in London, Birmingham and Leeds, twenty years after the original deadline.

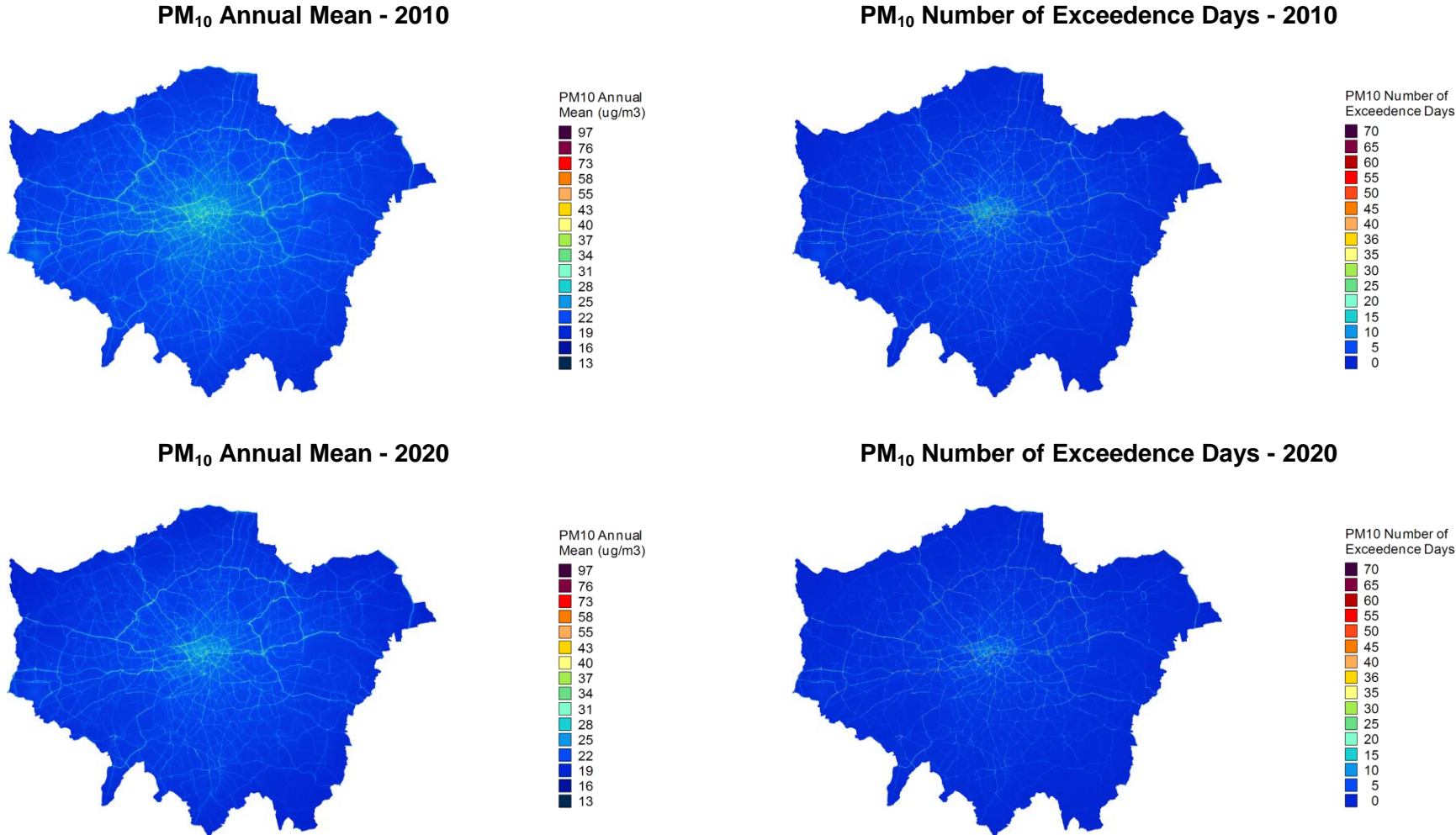


Figure 6: Concentrations of annual and daily average PM₁₀ 2010 & 2020

4. Emission sources in central London

4.1. London Atmospheric Emissions Inventory (LAEI)

In 2013 the LAEI 2010 was published online²⁵. This comprehensive dataset sets out the magnitude and location of emission sources for 2010 as well as projected emissions in future years. Total emissions can be broken down according to their sources in the ULEZ baseline. As a general rule, differences in the source apportionment of vehicle emissions can be attributed to the total kilometres being driven and the rate of pollutants emitted.

In projecting future scenarios, the LAEI takes into account funded schemes such as:

- The increased uptake of cleaner vehicles into fleets, as supported by implemented or planned policies such as the LEZ (lower PM emitting diesel heavy and light duty vehicles)
- TfL's bus improvement programme (lower NO_x, PM and CO₂ emitting vehicles), Congestion Charging incentives (100% discount for ultra low emission vehicles) and the taxi age limit (newer taxis).

A number of methodological changes have been made since the publication of the LAEI to coincide with the ULEZ proposal to create a ULEZ baseline. Using data from LAEI, it can be seen that high levels of NO₂ are concentrated close to the busiest roads in central London (Figure 7).

²⁵ Datastore and Cleaner Air for London website



Figure 7: Central London NO₂ exceedence in 2020

4.2. NO₂ (NO_x emissions)

Vehicle emissions are measured in terms of total NO_x (oxides of nitrogen), which is made up of Nitrogen Oxide (NO) and Nitrogen Dioxide (NO₂). However, the NO is subsequently converted into additional NO₂ by interaction with Ozone in the atmosphere – this reaction being dependent on the availability of Ozone.

Vehicle emissions standards refer to total NO_x emissions but EU air quality limit values refer to ambient concentrations and are set only for NO₂ (and not NO_x) as this is the harmful component. It is also important to note that diesel engines, by nature of their high compression ratio and increased cylinder pressures, produce higher engine out NO_x emissions than petrol engines.

In 2010, road transport was responsible for 48% of NO_x emissions²⁶ in central London. This is projected to reduce to 40% in 2020 (Figure 8). Looking at the source apportionment, it is quite clear diesel vehicles generally emit a greater level of NO_x as

²⁶ EU vehicle emissions are measured in terms of total NO_x to take into account the NO₂ directly emitted (primary NO₂) and the NO₂ formed from chemical reactions on NO (secondary NO₂).

size and engine capacity increases, which is also affected by the amount of kilometres being driven. TfL buses, taxis and diesel cars are projected to be the highest contributors to NO_x in central London in 2020.

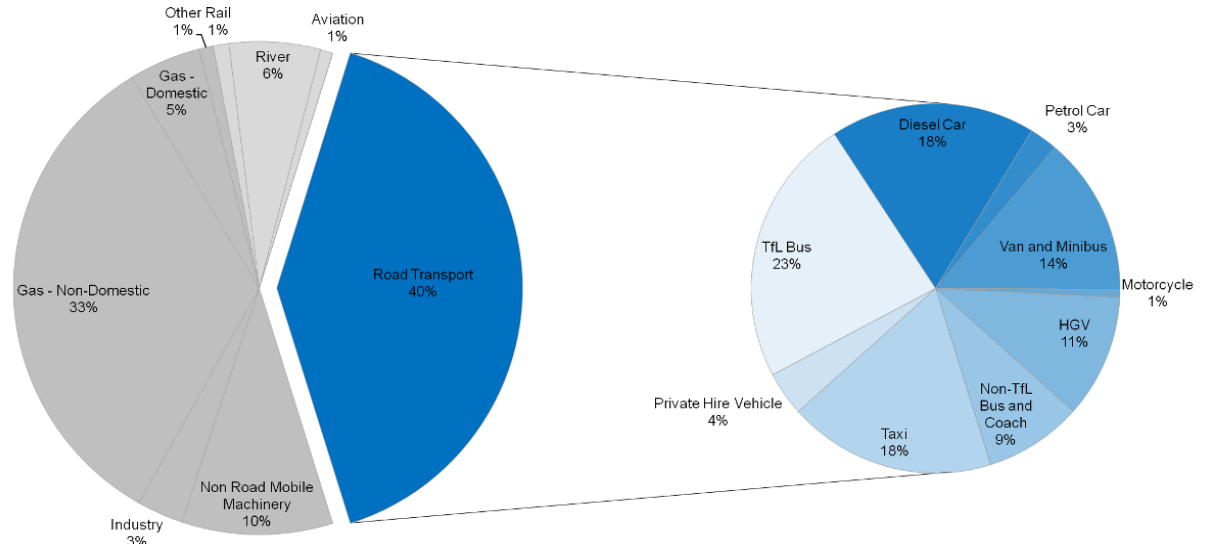


Figure 8: NO_x source apportionment in central London in 2020

4.3. Particulate matter (PM₁₀ emissions)

In 2010, road transport was responsible for 54% of PM₁₀ emissions in central London. This is projected to decrease to 47% in 2020 and 45% of PM₁₀ is projected to arise from exhausts from lighter vehicles, such as cars and vans due to the non-exhaust component of PM₁₀ (Figure 9). It is clear there is a need to ensure emissions from all types of vehicles are taken into account as part of the ULEZ proposal.

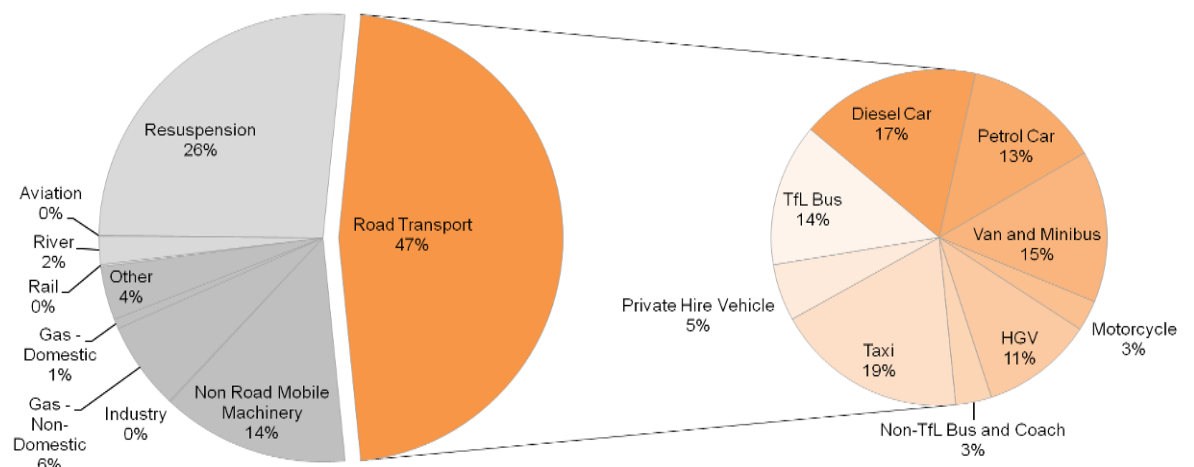


Figure 9: PM₁₀ source apportionment in central London in 2020

4.4. CO₂ emissions

In 2010, road transport sources were responsible for 21% of CO₂ emissions in central London. In 2020, this is estimated to increase (as a proportion) to 26% (Figure 10). However, the geographical location of CO₂ emissions is not critical to their impact (unlike 'local' pollution emissions) and it is important to consider CO₂ emissions over a larger area. Although a quarter of CO₂ is from road transport in central London, this equates to only 4% of total CO₂ emissions across Greater London. CO₂ emissions are predicted to reduce in future years, however the reductions from road transport will be less significant than that for local air pollutants owing to the differences in emissions legislation for new vehicles.

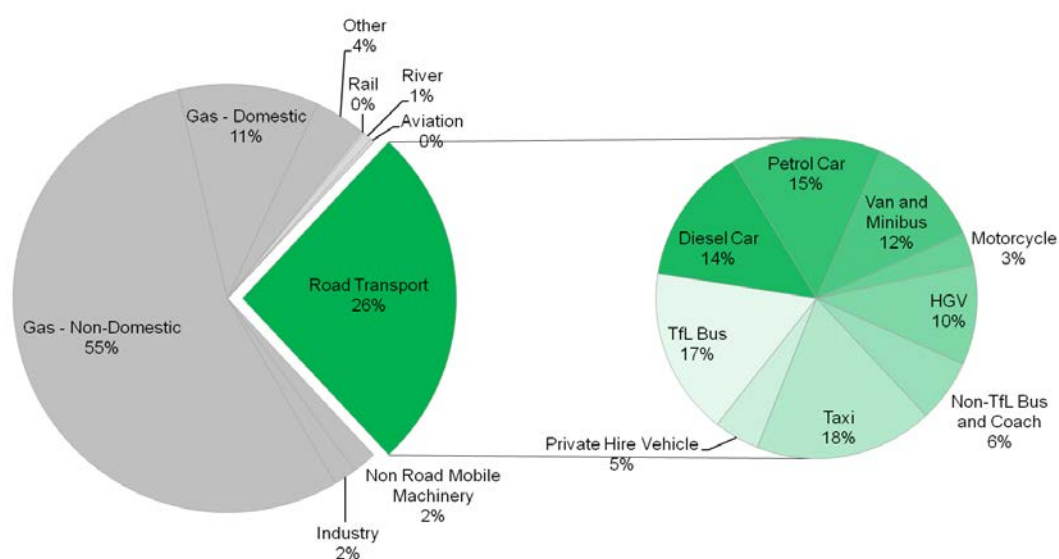


Figure 10: CO₂ source apportionment in central London in 2020 (excluding electricity)

4.5. Other emission sources

Improving London's poor air quality and reducing its contribution to climate change cannot be done through a reduction in road transport emissions alone. Emissions from non-transport sources account for a high percentage of total emissions. Whilst the ULEZ will focus on transport emissions, the GLA will continue to work closely with TfL and other stakeholders to explore opportunities to deliver further initiatives for all emission sources including buildings, construction sites, and energy and waste facilities. This includes measures to address emissions at construction sites, further retrofit of homes and buildings, CHP²⁷/biomass emissions standards, and providing

²⁷ Combined Heat and Power

guidance on the application of 'air quality neutral' in the planning system. The GLA is also taking a lead in integrating air quality into the public health system so that improving air quality is fully considered alongside other measures to improve public health.

The Mayor's intention is to use his other powers to complement the introduction of the ULEZ. For example, in 2015 the Mayor will introduce tough new standards to reduce emissions from construction sites and construction equipment (non-road mobile machinery). These standards will tighten in 2020 to coincide with the introduction of ULEZ.

Separately the Mayor will be consulting on new arrangements for the statutory Local Air Quality Management process in London in early 2015. This will place additional requirements on boroughs alongside additional support to help tackle local hotspots.

5. Transport Emissions Roadmap (TERM)

5.1. Transport Emission Roadmap (TERM)

TfL recently published its Transport Emissions Roadmap (TERM), which sets out a number of new and innovative ideas that could be implemented in London to reduce emissions from ground-based transport. The development of the TERM involved assessing a long list of measures 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.



The TERM contains a list of ten measures considered necessary to tackle transport emissions in the Capital, particularly in the context of achieving future compliance with limit values for NO₂ and meeting challenging CO₂ targets. These measures cover a broad range of interventions, such as regulation, infrastructure, innovation, lobbying, fleet-specific changes and education and awareness campaigns.

One of the proposed measures is the introduction of an ULEZ in central London, with the specific recommendation that a new emissions requirement is created in central London to discourage all but the cleanest vehicles. This should also be considered in conjunction with enhancements to the procurement and licensing requirements for TfL buses, taxis and PHVs to increase the number of zero emission capable vehicles in these fleets.

Over the past year, TfL has engaged in discussions with stakeholders to understand the issues, obstacles and boundaries of acceptability in relation to an ULEZ. An outline of stakeholder engagement is provided in Appendix 2. This included large stakeholder forums and an online survey to understand public opinion on the options to improve air quality.

Beginning in summer 2013, TfL engaged with stakeholders and used feedback from meetings, events and briefings to inform option development and sense-check technology and data assumptions. Engaging stakeholders at this early stage facilitated a dialogue between TfL, the GLA, vehicle owners, manufacturers, policy experts and user groups. This helped to develop levels of understanding and provided an opportunity for discussion on the most appropriate ways to balance the benefits and impacts of emerging options.

Part 2: Option Assessment

6. Overview of Part 2

6.1. Structure of Part 2

Part 1 of this document set out the ULEZ proposal and why it is considered to be the most effective means to reduce road transport emissions in central London in 2020. This section will now describe in detail how the elements of the ULEZ proposal were developed, including the changes to taxi and PHV licensing and TfL's buses. The assessment of options for the overall proposal considered issues including the likely development of technology and vehicle availability for different vehicle types, the projected emissions savings and factors such as the cost of compliance.

Part 2 begins with a summary description of the approach to assessment (the remainder of this chapter) and then summarises the three key parameters used to assess the emerging options: geographical area; hours of operation; and emissions standards for different vehicle types (chapters 7, 8 and 9).

This last parameter – emissions standards for different vehicle types – necessarily requires an extensive discussion, given the wide range of vehicles included and the development of improved emissions performance both in conventional engine types (diesel, petrol) and in zero emission technology. In order to give a full appraisal, then, the discussion is organised into five chapters.

Starting with conventional engines, Chapter 10 looks at the ways in which the Euro VI/6 emissions standard can reduce NO_x emissions from vehicles. The next chapter (11) moves to a consideration of more innovative technologies and the scope for zero emission capability; it also considers the costs and funding available for a move to this type of vehicle. Both these chapters give a general update on these two approaches and consider how they apply to different vehicle types. Then the final three chapters (12-14) focus on the specific implications of different options for buses, taxis and PHVs, with a chapter for each of these vehicle types.

Finally in Chapter 15 the process for the technical assessment of options arising from the earlier chapters is described. This includes a section on the modelling of behavioural responses to a daily charge.

6.2. Strategic assessment

Taking into account feedback from stakeholders and experience from previous schemes (such as the CC and the LEZ), a strategic assessment was undertaken of potential options for the establishment of a zone in central London where ultra-low emission vehicles would operate (the ULEZ). For this assessment, scheme options were defined in terms of the following parameters:

- Geographical area ('parameter 1')
- Hours of operation ('parameter 2')
- Emission standards for different vehicle types ('parameter 3')
 - Air pollutants
 - CO₂ emissions
 - Zero emission capability

The impact of these parameters, which are discussed in more detail later in the following sections, were assessed against a preliminary estimate of compliance cost²⁸, emissions savings, practicality, feasibility and deliverability. A summary of the strategic assessment criteria is given in Table 5 on the next page.

Options which performed well in this initial assessment were then taken forward as preferred options. These were subjected to a more comprehensive technical assessment, which sought to understand the implication of changes to various parameters in terms of the total cost of compliance and benefits of the scheme (such as emission savings). This technical assessment was done in two parts. It first considered options for TfL services (TfL buses, taxi and PHVs), which would be dealt with through licensing and contracts tendering, and then options for all other vehicles, where a daily charge is introduced for non compliant vehicles under road user charging powers.

6.3. Assessment of impacts

TfL assessed the impact of the final ULEZ proposal on emissions, air quality, health, exposure and costs. In addition, TfL commissioned Impact Assessments (IAs) of the proposal for consultation from Jacobs. These IAs, and an overarching Integrated Impact Assessment (IIA) for the proposal will be available as separate documents.

²⁸ This is the cost of swapping or replacing vehicles that do not meet the emissions standard.

IAs were produced for Health, Environment, Economic and Business and Equalities. More information about the impacts is given in Chapter 16.

Table 5: Summary of strategic assessment criteria

Criteria	Definition
Emissions savings	The anticipated reduction in NO _x , PM ₁₀ and CO ₂ emissions and consequent impact on public health is at the core of the ULEZ objectives.
Stakeholder complexity	The ease with which an option could be understood by the motoring public and businesses. The most complex schemes included multiple requirements, surcharges and unconventional operating hours. Those options that specified a single emissions standard (but targeted vehicles unfamiliar with emissions-based charging) were considered slightly less complex. The least complex were requirements administered through an existing licensing or procurement process (eg TfL buses).
Availability of vehicle technology	Options where technology was more readily available in 2020 were appraised more positively. Conversely, technology believed to only exist as proof of concept was treated with caution, unless evidence had started to emerge. Balanced options were considered to be those that specified technology widely available in 2020 but not market leader.
Complexity of delivery	Deliverability is in part determined by complexity. Schemes that require new infrastructure and charging mechanisms were considered to be complex. This was followed by amendments to existing schemes (large or minor) and finally those administered through an existing licensing or procurement process.

The remainder of this part of the report will discuss options consideration for each of the three key parameters and in turn, the two technical assessments that were undertaken. Part 3 of the report summarises the recommended proposal and the next steps following the public consultation.

7. Geographical area of the ULEZ (Parameter 1)

7.1. Central London Congestion Charging Zone

It is proposed the ULEZ will match the same area as the existing central London Congestion Charge (CC) for the following reasons:

- NO₂ concentrations are projected to be the highest in central London and this is where most people visiting and living in London are exposed to pollution on a daily basis.
- In 2020, 7% of London's total population will live in areas exceeding legal limits for NO₂. When considering central London alone, this increases to 63%.
- The CC area is well understood by the public because it has been in place for a number of years and has been well advertised.
- There are operating cost efficiencies using CC infrastructure (such as cameras) to enforce the ULEZ.

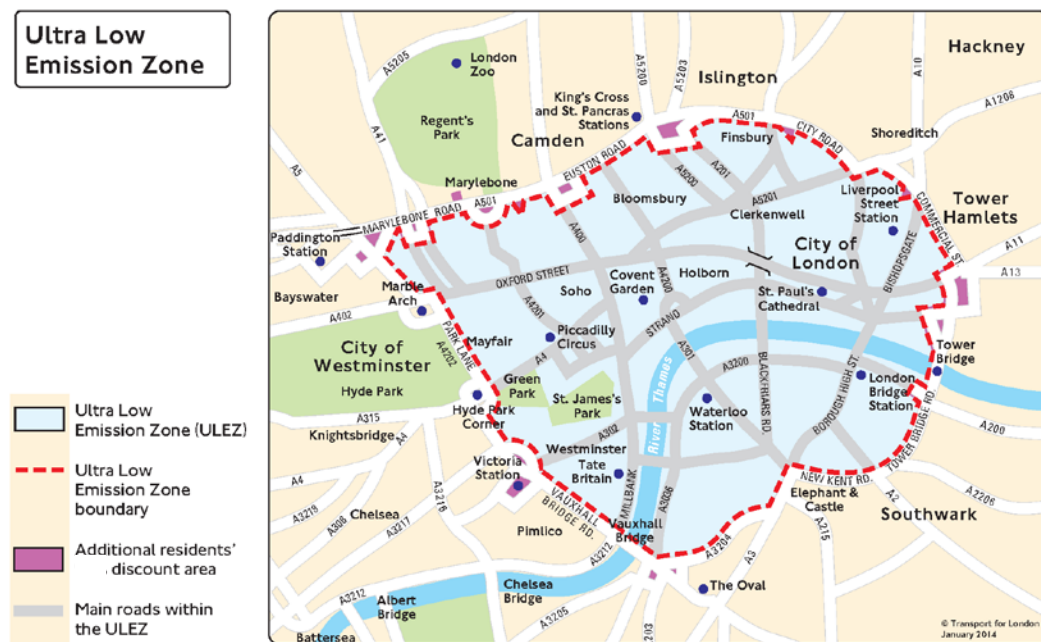


Figure 11: Proposed ULEZ area

As noted in section 1.2, this area has been chosen for consultation because it is the area where air pollution exposure is greatest and where a ULEZ may have the most positive effects. Additionally, the area of the ULEZ coincides with that of the CCZ, which is a well-understood boundary and scheme. All of these factors mean that this is the most appropriate place for the ULEZ to be introduced.

The benefits of the ULEZ are by no means confined to central London in terms of air quality and encouraging the switch to cleaner vehicles. The ULEZ will on average reduce the number of residents living in areas of NO₂ exceedance in each borough across London by at least 45 per cent (this reduction varies by borough depending on their initial level of exceedance and in some cases is considerably more than this).

In addition the role of central London as a leader and exemplar for other cities is important; as is the wider effect of stimulating the low emission vehicle market.

It is of course feasible in principle for the zone to be extended in the future beyond the current proposed boundaries. This would be likely to entail more extensive social and economic effects which would need to be carefully evaluated before such a proposal was put forward. TfL could consider an extension in due course and would be interested in consultees' responses on this issue. Any further expansion would require detailed proposals to be developed, and their impacts identified. Any proposals to expand the currently proposed ULEZ would need to be subject to a separate public and stakeholder consultation and could not be accommodated in the current exercise.

Finally, the Mayor's Air Quality Fund is available for London boroughs who wish to explore options to reduce emissions in local air quality hotspots and develop low emission neighbourhoods (LENs).

8. Hours of operation for the ULEZ standards (Parameter 2)

8.1. Outline of options

Three different time periods of enforcement were considered in the option development process for ULEZ. These are described below. The assessment sought to find a practical and pragmatic balance between the air quality impacts and the impact on drivers and businesses.

8.2. Weekday morning and evening peak hours (7 – 10am, 4 – 7pm, Monday-Friday)

These are times of peak traffic flow and high roadside activity, which can result in high human exposure to pollution. However, if the ULEZ emissions standards were enforced only at this time, it is likely the emissions savings would be disproportionately smaller than a scheme of longer duration because many users would re-time trips as opposed to changing to more sustainable modes or upgrading to lower emission vehicles. Having two discrete periods of operation within the same day could also be confusing and difficult to communicate to users, so much so that the disruption and inconvenience is likely to outweigh its benefits.

8.3. Congestion Charge hours (7am – 6pm, Monday-Friday)

The Congestion Charge (CC) is a well-established scheme for managing volumes of traffic and congestion in central London. Cars, vans and lorries are subject to a charge for entering the zone during operating hours, although motorcycles, buses, taxis and PHVs are not. Other exemptions and discounts also apply for a small number of user groups.

It can be assumed the majority of user groups affected by the CC are aware how the scheme works and the hours of operation because of the amount of publicity around the scheme and the length of time it has been in place. As part of the impact monitoring shortly after the CC was introduced, nearly all UK resident respondents (97 per cent) said they were aware of the scheme²⁹. Enforcement during the same hours would be consistent with an established scheme, although it may compromise the autonomy of the schemes.

It is likely the enforcement of the ULEZ standards during these hours would secure emissions savings and encourage a shift to lower emission private vehicles. Applying the ULEZ standards during CC hours would ensure emissions are reduced when the greatest amounts of people are exposed – over one million people enter central London during the morning peak period (by all modes)³⁰ and remain throughout the day. Currently 45 per cent of pollution from road transport in the CC area is emitted during its hours of operation. However, this still means that the majority of emissions

²⁹ <http://www.tfl.gov.uk/assets/downloads/thirdannualreportfinal.pdf>

³⁰ <http://www.tfl.gov.uk/assets/downloads/corporate/central-london-peak-count-supplementary-report.pdf>

would not be ‘captured’ if enforcement of the ULEZ were the same hours as the Congestion Charge.

8.4. Low Emission Zone hours (24 hours, seven days a week)

As is the case for the existing Londonwide LEZ (and other low emission zones in Europe), the ULEZ standards could be enforced 24 hours, 7 days a week.

Vehicle emissions contribute to poor air quality regardless of the time of day the vehicle is driven, which is the rationale for the operating hours of the LEZ. By contrast, the Congestion Charge applies only in peak traffic hours.

The LEZ operating hours ensure that compliance rates are high³¹ because operators and users cannot retime their journeys to take place outside the hours of operation. As a consequence, they are left with few choices other than upgrading a vehicle if they wish to continue travelling in the zone without paying a charge.

Roadside and urban background concentrations start to rise about 4am in line with the increasing traffic flow and begin to reduce around 7pm (Figure 12). Enforcing the ULEZ emissions standards all day, every day, would ensure that all road transport emission sources throughout the day are captured.

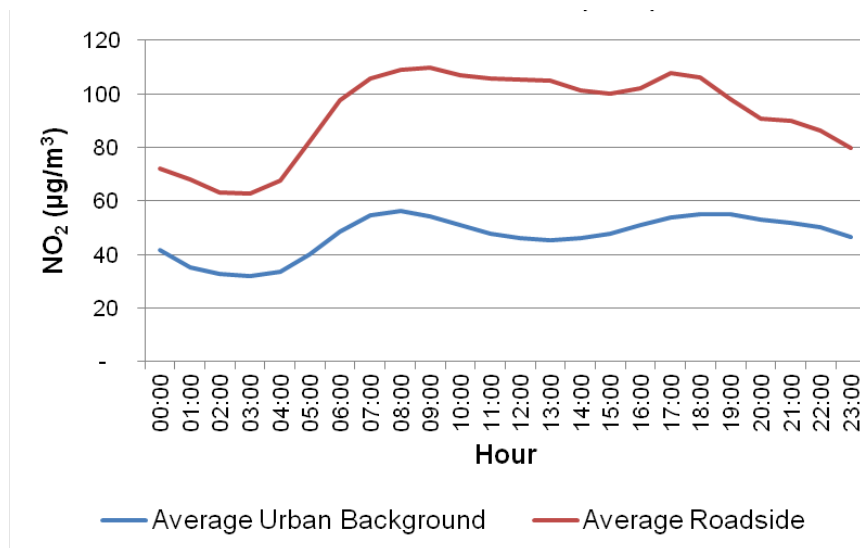


Figure 12: Average NO₂ diurnal profile of urban background and roadside monitors in the Congestion Charge area (2012)

³¹ Since January 2012, compliance has been an average 99% for vans and minibuses (Euro 3 for PM) and 96% for lorries, buses and coaches (Euro IV for PM). Source: TfL monitoring

Benchmarking modelling assessment was carried out to understand how 24/7 operation might affect total emissions and annual mean concentrations differently to daytime-only hours operation. Two standards were chosen for this exercise – Euro 6/VI for all vehicles and zero emission for all vehicles (the choice of standard wasn't necessarily important however as 100% compliance was assumed).

By using two distinct standards it was possible to explore how variations to hours of operation and standards affected overall emissions savings. This work demonstrated that lower emissions standards enforced over a longer period of time gained similar savings to a stronger standard over working hours only. This can be seen by comparing the emissions savings for zero emission in CC hours and Euro 6/VI for a 24 hour operation (Figure 13).

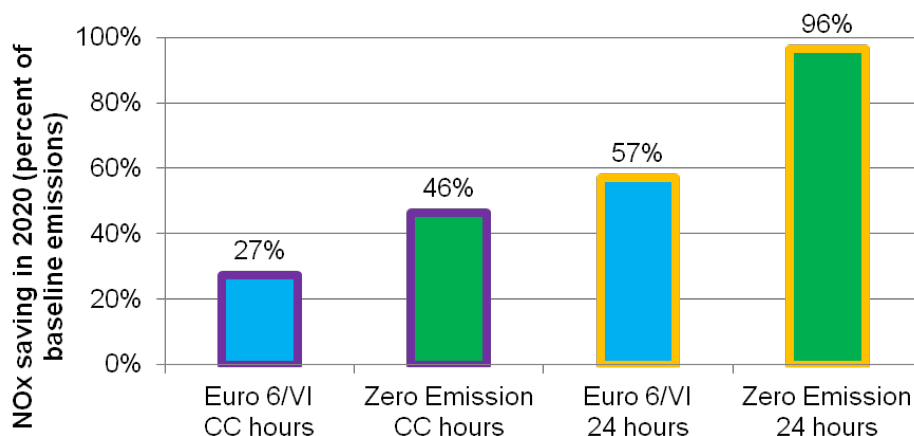


Figure 13: NO_x emissions saving for 2020 based on LAEI 2010 – benchmark scenarios

As already indicated, a lower standard has lower compliance costs and a 24-hour scheme may be more easily understood. These advantages, together with the overall emissions saving achieved, indicate that this is a suitable option to take forward.

9. Emission standards for different vehicle types (Parameter 3)

9.1. Minimum emissions standards

When determining the ULEZ standards for vehicles, consideration was given to the cost of compliance and the reduction in emissions (assessed in detail as technical

assessments covered in Chapter 15), alongside other influential variables such as the availability of suitable vehicles on the market by 2020.

There was a particular focus on emissions standards that reduce NO_x and CO₂ emissions, however any implications for other pollutants of concern, such as fine particulates, were also taken into consideration. The assessment of the availability of suitable vehicles by 2020 considered traditional petrol and diesel internal combustion engines (ICE) and hybrid vehicles (part electric and part petrol or diesel ICE) as well as fully electric vehicles.

Alternative fuels such as Liquefied Petroleum Gas (LPG), natural gas and bio-methane (only the source of the gas varies, the vehicle technology is the same) were also considered, but to a lesser extent. These fuels have existed for a number of years, both in terms of new vehicles and as after-market conversions. However, they are generally adopted only for niche operations, and mainly in the heavy commercial vehicle sector.

TfL is currently piloting an entire bus route operating on hydrogen with the same demands as conventional diesel buses (Route RV1). However, there are currently no commercially available hydrogen fuel cell vehicles, and once the amount of CO₂ emitted during the current approach to hydrogen generation is taken into consideration, it is a less effective technology than battery electric vehicles. This seems unlikely to change significantly before 2020 but it is important to continue to monitor the effectiveness of this technology.

The following two chapters discuss emissions standards in terms of the need to reduce NO_x and CO₂ emissions, so should also be considered part of the discussion on Parameter 3). They are followed by a chapter discussing possible zero emission (at tailpipe) requirements.

10. NO_x emissions

10.1. European vehicle emissions standards (Euro standards)

These are standards set by the European Union (EU) for maximum emissions of local air pollutants for new vehicles sold within EU member states. Euro standards range from Euro 1-6 for light vehicles and Euro I – VI for heavy vehicles, with Euro 6 and VI being the most recent standard for most vehicles. New vehicles are tested to

ensure they meet the Euro standards during the type approval process. The LEZ emissions standards are based on Euro standards to ensure fairness and allow consistency across Europe.

Each Euro standard has progressively tightened and reduced air pollutant emissions from vehicles since 1992. However, there have been concerns over the performance of Euro 5/V (mandatory October 2009 for HGVs, January 2011 for cars and January 2012 for vans), which despite tightening emission standards for NO_x has failed to reduce NO_x emissions from vehicles in service in urban environments. A key factor here is that the type-approval test procedures are tightly defined in legislation and an engine that complied with the emissions limits under those test procedures may emit much higher levels of NO_x under other driving conditions. This is one of the key reasons why ambient levels of NO₂ remain higher than had been previously expected. However, the next standards to be introduced, Euro 6 (for light duty vehicles) and Euro VI (for heavy duty vehicles), are expected to overcome these problems.

10.2. New Euro VI/6 vehicles

Beside more stringent emissions standards, the key difference for Euro 6 (light duty vehicles) / Euro VI (heavy duty vehicles) is the revised test procedures. Under preceding rules, emissions are measured at specific speeds and loads. For Euro VI this has been changed to a *range* of speeds and loads, within which measurements may be taken at random. This means that the engine must be compliant over a broader range of speed and load conditions, which should ensure the expected emissions standards of vehicles are realised in real world driving. A revised test cycle for light duty vehicles, which better represents real driving conditions, will be introduced as Euro 6b after 2017. A further requirement to measure on-road emissions will be introduced at a similar date for both light and heavy duty vehicles.

Studies undertaken by the Institution of Transport Economics in Norway (TOI) (Hagman & Amundsen, 2013) and (Hagman & Amundsen, 2013)b, the Association for Emissions Control by Catalyst (AECC) (May, Favre, & Bosteels, 2013) and the Joint Research Centre (JRC) (Weiss, et al., 2011) over the past 5 years have shown that vehicles type-approved to a particular Euro standard seldom meet that standard when used in daily real-world environments. This is especially true for diesel vehicles and thus, due to the so-called 'dieselisation' of the light-duty vehicle parc, the impact of light-duty diesel vehicles is much greater than first believed. These studies all

found that real-world NO_x emissions for diesel engine vehicles is on average 400-700mg/km for Euro 3-5 standards, while the Netherlands Organization for Applied Scientific Research (TNO) study of 2013 (Ligterink, Kadijk, van Mensch, Hausberger, & Rexeis, 2013) showed that Euro 6 diesel vehicles emit on average 250mg/km of NO_x when tested using the Combined Artemis Drive Cycle (CADC) urban phase.

Currently available reports on this subject. indicate that real-world emissions of NO_x from heavy duty vehicles are likely to be reduced by 80-90% compared with Euro V, whilst all other types of emission remain well-controlled. For light duty vehicles, emissions are also well controlled, but compression-ignition light duty vehicles continue to have very variable emissions of NO_x. The introduction of the World Light-Duty Test Procedure and Real-Driving-Emissions testing will be crucial in addressing this issue when introduced (scheduled for 2017).in

Euro VI/6 becomes mandatory for new heavy duty vehicles (HGVs, coaches and buses) in January 2014, for new cars / small vans in September 2015 and for larger vans / minibuses in September 2016. In broad terms, these standards reduce the allowable limit for NO_x from diesel engines by greater than 50 per cent from Euro 5/V.

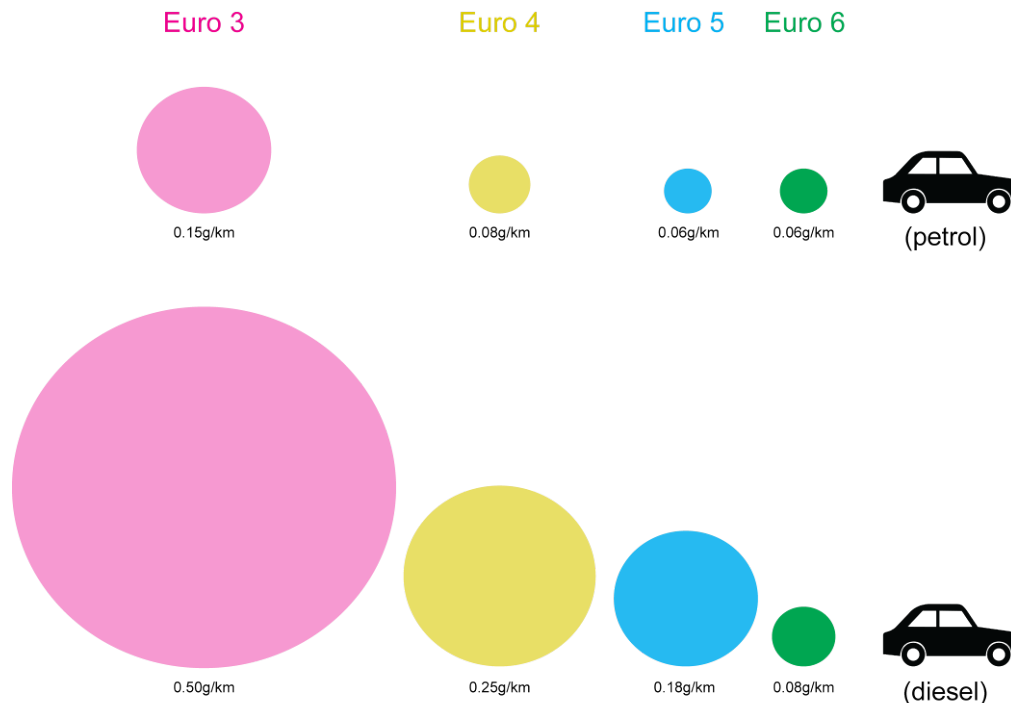


Figure 14: EU NO_x emission standards for passenger cars according to fuel type

TfL is aware that Euro VI NO_x retrofit systems are under development for buses and is considering the most appropriate time to facilitate trials of this technology to develop a cost effective solution for the conversion of TfL buses operating in the ULEZ to Euro VI or a level nearer to that standard.

In addition to the improvements to the EU emissions testing procedures, TfL has undertaken its own tests for heavy vehicles. The effectiveness of Euro VI for heavy duty vehicles has been substantiated in initial testing by TfL using a drive cycle specifically designed to reflect real world driving conditions in London³². A Euro VI TfL bus has been shown to have 98 per cent lower NO_x emissions than Euro V (down from 9g/km to 0.2g/km). This correlates with early testing conducted by manufacturers, indicating that Euro VI buses and HGVs will now have NO_x emissions in line with the Euro V diesel passenger cars. The Euro VI legislation has brought about the optimisation of SCR and EGR systems, The reductions in NO_x emissions compared to previous Euro standards is extremely significant, a factor of ≈20 as seen in a comparison of NO_x/CO₂ (g/kg) produced by long-haulage heavy-duty vehicles in real world driving. (Vermeulen, Spreen, Ligterink, & Vonk, 2014).

It is likely this effectiveness will be repeated for diesel vehicles in the light duty classes, dependent on development of the revised test procedure. This evidence suggests the ULEZ would be effective if it encouraged the use of newer, Euro VI/6 vehicles.

By 2020, the oldest Euro VI HGV will be six years old; whilst the oldest Euro 6 car will be five years old (this could be older for early adopters). The oldest Euro 4 petrol car would be fourteen years old. This means even without the ULEZ, it is estimated there will be a substantial number of Euro VI/6 vehicles driven in central London – approximately 77 per cent of HGV, 67 per cent of coach, 54 per cent of car and 43 per cent of vans driven on an average day in 2020 will be Euro 6/VI standard.

³² A driving cycle is a series of data points representing the speed of a vehicle versus time. They are used to undertake repeatable tests of vehicles and engines performance on a "typical" journey in a laboratory or testing facility.

10.3. Euro 4 petrol vehicles

Petrol and diesel engines are both popular in passenger cars in the UK, with current new car sales broadly a 50:50 split between the two types. Both technology options exist for light commercial vehicles, but in this case, diesel is the most popular choice by far because traditionally diesel engines are thought to be more durable and fuel efficient for high mileage.

Depending on their intended use, car buyers are able to make a choice to opt for either petrol or diesel. Petrol cars may be cheaper to buy than the equivalent diesel but have slightly higher fuel costs, whereas diesels may be more fuel efficient for high mileage but subject to increased maintenance costs. To date, there have been more diesel than petrol model vehicles that qualify for reduced Vehicle Excise Duty (VED) owing to lower CO₂ emissions. VED is the annual road tax paid by vehicle owners. The level payable is set by the Government and is determined by the engine size and type of fuel used by the vehicle. For cars registered since 2001, VED has been set according to CO₂ emissions: cars emitting higher levels of CO₂ have incurred higher VED rates and this tends to be petrol cars more than diesel.

Older petrol cars and vans (Euro 4) have the same NO_x standard as the new Euro 6 standard for diesel vehicles (0.08g/km). Adopting this emissions standard for petrol cars and vans would substantially reduce the cost of compliance without compromising NO_x savings and ensures 'neutrality' between technologies. It also means that there are likely to be many more vehicles available for purchase across a range of budgets – for example a Euro 4 petrol car will be approximately 14 years old in 2020 at a rough cost of £1,000³³ and as such will offer a more affordable means by which owners of older vehicles can meet the same NO_x emissions standard as a Euro 6 diesel car at a rough cost of £10,000, to enable compliance with the ULEZ.

³³ In 2014 prices based on an average new car price of £28,000. Vehicles at the lower end of the market would potentially be much cheaper.

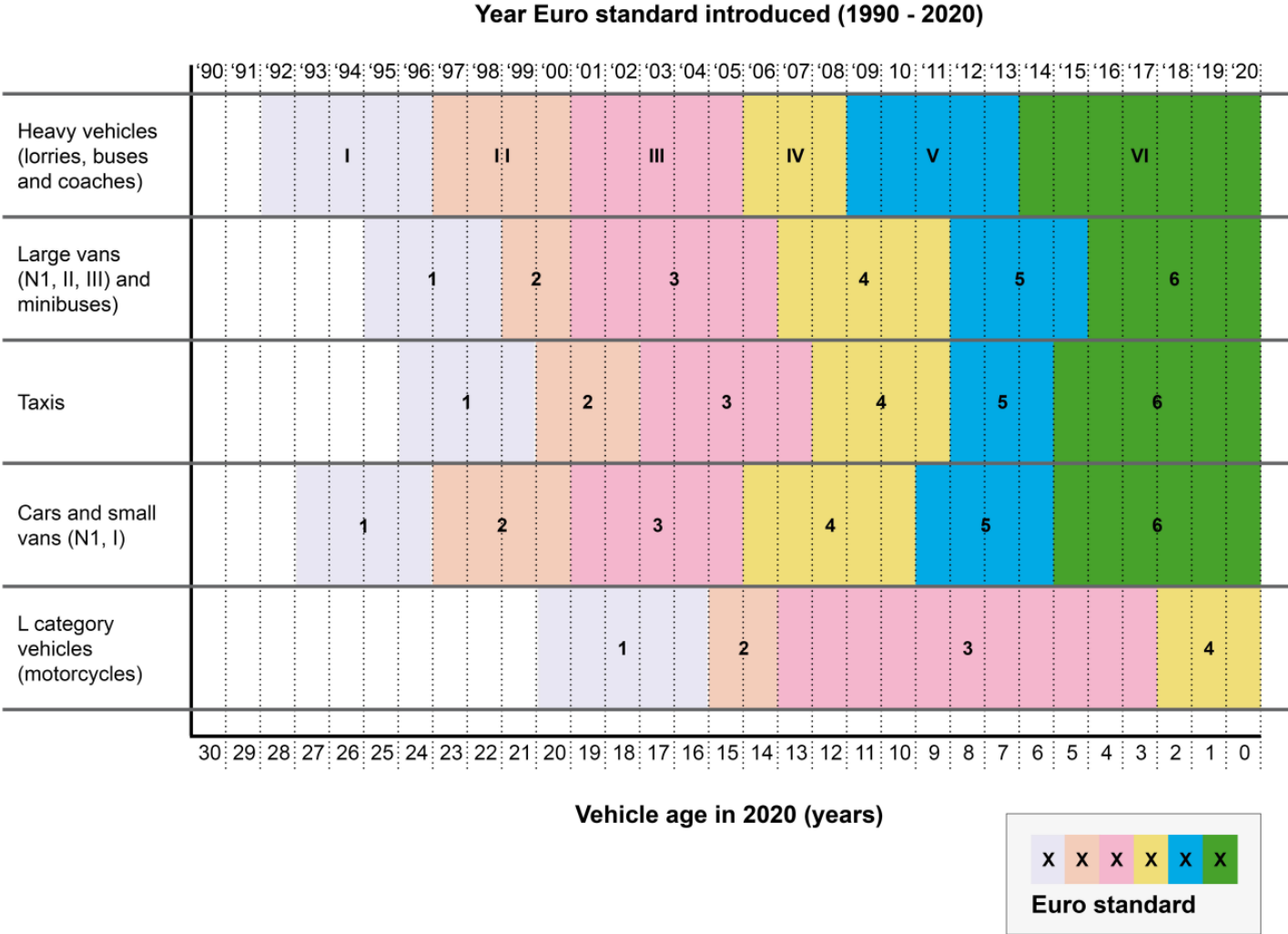


Figure 15: Age of vehicle in 2020 according to vehicle type and year Euro standard apply (1990-2020) for newly manufactured vehicles.

10.4. Reducing pollutants from powered two wheelers

EU emission standards for category L vehicles (which are predominantly motorcycles) began later than passenger cars and have lagged behind the trajectory of emission controls used for other vehicle types (Figure 15). Given the smaller number of vehicles and distance covered, this may have been regarded as a lower priority. Additionally, the cost and feasibility of emission reduction technology also differs substantially (there is limited space on a motorcycle and catalytic converters operate at very high temperatures).

Many motorcycles have traditionally utilised two-stroke engines, especially smaller machines. These were popular because of high power-to-weight ratio and fewer moving parts. Two stroke engines employ a “total loss” lubrication system where the lubricating oil is burnt along with the fuel. This leads to very high emissions of hydrocarbons in particular, including some metallic compounds from the lubricating oil, which is highly toxic. Owing to the way two stroke engines work, they tend to discharge more unburnt fuel than four stroke engines, adversely affecting fuel consumption and increasing air pollutant emissions. The Euro 3 standard has reduced the permissible levels of hydrocarbon and other emissions to the extent that two-stroke engines have virtually disappeared from the marketplace. This has been a positive step for air quality and indicates that reducing the age of this fleet would be advantageous despite their relatively small number and distance covered by these vehicles. Further advances will be made with the introduction of Euro 4 in 2017.

10.5. Alternative fuels

Some commercial vehicles are converted to run on compressed natural gas (CNG) or liquified natural gas (LNG). Sometimes the source of this gas is recycled materials (bio-methane). These gaseous fuel conversions are usually based upon compression ignition (diesel) engines which are adapted to substitute gas for diesel under certain operating conditions (dual-fuel). Some (usually smaller) gas vehicles are based upon spark ignition engines and run on gas alone (mono-fuel).

In either case, the conversion to run on gaseous fuel does not change the type-approval status of the base-vehicle, meaning that for the ULEZ the same emissions standards as for the pre-conversion vehicle apply. In practice this means that where the base-vehicle was diesel (regardless of the conversion), the ULEZ standards for diesel vehicles apply. Where the base-vehicle was petrol, the ULEZ standards for petrol vehicles apply.

11. Zero emission capability

11.1. Plug-in hybrid and range-extended electric and battery electric cars

Most hybrid cars use a combination of petrol and electric engine (a few diesel models exist). Hybrids have been available for several years and are an established and growing market. In electric mode, they have zero emissions at tailpipe. Petrol-electric hybrid engines, frequently emit less than 100g/km CO₂ and have air pollution emissions almost too small to measure (unless they are diesel-electric hybrid).

These vehicles are best suited to urban conditions and have very limited electric-only range, so most manufacturers are now moving toward developing plug-in hybrids which can receive an external charge to top up the battery when the vehicle is stationary. A more detailed summary on methods used to reduce CO₂ emissions from vehicles and an explanation of hybrid and electric technologies in use and in development can be found in Appendix 3.

A development of the hybrid is the plug-in hybrid and range-extended electric technologies³⁴, often referred to as Plug-in Hybrid Electric Vehicles (PHEVs) and (Range-Extended Electric Vehicles (REEVs). These utilise lithium-ion battery technology in place of nickel-metal hydride and can be recharged overnight (and top-up, using fast-charge technology), to provide zero emission driving for up to circa 80km. At this point, the internal combustion engine will start to power the traction motors, giving extended range. These vehicles are particularly suitable for urban driving, with occasional longer journeys. There are a small number of plug-in hybrid cars currently available, with many more nearing launches. These vehicles effectively address ‘range anxiety’, whereby people worry about how far they can travel in an electric vehicle before the battery power runs out, which is a barrier to uptake of battery electric vehicles.

Financial help is available for the cost of purchasing low emission vehicles. Passenger cars with CO₂ performance in the range from 29g/km to 75g/km³⁵ currently qualify for Government grant support through the Office for Low Emission Vehicles (OLEV). Whilst air pollution emissions will be zero in EV mode, the source

³⁴ The definition of these two vehicle types is described further in Appendix 3 but they are essentially both hybrid vehicles that can be plugged into an electricity supply so that they are able to run in pure electric mode for longer.

³⁵ <http://carfueldata.direct.gov.uk/>

of electricity generation also has an air quality and CO₂ impact, but at the point of generation. In addition, when these types of hybrid vehicles have their internal combustion engines in operation, their CO₂ and air quality emissions will be similar to conventional hybrid petrol and diesel cars.

It is essential that support from the Government for the purchase of ultra low emission vehicles continues because concerns about purchase price, range and battery replacement remain a barrier to widespread uptake of these vehicles. It is difficult to see how this situation can be improved until production volumes increase sufficiently for economies of scale to take effect. It seems quite conceivable however that plug-in hybrid may take over from conventional hybrids by 2020. The market for these vehicles is also reliant on other factors such as recharging infrastructure and grid capacity. Purchase price and residual value dictate leasing costs and will therefore strongly influence sales volumes. In time, the development of a second-hand market for plug-in vehicles in general will establish residual values and broaden the range of buyers for whom these vehicles are accessible. This will be a key step in reducing the total cost of ownership for these vehicles.

Taxi and private hire

A number of manufacturers are in the advanced stages of developing range extended hybrid and battery electric taxis for London by 2018. Likewise, several plug-in hybrid vehicles suited to the private hire vehicle market are already available to purchase and this is expected to increase, whereby there are sufficient models that cover the range of services being offered (eg chauffeur and executive). As all private hire journeys must be pre-booked through a licensed private hire operator, there will be opportunity to plan journeys and factor in time between bookings to charge vehicles.

More zero emission capable taxis and PHVs would raise the profile of these new cleaner technologies and demonstrate their viability in high-mileage vehicles. This could help to encourage some taxi and private hire vehicle passengers to also make the step change with their own cars. This has been recognised in the latest stance from the Government in relation to its proposed £500m funding package to encourage ultra low emission vehicles.

11.2. Hybrid buses

TfL has committed to operating 1,700 hybrid buses (including 600 New Routemasters) by 2016. This is 20 per cent of the total TfL bus fleet (8,500 buses). Although the cost of hybrid buses is currently higher than equivalent diesel vehicles, it is believed that total costs should fall owing to greater fuel efficiency. Bus purchasing and leasing cost reductions are being investigated through discussions with vehicle manufacturers, contract negotiations with operators and Government funding opportunities. CO₂ emissions are 1,350 g/km for a Euro VI diesel double deck bus, as opposed to 835 g/km for a Euro VI hybrid double deck and 690 g/km for a Euro V or Euro VI New Routemaster. Crucially, with the procurement of these vehicles the TfL bus fleet will be capable of zero emission operation in certain zones in the future, subject to further advances in technology to control when these vehicles are in electric mode based on their location, which we are investigating.

11.3. Zero emission (at tailpipe)

Recent advances in battery technology and the Government's focus on low carbon vehicles has made them a more viable product. There are currently 22 models of electric vehicle (EV) car and 12 models of EV van eligible for Government grants (correct at September 2014), with a couple of heavier models available but outside the scope of financial assistance. These vehicles have zero emissions (at tailpipe) but air pollution and CO₂ emissions exist at the point of electricity generation depending on the methods used to generate the electricity.

The current pool of all-electric single-deck buses in London increased from six to eight in September 2014 when two Optare electric buses joined route 312, which runs from Norwood Junction to South Croydon. There are currently two BYD (manufacturer) buses alternating in service on routes 507 and 521, and four Optare MetroCity vehicles on route H98. These trials are to allow TfL to assess how this technology could be cost effectively rolled out in the challenging London operating environment. The main barrier to adoption of pure electric buses is cost, although this can be offset by reduced maintenance costs and substantially cheaper fuel.

Funding has been secured from the European Commission to assess the potential of up to four range-extended double-deck hybrid buses employing high-power wireless induction charging infrastructure, whereby the bus parks over an induction charging pad to be recharged rather than having to be plugged in. Charging pads are to be installed at Walthamstow Central and Canning Town Bus Stations, to serve route 69

– subject to confirming grid connections and power upgrades at each location. The vehicles will operate for up to 24 months, starting in spring 2015.

The project is co-ordinated by the International Association of Public Transport (UITP) and part funded by the EU's FP7 grant programme. The aim is to demonstrate the wider benefits of electric buses in urban environments in eight cities across Europe. The bus demonstration will provide detailed evaluation of performance and the feasibility of further roll out.

12. Options to achieve zero emission capability and reduce NO_x emissions from TfL buses

12.1. Zero emission capable buses

Through its contractors and vehicle lease companies, TfL has increased its operation of hybrid buses over the last five years, leading to the largest fleet of hybrid buses in the world. TfL has introduced the latest cleanest technology available at the time, and worked with all parties to ensure this technology is now considered to be the norm.

An increased uptake in hybrid technology is now leading to reduced prices, thus making the procurement of additional vehicles more affordable. In the longer term, this is likely to lead to reduced operating costs from fuel savings, a reduction in TfL's impact on air pollution and climate change and a fleet capable of operating zero emission in certain zones³⁶. TfL is also trialling zero emission technology on single-deck bus routes (at point of use – both electric and hydrogen) and working in partnership with European partners to trial three zero emission capable (range-extended diesel-electric) double-deck hybrid buses employing high-power wireless induction charging infrastructure. These trials are to allow TfL to assess how this technology could be rolled out cost effectively in the challenging London operating environment.

12.2. Euro VI buses

Even with the current scale of investment in hybrid and zero emission technology, TfL buses are still projected to contribute significantly to NO_x emissions unless further

³⁶ We could adopt a 'technology neutral' approach to increase competition between technologies / manufacturers and keep costs down (eg flywheel). However, only certain 'low carbon' technologies are capable of being developed into zero emission capability (eg diesel-electric hybrid).

action is taken. This is partly related to the difficulty experienced with some Euro V buses not performing as well as anticipated and the high mileage of these vehicles. Table 6 sets out the emissions levels for different buses by Euro standard and engine type.

Table 6: Emissions factors according to type of double-deck TfL bus

		NO _x g/km	CO ₂ g/km
Diesel	Euro IV	10	1370
Diesel	Euro V	10	1325
Diesel	Euro VI	0.6	1349
Diesel-electric hybrid	Euro V	9	830
Diesel-electric hybrid	Euro VI	0.6	835
New Routemaster (diesel-electric hybrid)	Euro V	2	690
New Routemaster (diesel-electric hybrid)	Euro VI	0.5	690

The table shows the significant reduction in NO_x emissions from Euro VI as compared to Euro V. It also shows that a Euro V New Routemaster has substantially lower NO_x emissions than other Euro V conventional diesel buses. Additionally, the Euro V New Routemaster comes close in performance to the Euro VI (2g/km compared with 0.6g/km NO_x emissions).

Accelerating the uptake of new Euro VI buses would be effective at reducing NO_x emissions, although it could adversely impact our investment in hybrid buses because many of these only currently comply with the Euro V standard and a disruption to the normal life cycle of buses has the potential to impact future lease and contract prices, particularly for new technologies.

12.3. Option assessment for TfL buses

Taking into account the viability of technology and the Mayor's ambition to sustain investment in hybrid buses and secure zero emission capability, different options were assessed for the TfL bus fleet against cost and emissions savings (Table 7). Crucially, retrofit solutions are starting to emerge on the market for buses and this option assessment has assumed this will be a viable solution for existing vehicles in the fleet, however this is subject to technology trials.

Table 7: Options to reduce emissions from the TfL buses operating in the ULEZ area

TfL buses		NO _x saved (tonnes)	PM ₁₀ saved (tonnes)	CO ₂ saved (tonnes)	Future zero emission capability? ³⁷	Potential cost to TfL
Double-deck (around 2,700 buses operating in central London)						
1	All Euro VI ³⁸	104	1	negligible	X	Medium
2	All hybrid (Euro VI ³⁹)	104	1	9,000	✓	High
Single-deck (around 175 buses operating in central London)						
A	All Euro VI	7	negligible	negligible	X	Low
B	All zero emission	12	negligible	3,000	✓	Medium

From Table 7, it is clear the most effective way to reduce NO_x and CO₂ and deliver future zero emission capability in the double-deck TfL bus fleet is by specifying a hybrid requirement (Option 2). However, to reduce disruption to already-contracted services (and therefore retain value for money), Euro V hybrid buses would need to continue to operate in the ULEZ beyond 2020 (there are around 700 in total Londonwide). TfL will seek to introduce a retrofit solution for the regular (non-New Routemasters) Euro V hybrids (around 400) to ensure they achieve Euro VI NO_x emissions from 2020, in a similar way to the current pan-London programme to raise Euro III buses to achieve Euro VI for NO_x⁴⁰.

Approximately 300 New Routemasters (which have NO_x emissions much closer to the Euro VI standards than other Euro V buses) would continue to operate in the ULEZ without modification at 2020, as it is considered that the cost of retrofitting to make them nearer to or equivalent to Euro VI by that date (approximately £7m) would be more effectively spent on reducing emissions from the higher-emitting buses currently operating on routes outside the ULEZ.

³⁷ Subject to on-going investigation to include technology in hybrid buses, so switch to pure electric mode in certain air quality hot spots.

³⁸ Only double-deck buses type approved Euro VI allowed to operate in the ULEZ area

³⁹ Assumed retrofit solution

⁴⁰ <https://www.tfl.gov.uk/info-for/media/press-releases/2013/january/mayor-and-tfl-continue-drive-to-improve-air-quality-in-putney>

Zero emission buses⁴¹ are part of the Mayor's long term ambition and because technology is further advanced for single-deck buses, it is considered viable that single-deck buses could operate zero emission all the time (eg electric) in the ULEZ Area (Option B). Therefore, a combination of Option 2 and Option B was recommended because:

- It delivers both substantial NO_x and CO₂ emissions savings to improve air quality and mitigate TfL's contribution to climate change
- Contributes toward the Mayor's ambition for zero emission capability
- It is less disruptive to the normal life cycle of buses and therefore less likely to impact future lease prices and enables new technology to be introduced as it becomes viable (such as better range extended hybrids)
- It is likely to be deliverable by the manufacturing supply chain

13. Options to reduce NO_x emissions from taxis and achieve zero emission capability

13.1. Taxi licensing

As set out in section 1.8, all taxis must meet TfL's requirements to achieve accessibility, safety and emissions standards to be licensed for use as a taxi in London. These requirements are set out in TfL's Conditions of Fitness⁴². Emissions savings assumed from amending these requirements have been considered alongside the anticipated cost of compliance for drivers (see Table 8 towards the end of this section).

As the majority of London taxis operate in central London on a regular basis and all drivers are compelled to accept journeys within London⁴³, taxis will be exempt from the ULEZ emissions standards (and therefore the daily charge for non compliance). This exemption is in recognition that unlike PHVs, taxis do not have the option to not operate in central London. It also reflects the fact that only a few vehicle types are

⁴¹ Zero emission at source

⁴² <http://www.tfl.gov.uk/assets/downloads/businessandpartners/taxi-conditions-of-fitness.pdf>

⁴³ up to 12 miles, or 20 miles if the journey commences from Heathrow airport.

licensed to be used as taxis, meaning there is less choice for owners and drivers than there is in the PHV fleet.

Instead, changes are proposed to the taxi vehicle Conditions of Fitness in respect of stipulating zero emissions capability for new vehicles and a tightening of the existing Londonwide taxi age limit. This is also a more direct way of influencing emissions from taxis than applying a charge.

13.2. Zero emission capable taxis

The Mayor announced plans to require all new taxis presented for licensing in the Capital to be zero emission capable from 1 January 2018 (subject to consultation). This is with the intention that, subject to feasibility and technological advances, they will have the capability to automatically operate in zero emission mode while in areas where the Capital's air quality is at its worst, such as parts of central London.

A zero emission capable is considered to:

- Utilise plug-in / battery electric technology or equivalent to achieve a maximum output of 50g/km CO₂
- Achieve a minimum zero emission range of 30 miles to ensure capability of operating in the ULEZ for extended periods whilst in zero emission mode.

A zero emission capable taxi would retain the current 15 year maximum age limit.

Several manufacturers are developing a zero emission capable taxi for London. As already described, there are specific requirements for a London taxi in terms of accessibility, capacity and resilience. A vehicle that meets these requirements and is zero emission capable is therefore likely to be relatively expensive. This has implications for the ULEZ proposal. The provision of appropriate financial support for vehicle purchase and the availability of the appropriate charging infrastructure will be critical to the timely uptake of zero emission capable taxis. There is of course some interdependency here: the expectation of the ULEZ will encourage vehicle manufacturers and charging providers in terms of assuring a ready market. At the same time it is important for TfL to put forward support as described below.

13.3. Purchasing grants for zero emission capable taxis

Taxis are relatively expensive vehicles and are built for a long service life. Unlike PHVs, owners have a very limited choice of models to meet with licensing requirements. As such the purchase of a taxi represents a considerable investment and it is therefore considered appropriate to assist drivers affected by vehicle replacement earlier than anticipated.

The Government recognises that taxis provide a direct means of demonstrating the benefits of zero emission capable vehicles to passengers, and could encourage them to consider these when they next buy a vehicle. As part of a £500m package of measures to support the development and use of ultra low emission vehicles (ULEVs), the OLEV has announced that substantial funds will be made available to local authorities who commit to supporting a step change in cleaning up the taxi fleets in their areas.

The Mayor and TfL are in discussion with the OLEV to ensure that London's taxi and private hire vehicle owners and drivers are able to benefit from the Ultra Low Emission Taxi Scheme and, therefore, the new zero emission capable taxis are affordable. Final confirmation of the level of OLEV funding to provide support is expected in the Chancellor of the Exchequer's Autumn Budget statement, which is expected in December 2014.

13.4. Supporting infrastructure for zero emission capable taxis and PHVs

As well as helping with the cost of taxi purchase, it is also important that the right infrastructure is in place to allow them to operate effectively. In particular, there will need to be appropriate vehicle charging facilities, which for taxis will need to be of the 'rapid-charge' type so that charging stops can be incorporated into the working day.

There has been considerable interest from private companies to deliver rapid charging facilities for commercial vehicles in London, including taxi and private hire vehicles. TfL will be exploring this area in more detail with relevant stakeholders including the taxi and private hire trades, London boroughs, OLEV and UK Power Networks. Again, confirmation of the level of any Government support is expected the Chancellor's Autumn Budget statement. An outline of the proposed technical requirement, supporting infrastructure and funding is included in Appendix 6.

13.5. Reducing NO_x emissions from taxis

For both taxis and PHVs, the proposals seek to encourage the development of a zero emission capable fleet at the same time as removing the oldest and most polluting vehicles from the roads.

The proposed change in taxi licensing requirements to require all newly licensed taxis from 1 January 2018 to be zero emission capable would not achieve sufficient NO_x emissions savings by 2020 on its own. Taxis are projected to be the second highest contributor to NO_x emissions from road transport in 2020 and, similarly to other vehicles, it is necessary to accelerate the retirement of the most polluting older taxis and accelerate the uptake of zero emission capable taxis.

One option to do this would be to mandate that every taxi must be either Euro 6 or zero emission capable as a taxi vehicle licensing requirement from 2020. Whilst this approach would be very effective at reducing NO_x and PM, it would result in nearly half of London's taxi drivers requiring new vehicles. It is considered that this would be excessively onerous in terms of cost and may not be practicable given the supply of vehicles.

An alternative approach would be to reduce the age limit for current taxis. This would save NO_x by removing the oldest diesel vehicles and if adopted alongside a newly licensed requirement from 2018 it would help speed up the uptake of electric technology (zero emission capable). Whilst feasible, it would still pose a challenge to the taxi trade owing to the number of operators of conventional vehicles affected. Table 8 outlines the impact of each option to reduce NO_x from the taxi fleet in 2020.

Table 8: Options to reduce NO_x from Londonwide taxi fleet in 2020 ⁴⁴

Taxis		NO _x saved (tonnes)	PM ₁₀ saved (tonnes)	CO ₂ saved (tonnes)	Proportion of fleet affected	Scale of cost of compliance
1	All zero emission capable	116	5	32,000	81%	High
2	All Euro 6	108	5	27,000	66%	Medium
3	10 year age limit ⁴⁵	54	3	16,000	34%	Low
4	12 year age limit ⁴⁶	37	2	12,000	22%	Low

The proposed reduction in the taxi age limit from 15 to 10 years in 2020 is considered favourable because it:

- Reduces the number of taxis affected in 2020 compared to an all Euro 6 option
- Substantially cuts NO_x emissions from taxis throughout London (by 45 per cent)
- Enables drivers to continue to license taxis up to ten years old (no other ULEZ compliant diesel vehicle would be older than this in 2020)
- Supports the proposal for all newly licensed taxis to be zero emission capable from 2018, by encouraging a switch to newer, cleaner vehicles with a longer 15-year maximum age limit. This would lead to greater emissions savings in the long-term and the entire fleet being zero emission capable much sooner (from 2028).

13.6. Taxi fund for drivers affected by a reduced age limit

A proposed 10 year age limit would result in around 7,500 taxis becoming non compliant by 2020. TfL is therefore proposing to introduce a fund to assist drivers in purchasing newer vehicles. The funding would be offered as a grant to the eligible drivers, and would be phased to smooth the impact of a new 10 year age limit in 2020.

⁴⁴ Accounting for a 2018 newly licensed zero emission capable requirement

⁴⁵ Except zero emission capable taxis, which would retain a 15 year age limit.

⁴⁶ Except zero emission capable taxis, which would retain a 15 year age limit.

TfL is currently developing the details of this scheme including determining the appropriate level of support. As part of this, TfL will be carrying out further work, including commissioning independent expert advice, to understand the impact on the market of the proposed policies and will discuss this with the taxi trade. More detail on this support will be available when TfL's Business Plan is published later this year, during the consultation period. Likewise, it is anticipated further announcements will be made by the OLEV in due course.

14. Options to achieve zero emission capability and reduce NO_x emissions from PHVs

14.1. PHV licensing

Any vehicle that seats up to eight passengers and is available for hire with a driver requires a PHV licence. PHV London legislation sets 'prescribed requirements' with which vehicles must comply before they can be licensed. As already stated in section 1.8, owners and drivers are able to choose from a very wide range of vehicle models (which is not the case for taxis) and as a consequence of this, and the range of services offered under the PHV umbrella, the fleet is very diverse.

14.2. Zero emission capable PHVs

While the proposals are intended to incentivise the development of zero emission capable PHVs and taxis, it is likely that in any case these will be available more readily for the PHV market given its diverse fleet.

To coincide with the Mayor's ambition for zero emission capability, TfL is seeking to introduce a similar requirement for PHVs as for taxis whereby PHVs presented for licensing from 2018 must be zero emission capable. However, it is recognised that unlike taxis, the majority of PHV drivers enter the trade with vehicles that are not newly manufactured and have not been previously licensed as PHVs⁴⁷. Therefore, TfL needs to continue to allow for some second-hand vehicles to also be licensed for the first time. It is proposed there are two distinct requirements depending on whether the vehicle is newly manufactured or already used.

⁴⁷ There are around 14,000 PHVs licensed for the first time every year and 65 per cent of these are second-hand vehicles. There are approximately 1,400 taxis new to licensing every year and nearly all of these are newly manufactured.

For newly-manufactured PHVs, the proposed definition for a zero emission capable PHV is as follows:

- Utilise plug-in / battery electric technology or equivalent to achieve a maximum output of 50g/km CO₂
- Achieve a minimum zero emission range of 30 miles to ensure capability of operating in the ULEZ for extended periods whilst in zero emission mode.

The determination of whether a PHV is newly-manufactured or not would be made by reference to the date of first registration with the Driver and Vehicle Licensing Agency (DVLA), or date of vehicle manufacture.

For PHVs other than those newly-manufactured, the following criteria would apply:

- All other older (second hand) vehicles presented for licensing from 2018 (must be not less than 18 months old as determined by the date of first registration with the DVLA) would need to meet the ULEZ emissions standards (ie Euro 6 diesel or Euro 4 petrol).
- The current five year introductory age limit would be discontinued at this time.

Further information on the supporting infrastructure and funding for zero emission capable taxis and PHVs is included in Appendix 6.

As set out in Chapter 13, there is some uncertainty around the large-scale uptake of zero emission capable taxis and PHVs due to the fact that this is a relatively new vehicle market and the need to put in place the appropriate charging infrastructure for these vehicles. The issue of vehicle availability is less of a challenge for the PHV market as, unlike taxis, the choice of vehicle is not limited to a few models. As stated above, hybrid and electric PHVs are already in use. Nevertheless, it will be important to ensure that this market continues to develop and is supported by rapid-charging points in the right locations.

14.3. Reducing NO_x emissions from PHVs

The PHV fleet is roughly double the size of the taxi fleet (up to 51,000 vehicles) but it is only projected to contribute to 4 per cent of NO_x emissions from road transport in central London in 2020. This is partly owing to a low average fleet age (4.5 years), a

wide variety of vehicles being used (including hybrid and a larger proportion of petrol as opposed to the dominance of diesel in the taxi fleet) and a smaller frequency of journeys in central London.

There is currently a ten year age limit for PHVs and, similar to taxis, this could be reduced to accelerate the turnover of vehicles (in conjunction with an exemption from the ULEZ charge). However, the impact of doing so was considered to be disproportionate given PHVs contribute far less to NO_x emissions and many drivers do not operate in central London (approximately 40 per cent of the fleet are not observed driving in central London).

Instead, an alternative option was considered whereby PHVs (unlike taxis) would need to meet the ULEZ emissions standards just like other private and commercial vehicles. It is assumed market competitiveness would warrant journeys into central London and it would be at the operator's discretion whether or not to comply with the ULEZ emissions standards (or pay the charge) if it was driven in the zone. The age limit would remain and TfL would continue to permit PHVs to be licensed up to ten years in age⁴⁸.

⁴⁸ This would allow the gradual introduction of newer and cleaner, safer vehicles to the industry while still achieving a realistic working life from a vehicle without significant financial impact to an operator.

Table 9: Options to reduce NO_x from PHV fleet in 2020⁴⁹

PHVs	NO _x saved	PM ₁₀ saved	CO ₂ saved	Total cost (£m)	No. of vehicles affected	% of fleet affected	Cost per vehicle (range on minimum cost)
7 year age limit	-14%	-47%	-1%	Medium	7,500	15%	£1,000-£5,000
5 year age limit	-27%	-47%	-3%	High	16,500	32%	£2,000-£8,500
All ZEC	-33%	-47%	-53%	High	38,000	74%	£5,000-£17,000
All Euro 4 or Euro 6	-26%	-37%	-2%	Medium	16,000	31%	£500-£10,000
In ULEZ	-25%	-21%	0%	Low	9,500	19%	£500-£10,000

The option not to reduce the PHV age limit and instead, make PHVs subject to the ULEZ emissions standards was considered favourable because:

- It is fair to the fleet of PHVs that operate in outer London that do not operate in central London very often, and do not contribute significantly to NO_x emissions when they do
- It achieves the same emissions savings in central London as a reduced age limit⁵⁰
- It substantially reduces the number of vehicles affected and therefore cost incurred by the industry
- It affects PHVs when driven in central London for private use (and not working as a PHV)

⁴⁹ Worst case emissions saving assumed (where no new ZEC vehicles enter the market to respond to the age limits and Euro 4/6 policy). For all policies except 'in ULEZ' the savings are Londonwide with the equivalent saving achieved in central London. 'In ULEZ' is just a saving in central London

⁵⁰ A competitive PHV market is assumed to result in high compliance with the ULEZ

15. Technical assessment of ULEZ emission standards

15.1. Technical assessment

The aim of the technical assessment was to identify a single option to be taken forward for public consultation. Following the earlier strategic assessment, the most practical, feasible and deliverable variables were considered for a complete technical assessment (

Table 11). The combined impact of these variables was then analysed according to how drivers might respond to costs (eg the likely purchase price of a compliant vehicle) and the corresponding emission savings in 2020. Owing to the large number of vehicles, small changes to scheme parameters can lead to significant changes in the total cost of compliance and benefits of the scheme (such as emissions saving and traffic reduction).

Table 10: Variables for technical assessment

Vehicle type	Potential emissions standards	Charge level	Operating hours
Powered two-wheelers	Euro 3	Low or High	CC hours or 24/7
	Euro 4		
Cars and small vans	Euro 4 / 6		
	Euro 6 ⁵¹		
	Zero emission capable		
Large vans and minibuses	Euro VI		
Lorries, buses and coaches	Euro VI		

Behavioural responses were modelled as part of the technical assessment, which in turn enabled the estimation of potential secondary impacts, such as changes to traffic volumes and emissions. The assessment made use of the LAEI, and for the final option, used TfL's traffic models, surveys undertaken with Londoners to assess the likely behavioural responses and full runs of the London Emissions Toolkit and London Air Quality Model.

⁵¹ For comparative purposes

The number of users that would already be compliant with a given emissions standard in 2020 was estimated using the London Atmospheric Emissions Inventory (LAEI), which includes projected vehicle fleet compositions in 2020 (adjusted to reflect central London vehicles rather than a London-wide average). Once ‘already compliant’ users were identified, additional analysis was undertaken to assess the response of non-compliant users (Figure 16).

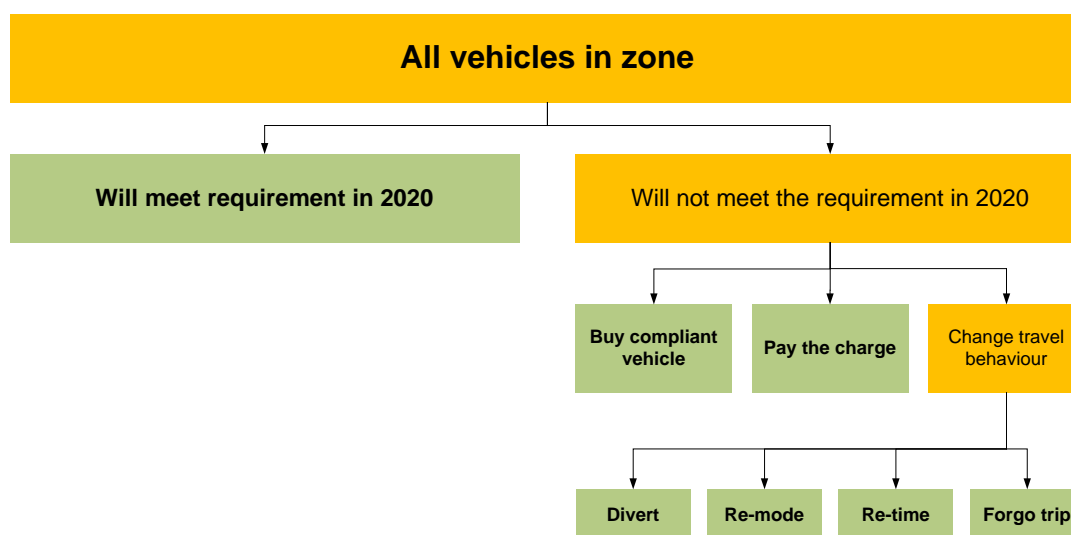


Figure 16: Schematic of possible responses to the ULEZ emissions standards

15.2. Estimating ‘non-compliance’ and behavioural response in 2020

Estimating the response of non-compliant users (those not expected to be compliant under a ‘business as usual’ scenario in 2020) required information on the relative costs of the different behaviours that could be adopted by vehicle operators and the frequency with which the user would enter the ULEZ.

The cost per trip of buying a compliant vehicle was compared with the cost of making a trip in an existing, non-compliant vehicle (ie staying and paying the daily charge). Calculations of vehicle costs took into account the average age of the compliant and non-compliant vehicles (ie fleet age profiles) and their depreciated value. The more frequently a user enters the ULEZ, the more frequently they become liable for the daily charge if they drive a non-compliant vehicle. Consequently, the more frequently a user enters the ULEZ, the more likely they are to buy a compliant vehicle to avoid this charge. Whilst frequent users of the zone make up a small proportion of total unique vehicles that enter the ULEZ over a period of a year, they contribute a large proportion of the distance driven on a given day (and thus emissions). As outlined earlier in Chapter 4, this varies substantially across different types of vehicles.

The decision on whether to incur the relative costs of paying a daily charge or upgrading a vehicle is dependent on the price elasticity of demand. This was calculated using values derived from TfL^{52,53} and academic studies⁵⁴, applied to each of the different vehicle types. This allowed an estimate to be made of the proportion of users who were likely to upgrade, pay or stop driving in the ULEZ during the period of enforcement.

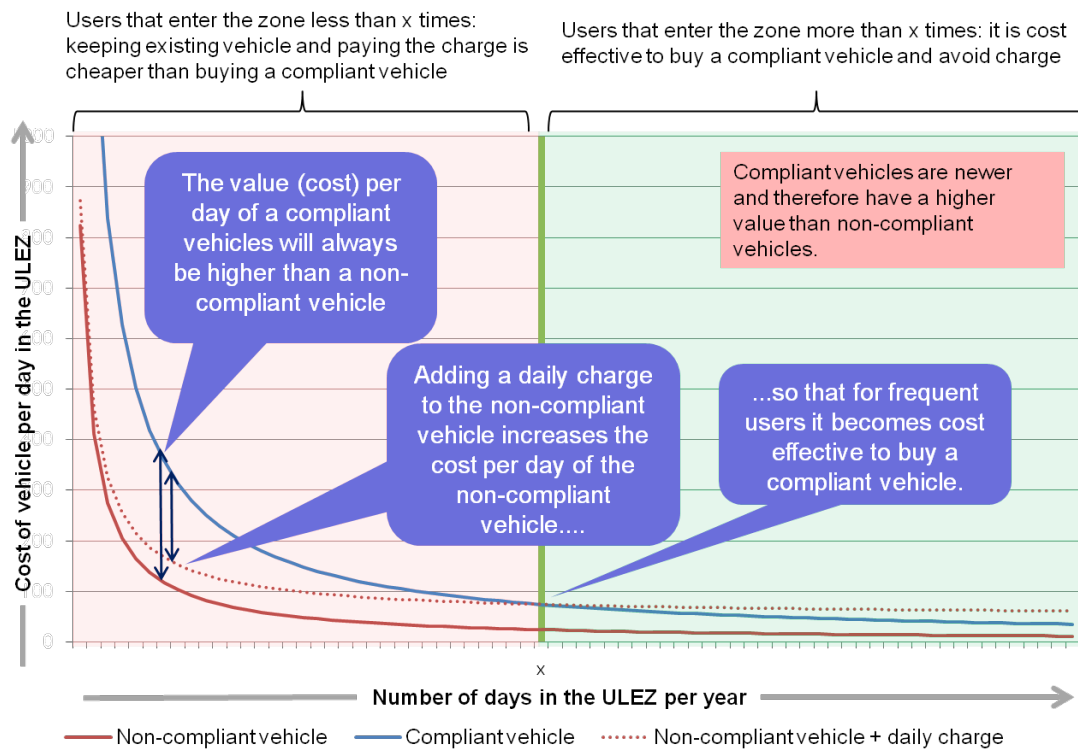


Figure 17: Illustration of how a daily charge induces vehicle upgrade

Using this data, the breakdown in user behaviour for each option was estimated (Figure 19). In most instances, a high daily charge levied on non-compliant vehicles demonstrated a larger uptake of compliant vehicles but also a much higher proportion of journeys being deterred (ie not being made). Very few car and van users were assumed to stay and pay a high daily charge. The proportion of deterred journeys was estimated to be as high as 50 per cent under high daily charge scenarios where compliant vehicles were relatively more expensive than the average non-compliant

⁵² <http://www.tfl.gov.uk/assets/downloads/demand-elasticities-for-car-trips-to-central-london.pdf>

⁵³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/232294/hgv-charging-tax-information.pdf

⁵⁴ Graham, D. J., & Glaister, S. (2004). Road traffic demand elasticity estimates: a review. *Transport reviews*, 24(3), 261-274.

vehicle. Under low level daily charges, users are less likely to be deterred altogether and, depending on the standard, more likely to stay and pay each day instead of purchasing a compliant vehicle. Where the emissions standard reflects more conventional and mainstream technology then the likelihood of vehicles being upgraded is increased. It should be noted here that reducing the volume of traffic in central London is not an explicit goal of this policy.

Having calculated the likely behavioural response, fleet compositions were updated to reflect the assumptions made, and total distance driven in the zone was revised (to take account of trips no longer being made). The associated costs and emission savings calculated were plotted to identify the best balance between cost of compliance and emissions savings (Figure 18).

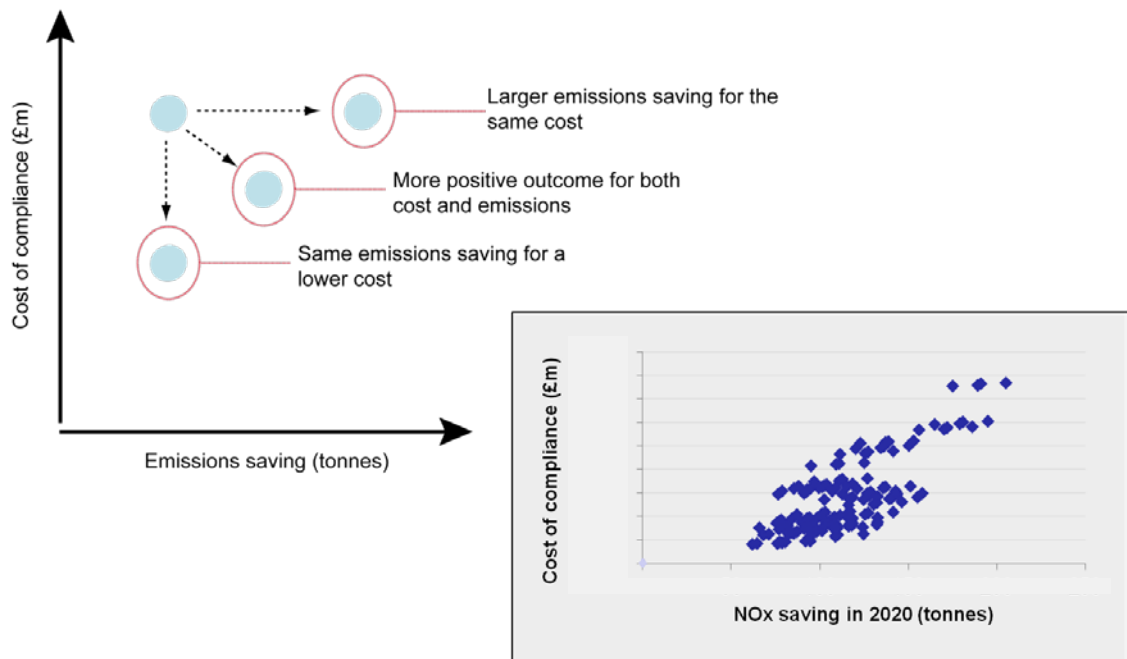


Figure 18: Illustration of the technical assessment

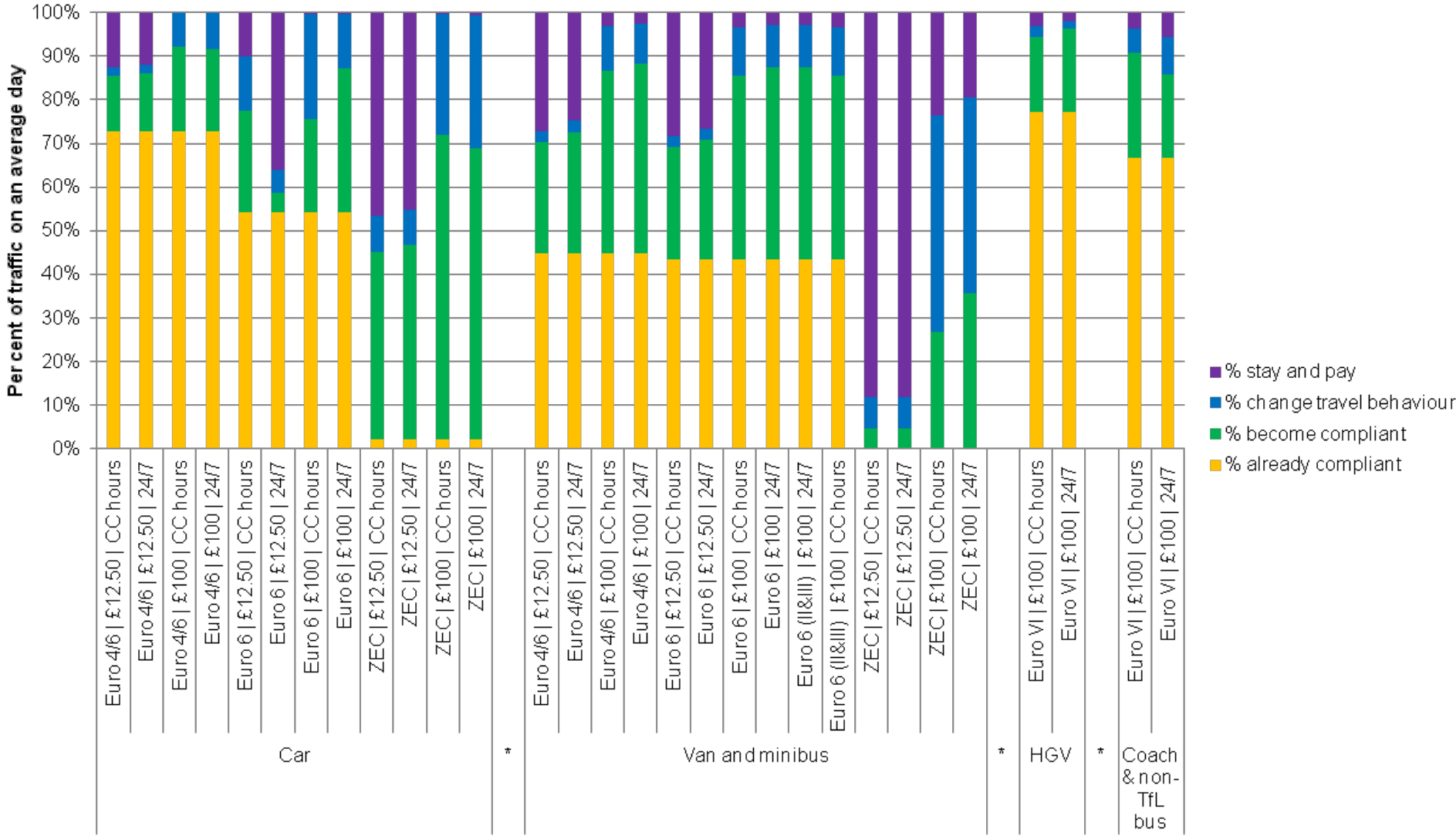


Figure 19: Estimated behavioural response for unique vehicles in 2020

15.3. Hours of enforcement

Initial sensitivity analysis demonstrated that a 24/7 scheme could save more than double the NO_x emissions of a CC hours only scheme across a year (assuming no changes in vehicle flows across the day). This would lead to a greater reduction in the annual mean concentrations of NO₂ which would be most apparent in areas closest to road transport sources.

Taking into account the analysis of behavioural responses, Figure 20 reinforces the proposition that the longer the enforcement period, the larger the vehicle catchment is likely to be and therefore the greater the emissions saving. This is particularly the case for commercial vehicles because the decision whether to upgrade vehicles is less likely to be influenced by operating hours because journeys are more time critical. Enforcing the ULEZ emissions standards 24/7 is consistent with existing policy to control emissions (eg LEZ enforcement hours, which are also 24/7) and retain autonomy from the CC.

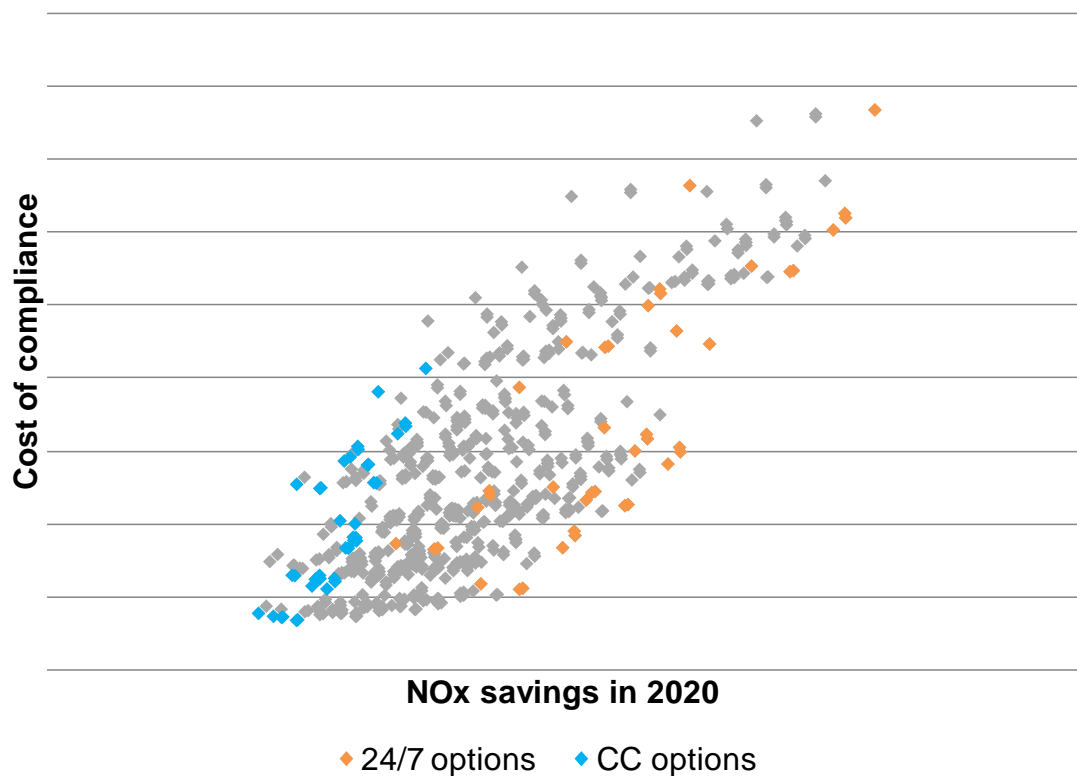


Figure 20: Distribution of options according to hours of enforcement

15.4. Daily charge

Vehicles that do not meet the ULEZ emissions standards would need to pay a daily charge if they choose to continue to drive within the ULEZ. This would result in differing responses amongst drivers of non-compliant vehicles:

- Continue to drive within the zone and pay a charge
- Change route of journey to avoid the zone
- Change destination
- Change mode of travel
- No longer make some trips

Higher charging scenarios for light vehicles result in a much more constrained behavioural response because it encourages non-compliant users to change their travel behaviour (rather than just paying the charge), including forgoing the trip entirely. Whilst ‘stay and pay’ behaviour does not reduce emissions, it is reasonable to expect a number of users to enter the ULEZ without upgrading their vehicles from the start of the scheme in 2020, owing to the lower frequency of their journeys. This capacity to choose a response provides users with more flexibility and time to facilitate vehicle upgrades or permanently adjust travel behaviour. This is particularly relevant to van drivers, for which new Euro 6/VI vehicles emerge much later onto the market. Therefore, a charge of £12.50 for light vehicles is considered to generate the greatest emissions savings possible without resulting in an overall negative economic impact.

Similarly, a charge of £100 for heavy vehicles is expected to be necessary to generate a response that will result in substantial emissions savings. This scale of difference recognises that heavier vehicles emit around 10 to 12 times the quantity of NO_x per kilometre than lighter vehicles. It is also broadly consistent with the LEZ, which specifies a higher charge to strengthen the economic case for operators to purchase or upgrade vehicles and encourage a high level of compliance.

15.5. Large vans and minibuses

There is a substantial difference in the cost of compliance when large vans and minibuses are given the same level of charge as other heavy vehicles. This is because new Euro VI large vans are unlikely to be available to purchase until 2016, which is nearly two years later than other heavy vehicles (eg HGVs). This is likely to result in operators with a majority of large vans in their fleet being disproportionately

affected owing to a shorter lead time to purchase vehicles. In addition, preliminary analysis of CC Fleet Auto Pay data indicates that approximately 40 per cent of vans are operated by small businesses in comparison to 10 per cent of HGVs⁵⁵. Therefore, vans and minibuses have been positioned alongside light vehicles, such as cars, to reduce the financial burden on small business operators that have non-compliant vehicles (ie a lower daily charge level).

15.6. Zero emission capable emissions standard for light vehicles

The Mayor has stated he is keen to accelerate the uptake of vehicles with zero or near-zero emissions. An alternative zero emission capable ULEZ emissions standard was therefore also investigated for light vehicles. Figure 21 shows that under low charges, zero emission capable policies lead to a large proportion of users staying and paying the ULEZ charge. Under a high charge scenario many users change their travel behaviour (ie taking a different mode or deferring their journey altogether), which is likely to have a negative impact on central London's economy if the latter is more prominent. Reducing vehicles use is not the purpose of the scheme.

Production volumes of zero emission capable vehicles will need to increase sufficiently for economies of scale to take effect, which in turn enables the new vehicle market to mature and a potential second-hand market to emerge. A strengthening of the ULEZ emissions standard (eg 2025) will be considered at a later date, with reference to developing technologies, the availability of vehicle models and their associated costs. In the meantime, TfL will continue to work with the Government to secure financial support for the purchase of these vehicles and monitor the effectiveness of incentives such as the Ultra Low Emission Discount (ULED) on the Congestion Charge. Likewise, TfL is seeking to increase the number of buses, taxi and PHVs capable of operating with zero emissions. This will create demonstrator fleets in London, boost industry sales and help lead the transition towards this technology.

⁵⁵ Small business defined with less than five vehicles and at least one van or three cars registered on an Auto Pay account.

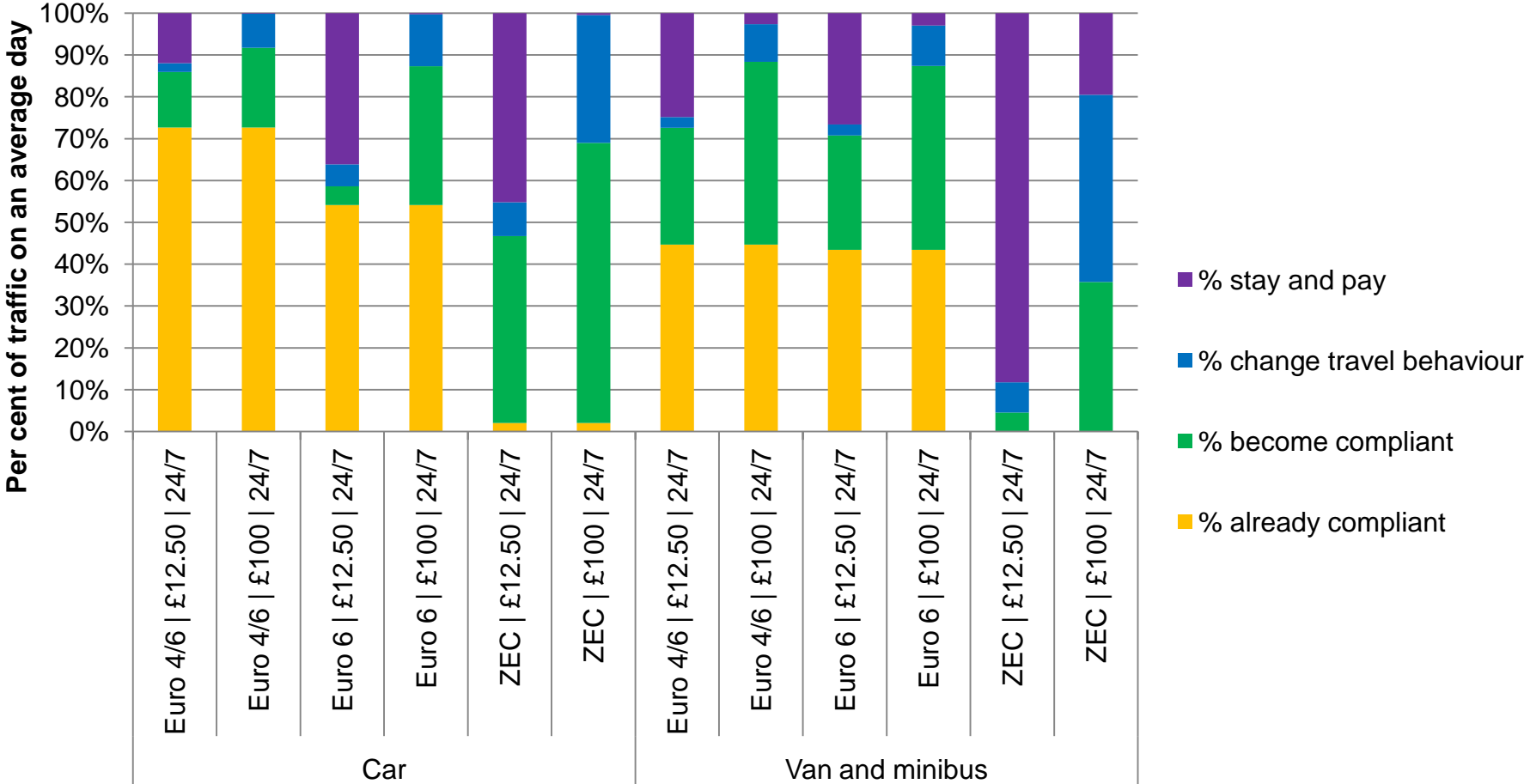


Figure 21: Projected behavioural response of different ULEZ emission standards for car and van users

15.7. Exemptions and discounts

It is proposed that the small number of vehicle types that are currently exempt from the LEZ would also be exempt from the ULEZ. These include agricultural vehicles, military vehicles, historic vehicles⁵⁶, non-road going vehicles which may be driven on the highway (for example excavators) and certain types of mobile crane. These vehicles typically use engines certified to different standards than road-going engines. Some of these vehicles are proposed to be exempt owing to their unsuitability for conversion to an alternative fuel or engine replacement. The Mayor continues to seek improvements to these other vehicles, such as non-road going vehicles, as set out in the MAQS.

Taxis

In light of the proposed changes to taxi licensing and the reduction in the taxi age limit, it is proposed all taxis licensed in London will be exempt from the ULEZ emissions standards (irrespective of being zero emission capable or not). PHVs would not be exempt.

Residents of the zone

It is proposed all residents living in the ULEZ while it is operational in the phase September 2020 to September 2023 will be granted a three year time-limited 100 per cent discount on any ULEZ charge that their vehicle might incur. This is to acknowledge that they are unable to avoid the ULEZ (for example by re-routing a journey) and may require more time to change their vehicle for one to meet the ULEZ emissions standards. ULEZ residents' vehicles would therefore need to be compliant with applicable ULEZ emissions standards from 7 September 2023 (instead of 2020). After that point all residents must pay 100 per cent of the daily charge to drive a non-compliant vehicle in the ULEZ. This provides residents with eight years advance notice.

Residents' vehicles registered for the Congestion Charge Residents' discount will automatically be registered for the ULEZ discount (until it ceases in 2023). Residents not registered for the CC Residents' discount will have to register with TfL (£10 registration fee) to receive the ULEZ residents' discount for their registered vehicle.

⁵⁶ vehicles manufactured before 1973

The ULEZ residents' discount will be available to residents within the zone and in designated areas next to the zone (as apply to the CC Residents' discount).

15.8. Enforcing the ULEZ emissions standards

It is proposed the ULEZ emissions standards would be enforced using Automatic Number Plate Recognition (ANPR) cameras – both fixed and mobile – already installed within the ULEZ area, which are also used for Congestion Charge enforcement. The cameras would capture the number plates of vehicles and check vehicle details against a database of vehicles that met and didn't meet the required emissions standards and for which the ULEZ charge had been paid.

If a vehicle did not meet the emissions standards and the daily charge had not been paid, a PCN would be issued to the registered keeper of the vehicle. It is proposed this would be £1,000 (reduced to £500 if paid within 14 days) for heavy vehicles and £130 (reduced to £65 if paid within 14 days) for light vehicles (cars, vans, motorcycles and other L1 vehicles).

For drivers registered with AutoPay, the combination of CC and ULEZ charges would be automatically calculated and billed (this does not include any penalty charges for which a separate procedure exists). For drivers who are not registered but are paying the CC, a ULEZ charge would automatically be added if applicable and itemised accordingly. Anyone who is not registered and is driving in the ULEZ outside CC hours would need to remember to pay the daily ULEZ charge if they are driving a vehicle that does not meet the ULEZ standards.

It is expected that the ULEZ would have signs at its boundary and repeater signs within the zone, similar to those for the CCZ. If ULEZ is approved by the Mayor, TfL would work with DfT on developing an appropriate sign. We would also engage with the London boroughs affected. We would seek to minimise adverse visual impacts of signage. As well as the signs, an extensive publicity and marketing campaign would be undertaken in the run-up to the introduction of the ULEZ to ensure that drivers are aware of where the zone is, the emission standards and options for compliance. Using the same boundary as the CCZ will help to ensure that the ULEZ is well-understood by drivers

15.9. Conclusion of the technical assessment for the ULEZ emissions standards

To project behavioural response to the ULEZ, fleet compositions were examined to estimate the proportion of 'already compliant' vehicles. Non-compliant users were able to respond in several ways, such as purchasing a compliant vehicle, deterring a journey or paying a charge and estimates of these charges were made.

In most instances, a high charge or a more 'conventional' emissions requirement resulted in an increased likelihood of vehicles being upgraded. However, there was a clear trade-off between the proportion of users opting to forgo their journey and those purchasing a compliant vehicle. A high charge where compliant vehicles are relatively more expensive than the average non-compliant vehicle resulted in high deterrence (which was considered detrimental to London's economy).

Where a high proportion of users change their travel behaviour, there is assumed to be a greater efficiency as emissions savings have less cost to the user. However, in reality, trips being deterred could lead to secondary economic disbenefits, which need to be taken into consideration. Emissions savings from heavy diesel vehicles are significant across all options with the emissions impact of options for lighter vehicles diminishing substantially if the charge only operated during CC hours. It should be noted here that the options for changing travel behaviour vary by vehicle type. While a journey made in a car for personal reasons may for example be switched to public transport, this is unlikely to be a viable option for commercial vehicles such as vans and lorries.

There was a broad correlation between increased compliance cost and emissions savings. This is with the exception of a Euro 6 requirement for cars and vans, where the introduction of a concession for petrol fuelled vehicles (Euro 4) was considered more acceptable as it made no difference to NO_x but reduced cost substantially. This concession also addresses issues of operational feasibility and fairness.

A balance was therefore struck between the source of the emissions savings, the total amount saved and the cost per tonne saved and operational issues. The proposal considered most effective in reducing emissions and acceptable and/or feasible by stakeholders was recommended for further assessment. Figure 22 illustrates the cost effectiveness of the recommended proposal, which achieves a balance in both the NO_x emissions savings and cost of compliance for vehicle owners. The recommended proposal was then analysed in more detail, incorporating

survey results, traffic model outputs, detailed emissions and air quality impacts and a further impact assessment.

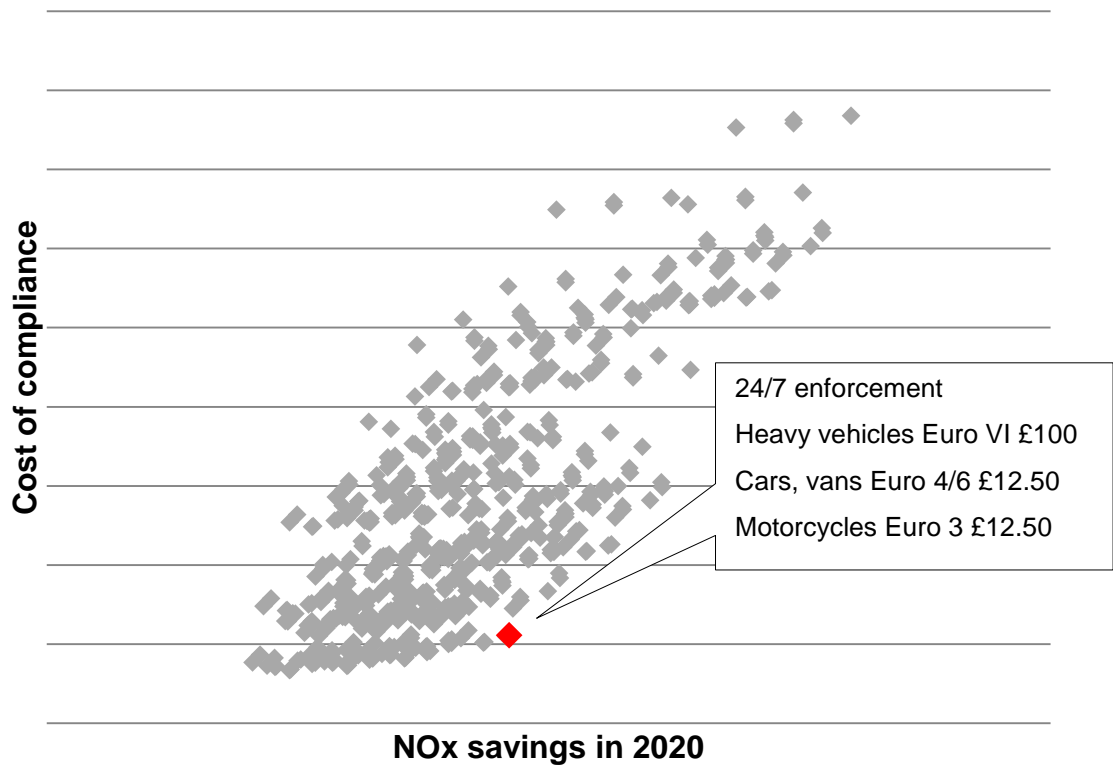


Figure 22: Recommended proposal to be taken forward according to cost of compliance and NO_x savings in 2020

Part 3: Proposed scheme and next steps

16. Recommended ULEZ proposal

16.1. Description of the recommended ULEZ proposal

It is recommended the ULEZ proposal would require all vehicles in central London to meet emissions standards in order to drive in the zone without paying a charge. This would operate in the same area as the Congestion Charging Zone, 24 hours a day, 365 days a year.

The ULEZ charge for non-compliant light vehicles, such as cars and vans, would be £12.50 a day. For heavier vehicles, such as lorries and coaches, it would be £100 per day. This will be enforced using the existing camera network and failure to pay would result in a penalty charge notice of £1000 (reduced to £500 if paid within 14 days) for heavy vehicles and £130 (reduced to £65 if paid within 14 days) for light vehicles.

This would be supported by additional requirements for TfL services:

- A requirement that all taxis and new PHVs presented for licensing from 1 January 2018 would need to be zero emission capable⁵⁷;
- A reduction in the age limit for all non zero emission capable taxis from 7 September 2020 from 15 to 10 years (irrespective of date of licensing); and
- Investment in the TfL bus fleet so that all double deck buses operating in central London will be hybrid and all single deck buses will be zero emission (at tailpipe) by September 2020.

A summary infographic of the recommended ULEZ proposal is provided in Appendix 7. Table 12 demonstrates the corresponding emissions savings and estimated compliance costs. In the column for cost per vehicle, the range given is based on the minimum cost of compliance. The upper end of the range is the cost of buying the oldest compliant vehicle if the current vehicle owned was worth nothing. The lowest value applies where a non-compliant vehicle is just a year too old to be compliant and the owner then buys the oldest compliant vehicle. The £500 for cars takes into account the ability to buy a compliant petrol vehicle of a similar age.

⁵⁷ See sections 13.2 and 14.2 for a definition of zero emission capable

Table 11: Emissions savings and compliance costs according to vehicle type

Vehicle type	Emissions standard and charge	NO _x saved (tonnes)	PM ₁₀ saved (tonnes)	CO ₂ saved (tonnes)	Cost per vehicles (minimum, £)
HGVs	Euro VI £100	34	<1	859	3,000-16,000
Coaches and non TfL buses	Euro VI £100	28	<1	441	10,000-50,000
Vans and minibuses	Euro 6/4, £12.50	35	1	2115	2,500-12,000
Cars	Euro 6/4 £12.50	68	2	5512	500-10,000
Motorcycles and other L category	Euro 3 £12.50				

16.2. Impact on air quality and CO₂

Based on current calculations, the ULEZ proposal as specified above would deliver a 51 per cent reduction in NO_x emissions (Figure 23), a 64 per cent reduction in PM₁₀ exhaust emissions and a 15 per cent reduction in CO₂ emissions from road transport in the ULEZ in 2020⁵⁸.

Emission reductions from the ULEZ proposal will take London well towards meeting legal limits for NO₂. Crucially, the number of people living with levels of NO₂ that exceed legal limits will reduce by 74 per cent in central London. There will also be a positive impact on concentrations of PM₁₀ and PM_{2.5}, which can be found in Appendix 8 and Appendix 9.

⁵⁸ These are the latest emissions calculations following analysis by King's College London

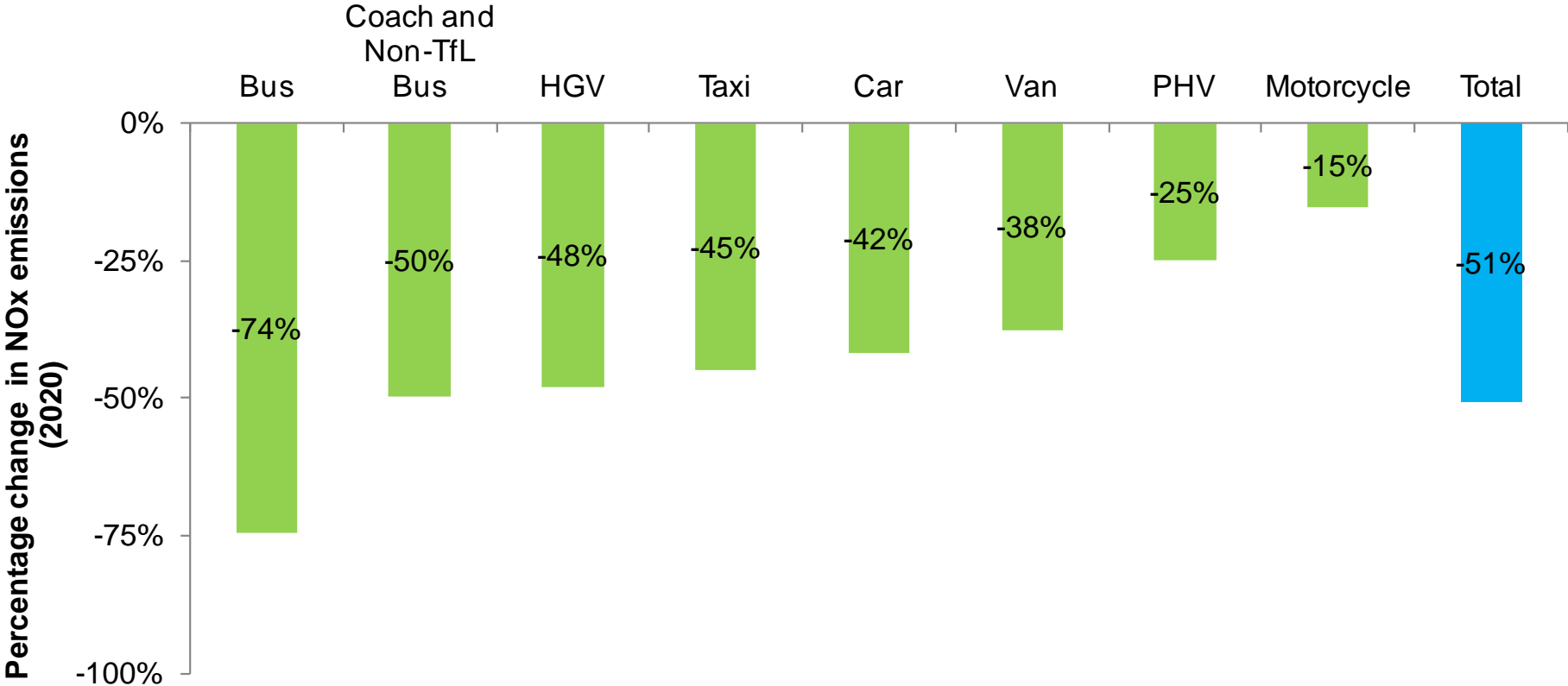


Figure 23: Impact of ULEZ proposal on NO_x emissions in the ULEZ according to vehicle type

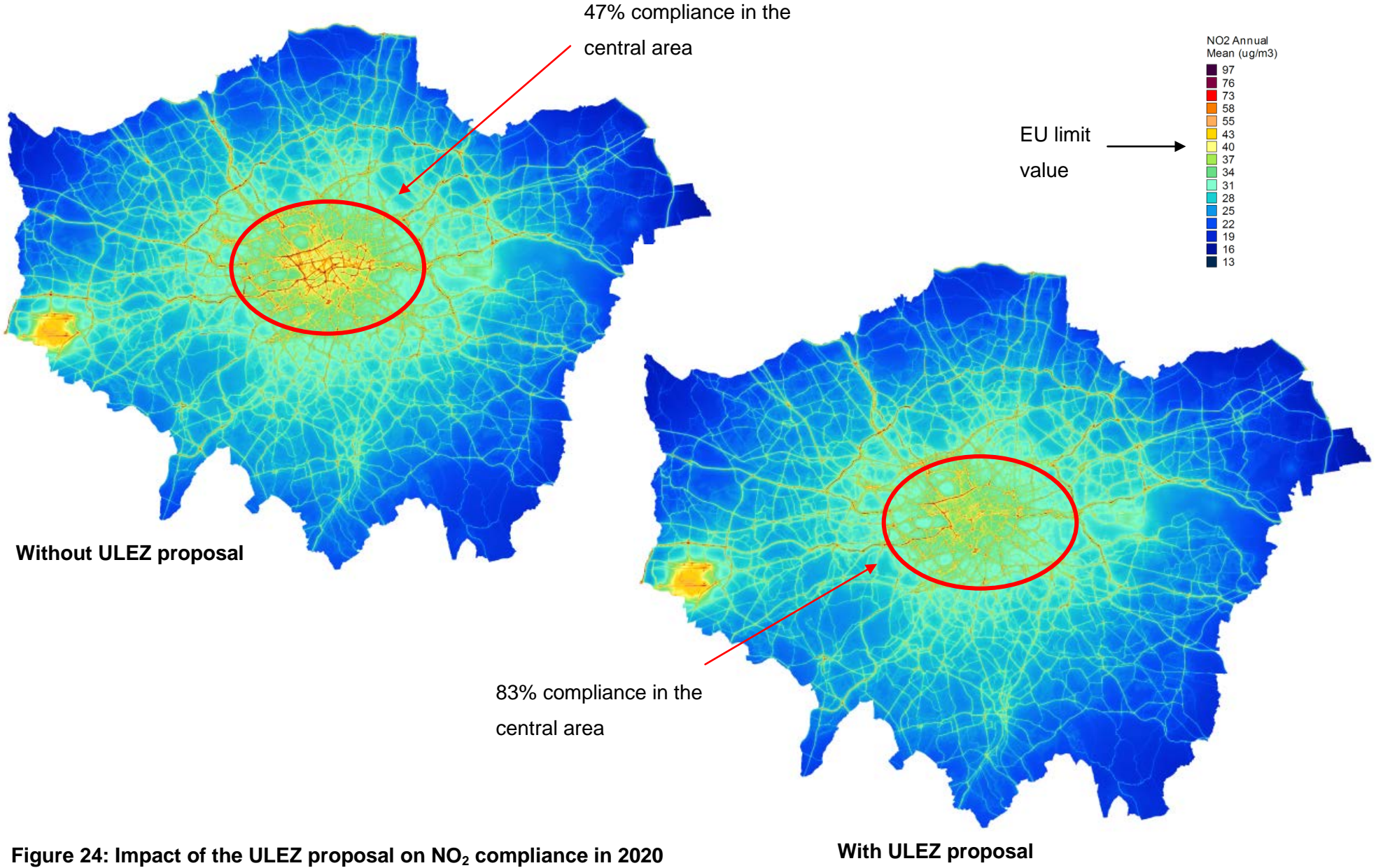


Figure 24: Impact of the ULEZ proposal on NO₂ compliance in 2020

16.3. Emissions impact across London

The ULEZ proposal will achieve reductions in emissions more widely across London than just those in the ULEZ alone. This is because many drivers start and end their journeys outside of central London. These additional reductions form a worthwhile benefit of the scheme. An assessment has been undertaken to estimate the emissions impact elsewhere in London (Table 13).

Table 12: E emissions impact from the ULEZ proposal in 2020

	ULEZ	Inner London	Outer London
CO₂	-15%	-3%	-1%
NO₂	-50%	-18%	-10%
NO_x	-51%	-16%	-10%
PM₁₀ (exhaust)	-64%	-19%	-4%
PM_{2.5} (exhaust)	-64%	-19%	-4%

These savings in emissions outside the ULEZ will help the achievement of legal limits for NO₂ more widely, particularly in inner London where any increases in traffic flow of non-compliant vehicles on the Inner Ring Road is offset by the cleaner vehicle fleet operating as a result of ULEZ.

16.4. Traffic and transport effects

The reduction of traffic or congestion is not an aim of the ULEZ. However, as demonstrated in the behavioural analysis, introducing an emissions requirement for vehicles is likely to deter a small proportion of trips. For drivers who make only infrequent trips in the zone (of which there is a high level), it would not be economically rational to upgrade their vehicle specifically to comply with the ULEZ standards and so these users are more likely to 'stay and pay' the ULEZ charge. Those who visit more frequently are more likely to upgrade their vehicle. In both cases there will be a small number of users unwilling to pay either the ULEZ charge or the cost of upgrading their vehicles and so will be deterred from using their vehicle in the ULEZ.

Through the behavioural analysis undertaken for ULEZ the final proposal is expected to lead to around a seven per cent reduction in car trips, an eight per cent reduction in van trips, a four per cent reduction in coach trips and a two per cent reduction in

HGV trips. For cars and vans respectively only two and three per cent of trips are expected to not occur at all with the remainder being made by another mode or route.

An estimate of the proportion of traffic reduced as a result in this change in trip making is presented in Appendix 10.

Trips diverting around the ULEZ could use the Inner Ring Road. Experience with the CC suggests that 'new' trips diverting onto the Inner Ring Road will be counterbalanced by capacity 'freed up' by otherwise deterred trips. Additionally, given that the CC is already a deterrent, the number of 'through trips' during the daytime hours are likely to be small in number. Other traffic deterred from the ULEZ could be reflected in less traffic in inner and outer London, as the legs of these trips in these areas are also not being made.

Traffic modelling has been used to approximate the reduction in vehicle kilometres outside of the ULEZ (see Appendix 10) and the knock-on emissions benefits associated with ULEZ compliant vehicles driving outside the zone (see below).

16.5. Assessment of Impacts

TfL commissioned Jacobs to assess the impacts of the ULEZ proposal. Four assessments were undertaken:

- Environmental Assessment (EA);
- Health Impact Assessment (HIA);
- Equality Impact Assessment (EqIA);
- Economic and Business Impact Assessment (EBIA)

In addition, an overarching Integrated Impact Assessment (IIA) was prepared, bringing together the findings of the four assessments. The results of these assessments are summarised below: the full assessments will be available during the consultation alongside this Supplementary Information document. The IIA contains information on the stakeholder engagement undertaken to inform the assessment exercise.

The assessment for each aspect commenced with a scoping exercise to determine which aspects of each theme were in scope for an assessment of the ULEZ proposal.

For example, an Environmental Assessment can consider the impacts of a proposal on soil and water; however since no impact from the ULEZ was identified, these issues were scoped out of the assessment.

In assessing the impacts of the proposals, Jacobs used the objectives and criteria used to appraise the MTS in 2009, which was available during the MTS public and stakeholder consultation⁵⁹. The topics and objectives are presented in Table 14 below.

Table 14: IIA topics and objectives for the assessment

Assessment	IIA Topic	IIA Objective
EA	Air quality	To contribute to a reduction in air pollutant emissions and compliance with EU limit values
	Noise	To reduce disturbance from general traffic noise
	Climate change	To reduce CO ₂ emissions and contribute to the mitigation of climate change
	Biodiversity including flora and fauna	To protect and enhance the natural environment, including biodiversity, flora and fauna
	Cultural heritage	To protect and enhance historic, archaeological and socio-cultural environment
	Material resources and waste	To promote more sustainable resource use and waste management
	Landscape, townscape and urban realm	To protect and enhance the built environment and streetscape
HIA	Health and well being	To contribute to enhanced health and wellbeing for all within London
EqIA	Population and equality	To enhance equality and social inclusion
EBIA	London's economic competitiveness	Provide an environment will help to attract and retain internationally mobile businesses
	SMEs	Support the growth and creation of SMEs

The assessment used a seven-point scale to indicate the magnitude of the potential impacts (major, moderate and minor) for both positive and negative impacts, with a

⁵⁹ <https://www.london.gov.uk/priorities/transport/publications/mayors-transport-strategy>

further category of 'neutral'. In addition it described whether effects were expected to be long, medium or short-term. The assessment also identified complementary policies that TfL or others (such as the Government) could use to optimise the benefits of the ULEZ, and suggested opportunities for enhancement or mitigation where appropriate.

In assessing the impacts of the proposal, Jacobs used the outputs of the TfL analysis presented elsewhere in this Supplementary Information document as well as additional quantitative and qualitative analysis.

16.6. Environmental impacts

For air quality there are positive, major long term effects from a decrease in NO₂ concentrations and the reduction of the number of residents living in areas of NO₂ exceedence. There would be a minor positive effect from the decrease in PM₁₀ emissions. For noise and biodiversity, there are moderate and minor positive short and medium-term effects, and positive long term effects for cultural heritage. The impact for climate change is minor positive. For landscape and urban realm, however, there is potential for minor negative impact if associated cameras and signage are not mitigated and managed well. A neutral effect on material resources and waste was identified as a result of phasing out of vehicle fleets.

The assessment noted the many opportunities to enhance the positive environmental impacts of the proposal via the other air quality improvement and transport policies either in place or being developed in London.

16.7. Health impacts

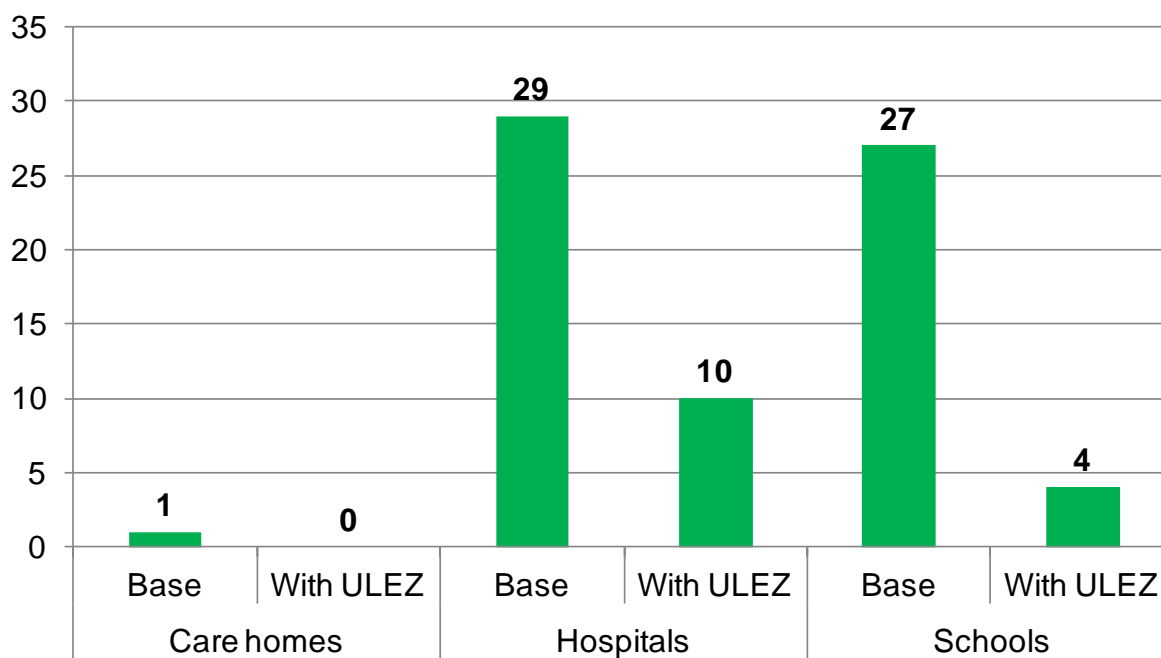
The HIA identified major, long-term positive effects for personal health and wellbeing, mainly as a consequence of improved air quality but also due to the potential for an, increased use of public transport, walking and cycling and a decrease in private car usage. It found a minor positive impact from any noise reduction associated with reductions in road traffic and a neutral impact on crime reduction and community safety. Again it noted the opportunity to enhance the positive impacts of the ULEZ by using other transport and air quality initiatives.

The number of people living in areas exceeding the NO₂ limit value is projected to decrease across London, with the most dramatic effect seen in the ULEZ. This is presented in Table 15 and Figure 26 below.

Table 15: Proportion of population living in areas of NO₂ exceedence in 2020

Area	Estimated population in 2020	Proportion of population living in areas of NO ₂ exceedence in 2020	
		Without ULEZ	With ULEZ
ULEZ	200,000	63%	16%
Inner London	3,410,000	13%	6%
Outer London	5,520,000	2%	1%
Greater London	9,130,000	7%	3%

The number of ‘sensitive receptors’ (eg hospitals) in areas exceeding the NO₂ limit value is projected to decrease in the ULEZ (Figure 25).

**Figure 25: Number of sensitive receptors in the ULEZ in areas of exceedence (NO₂)**

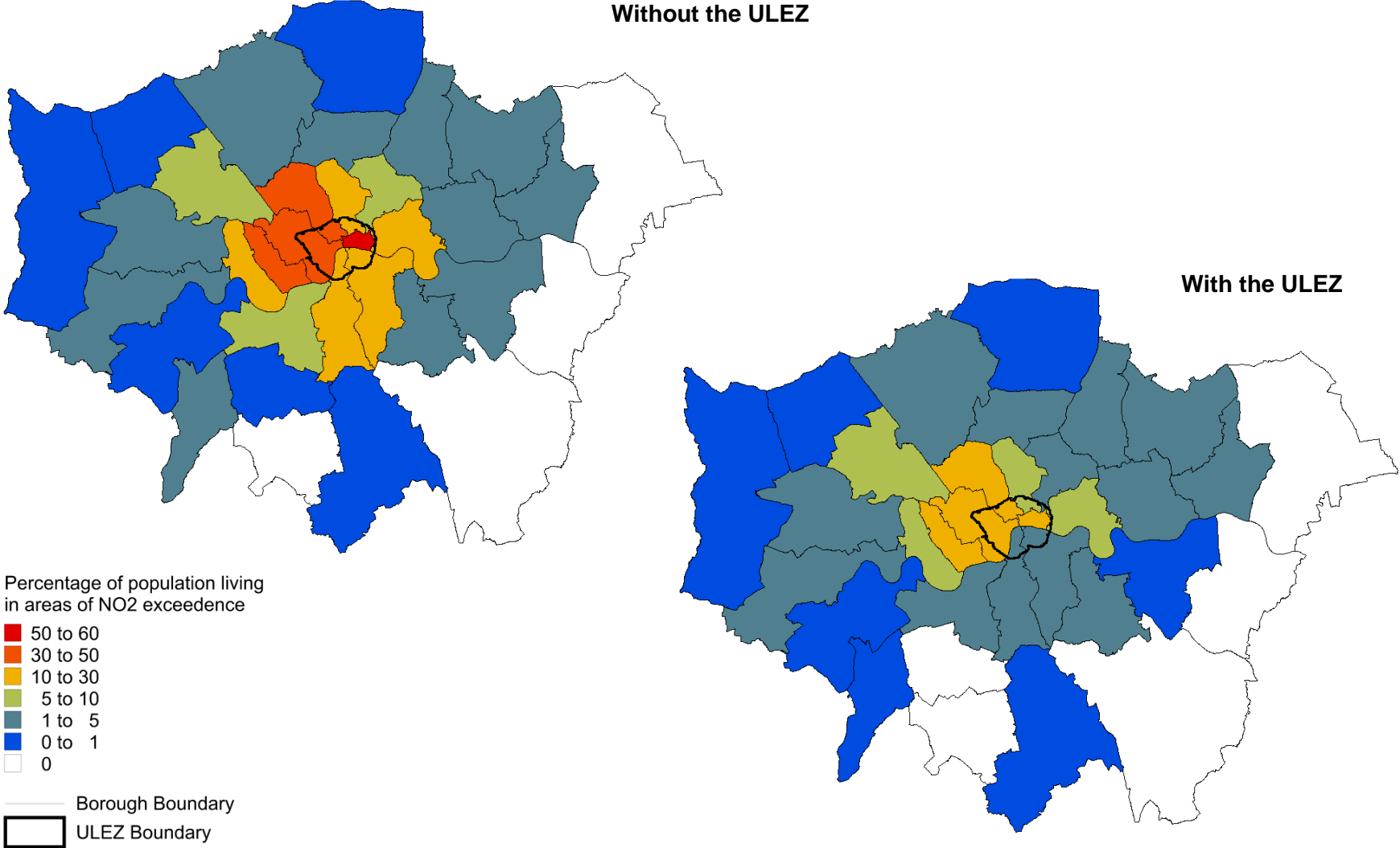


Figure 26: Percentage of population living in areas of NO₂ exceedence in 2020 with and without the ULEZ proposal

16.8. Equalities impacts

The EqIA considered both the overall potential impacts of the ULEZ and the particular impacts from the perspective of owners and users of the different vehicles included in the proposal. In terms of the overall impact, it identified a positive long term effect on school-age children, older people and pregnant women as consequence of a reduction in air pollution. This would be of a major degree in central London, moderate in inner London and minor in outer London.

It also identified potential minor negative short to medium term effects as a result to increased costs and/or limited availability of transport services or vehicle purchase where vehicles do not comply with the ULEZ standards. These include for example some groups using coaches to access central London (if the costs of upgrade are passed on); small businesses using vans for servicing and deliveries and taxi and PHV drivers who will incur costs of complying with the ULEZ. The EqIA sets the assessment in full.

As a mitigation, it recommended that TfL undertakes extensive marketing to make users aware of the ULEZ requirements and how they could comply and to work with manufacturers and the Government on ways to develop the vehicle market and provide appropriate financial support where required.

16.9. Economic impacts

This assessment identified minor positive impacts on London's economic competitiveness arising from improvements to air quality as a result of the proposal. There could be minor negative impacts in the short term as a result of compliance costs for vehicle owners including small and medium sized enterprises (SMEs) and other businesses such as taxi owner/drivers. The health benefits from ULEZ will result in an economic benefit associated with reductions in air pollution, quantified as moderate positive long term.

It noted the importance of the OLEV grant for the purchase of low emission vehicles and identified opportunities for mitigation of negative impacts, for example the enhanced provision of night-time public transport services.

17. Costs

17.1. Costs to TfL

The capital costs of setting up the proposed ULEZ are estimated to be approximately £30m. This estimate includes policy development, consultation and marketing costs prior to go-live. It also accounts for the development and implementation of enhanced road user charging operations.

Annual average operating costs of the ULEZ are estimated to be £6m. These include costs of handling enquiries, registrations and payments, on-going enforcement of the scheme and maintenance of the website. TfL will continue to seek efficiency savings in its service provider contract for road user charging schemes as opportunities arise. In addition, there will be an estimated increase of up to £14m, beyond the current business plan, in cost of operating bus services per annum.

Owing to the anticipated reduction in vehicle km driven in the ULEZ, there will be a reduction in CC revenue (estimated £4m) but this will diminish over time as vehicles become compliant. Conversely, the ULEZ daily charge is estimated to accumulate some net revenue in year one (approximately £12m) but this will diminish accordingly. However, it is estimated that ULEZ will cost TfL an additional £8m to operate, effectively offsetting any additional revenue generated, and therefore ULEZ is expected to be revenue natural in the first year.

As indicated above, revenue from the scheme is expected to fall as the proportion of compliant vehicles entering the ULEZ increases. TfL will seek to reduce operating costs over time, through efficiency savings and contract negotiations, to offset any fall in revenue. In the unlikely event a surplus is achieved, revenues will be invested in other initiatives to support improvements in air quality and CO₂ emissions set out in the Transport Strategy, such as rapid charging facilities and the Mayor's Air Quality Fund for boroughs.

The cost to TfL associated with upgrading buses on routes operating in central London to achieve a Euro VI (or near equivalent) NO_x emissions standard and to procure additional hybrid double-deck and zero emission single-deck buses is under review. Any changes will need to be implemented through the planned contract tendering process.

Subject to approval, TfL is considering establishing a fund for taxi drivers affected by a reduction in the age limit to ten years and for TfL fleets and Dial-a-Ride services to comply with the ULEZ standards. This should help accelerate the uptake of zero emission capable vehicles

17.2. Costs to vehicle owners

TfL has modelled the estimated costs to vehicle operators of complying with the ULEZ standards. This takes into account the volumes of vehicles that could be affected and the likely costs of upgrading or replacing vehicles or reconfiguring vehicle fleets. Whilst many vehicles will already be compliant owing to natural fleet turnover, the ULEZ proposal would accelerate this process.

Table 16: Estimated compliance with and without ULEZ

Type of vehicle	ULEZ emissions standard	Percentage of annual km driven by compliant vehicles in 2020 (without ULEZ)	Percentage of annual km driven by compliant vehicles in 2020 (with ULEZ)	Compliance cost per vehicle type
HGV	Euro VI	77%	98%	£3,000 - £16,000
Coach / other bus	Euro VI	67%	94%	£10,000 - £50,000
Van	Euro 6 (diesel) Euro 4 (petrol)	44%	83% ⁶⁰	£2,500 - £12,000
Car (inc. PHVs)	Euro 6 diesel) Euro 4 (petrol)	73%	93% ⁶¹	£500 - £10,000

17.3 Monetised Benefits

The benefits associated with the emissions reductions of ULEZ can be monetised. As a consequence of the way the scheme will be implemented, with a charge for non-compliant vehicles, there will be further benefits (and disbenefits) arising from changes in journey times, the payment of charges, and inconvenience to the individual due to them possibly having to change behaviour. Each of these can be

⁶⁰ Corrected as of 29 October 2014

⁶¹ Corrected as of 29 October 2014

monetised. In the first year of the scheme being in operation they are estimated to be:

- £105m of benefit from NO_x abatement
- £7.6m of CO₂ emissions reduction
- £31.7m of benefit from journey time savings
- £25m of disbenefit arising from charging

The benefits of ULEZ diminish overtime due to the fact that the proportionate reduction in emissions brought about by the scheme compared to the reduction in emissions that would have happened without the scheme reduces. This is because the 'natural' turnover of the vehicle fleet would result in cleaner vehicles over time anyway and ULEZ essentially encourages newer and thus cleaner vehicles to be adopted more quickly.

There are also qualitative impacts associated with ULEZ, which are not easily represented in a monetised way. These wider impacts are described more fully in the Integrated Impact Assessment (IIA) and associated assessment reports.

18. Indicative timetable and next steps

18.1. Scheme legislation

TfL has powers under the Greater London Authority Act 1999 to make and amend road user vehicle charging schemes. It is required by law to consult the public and stakeholders about the proposed changes to implement the ULEZ emissions standards.

Changes will be made to the LEZ, which exists for the purpose of improving London's air quality. The LEZ scheme will be modified through a Variation Order to establish emissions standards for the ULEZ and to set the level of daily charges and penalty charge amounts.

Public and stakeholder responses to the vehicle charging scheme proposals will be analysed by TfL and then reported to the Mayor. After considering these, the Mayor will decide whether or not to confirm TfL's Variation Order, and if to confirm, whether or not to make modifications in light of the responses to the consultation. If the Variation Order is confirmed, the proposed ULEZ emissions standards will apply from 7 September 2020.

18.2. Before go-live

Subject to the scheme legislation being put in place, there would be a number of activities carried out in advance of the ULEZ emissions standards going live.

TfL would run a large-scale publicity campaign with operators / vehicle owners to make them aware of the requirements of the scheme. This would include the use of broadcast media, print, websites and European trade press, in advance of the proposed go-live date. These activities would form part of a programme of work to ensure that, as far as practically possible, vehicle operators were aware of the daily charge and were given the opportunity to take any necessary action to ensure their vehicles were compliant ahead of the proposed introduction of the scheme.

Vehicle owners would be given the opportunity to register any compliant or 100 per cent discounted vehicles in advance of the possible introduction of the ULEZ (including residents of the zone). Those that already receive a discount or exemption as part of the LEZ would be automatically registered. If the ULEZ became operational on 7 September 2020, it is planned that people would be able to register their vehicles well in advance.

TfL buses

Following consultation, TfL will progressively increase the number of these buses to the point that from 2020 only buses that meet the requirements set out in Chapter 12 will be operated on routes that enter the ULEZ. Subsequently, this means nearly all double-deck buses in inner London will be hybrid and many in outer London too. By progressively introducing these vehicles into the fleet as new contracts start over the next five years, emissions savings will be realised even sooner than when the ULEZ standards are introduced from 2020.

Some Euro V hybrid buses would need to continue to operate in the ULEZ beyond 2020, including some New Routemaster buses. TfL would seek to introduce a retrofit solution for the regular (non New Routemaster) Euro V hybrid buses to ensure that they meet Euro VI NO_x emissions standards. There is more information on the emissions from TfL's buses and the rationale for this proposal in section 12.3.

Changes to licensing requirements for taxis and PHVs

If the taxi and private vehicle licensing requirements are amended by TfL to accommodate a new requirement for newly licensed vehicles and subsequent reduction in the taxi age limit for non zero emission capable taxis, further activity will be required to ensure the respective industries are well informed. This will include discussions with the trade and manufacturers to ensure a proactive dialogue, particularly regarding new zero emission capable models brought onto the market. In addition, TfL will work to ensure each industry benefits from financial support from the Government. Taxi Conditions of Fitness and PHV prescribed vehicle regulations will be revised to reflect the licensing changes.

More detail on this support will be available when TfL’s Business Plan is published later this year, during the consultation period. Likewise, it is anticipated further announcements will be made by the OLEV in due course.

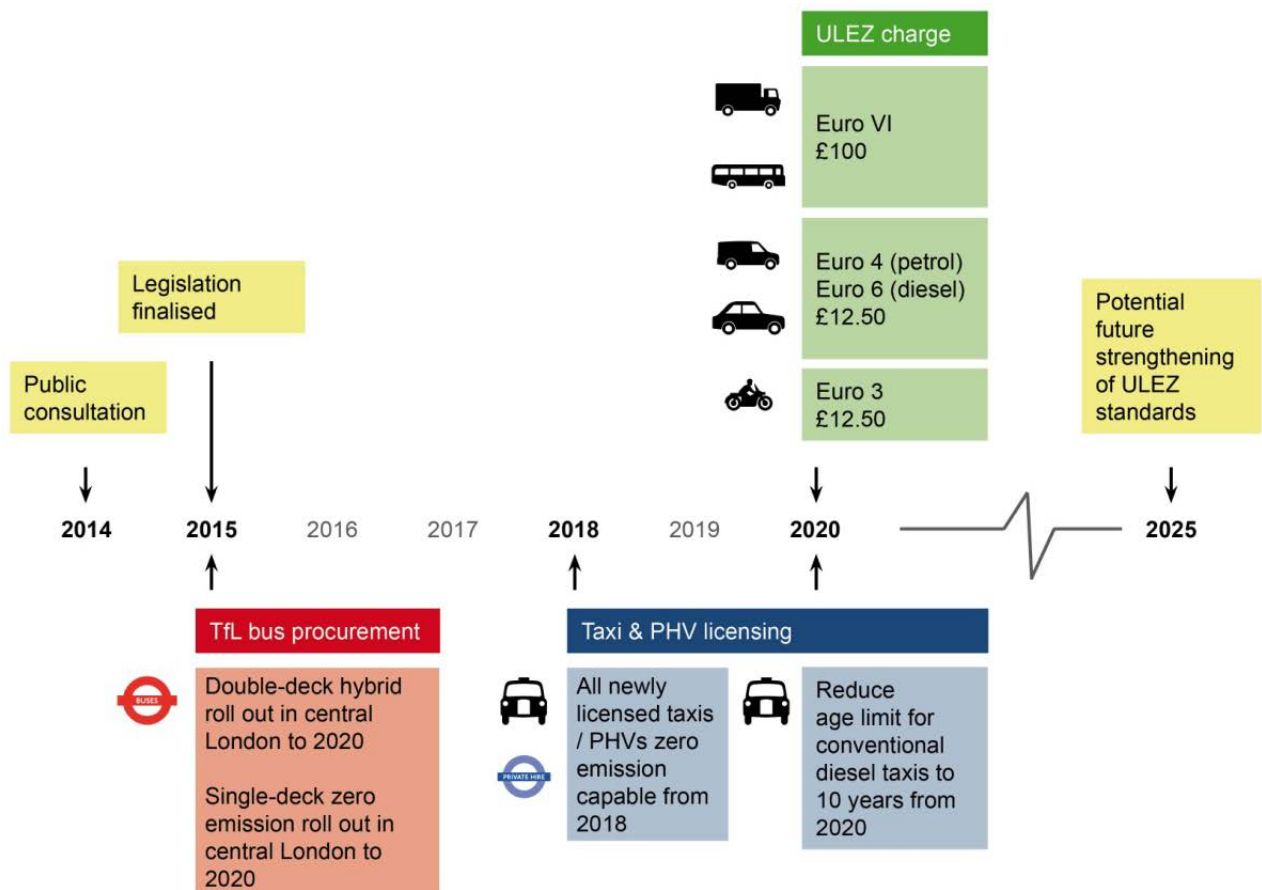


Figure 27: Indicative timeline for implementation of the ULEZ proposal

Appendix 1: Glossary

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

ANPR- Automatic Number Plate Recognition. A system which uses cameras to identify vehicles from their licence plates.

CC, CCZ – Congestion Charge, Congestion Charging Zone. An area in central London where a daily charge (£11.50) applies to vehicles using the zone Monday to Friday 07:00 to 18:00.

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

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

EU limit values – Legal maximum levels of atmospheric concentrations of air pollutants

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 1-6 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

HGV – Heavy Goods Vehicle: type of truck 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 London.

LEZ – Londonwide Low Emission Zone: a charging zone across most of Greater London for vehicles that do not meet emissions standards for PM₁₀

LPG vehicles- These vehicles are converted to run on liquefied petroleum gas (LPG). They are usually spark ignition (petrol) powered vehicles that have undergone an aftermarket conversion to run on a combination of petrol and LPG (Bi-fuel). This conversion does not change the type approval status of the base vehicle.

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

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

Taxi (black cab)- A specialist vehicle licensed by TfL to ply for hire in London. Most taxis are licensed to carry five passengers although some are licensed to carry six.

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

Zero emission capable vehicle (ZEC) – A vehicle that is constructed to be capable of operating in zero emission mode for at least part of its operating cycle. The zero emission mode may be augmented by an internal combustion engine configured to extend the driving range of the vehicle, either by propelling the driven wheels or by powering an on-board generator.

Zero emission (at tailpipe) vehicle – A zero emission vehicle is defined as a vehicle which has no tailpipe emissions at the point of use. There may still be emissions of particulate matter arising from abrasion at the tyres and brakes (eg a battery electric vehicle where no products of combustion are emitted from the vehicle).

Appendix 2: Stakeholder engagement

Engagement with external stakeholders was initiated in July 2013 by the London Assembly Environment Committee as part of their scrutiny of the Mayor's ambition. This provided an opportunity to make a wider range of key stakeholders aware of the ULEZ policy options and initiate more detailed discussion. Regular liaison meetings were held in 2013 and 2014 with the following organisations:

- Greater London Authority (GLA),
- Department for Transport (DfT),
- Department for Food, Environment and Rural Affairs (DEFRA),
- Office for Low Emission Vehicles (OLEV),
- Low Carbon Vehicle Partnership (LowCVP),
- Society for Motor Manufacturers (SMMT),
- Central London boroughs
- Representatives of the Taxi and Private Hire trade and vehicle manufacturers
- Cross River Partnership
- Central London Forward,
- The Motorcycle Industry Association

Additional workshops were held on 5 and 6 August 2013 with transport industry experts to inform assumptions on how vehicle users would respond to different policy options. These workshops explored different test scenarios to unearth views about likely behaviour change.

Stakeholder engagement widened as the feasibility work progressed and continued up to the formal Scheme Order Consultation. Presentations at pre-arranged events for specific sectors including freight, taxi and private hire bodies and local business organisations took place through 2013 and 2014. In addition to these, specific meetings and briefings were established with those interested in having a more detailed conversation.

A larger event was organised in November 2013 to update stakeholders on the technical analysis. Additional representative groups were invited at this time, including taxi and private hire representatives, environmental groups, business bodies, health groups and air quality experts. This event shared more detailed

information on emission levels, vehicle contributions, fleet profiles, availability of lower emission vehicles and behavioural modelling.

A further stakeholder forum was held in March 2014 to present and discuss the policy development. In addition, a public survey was launched to consider views on air quality in London.

Appendix 3: Summary of hybrid and electric vehicle technologies

Average new car CO₂ emissions and conventional hybrids

Car manufacturers are mandated to reduce new car fleet average CO₂ emissions. The EU requires the average new car (fleet weighted) CO₂ emissions to be 130g/km in 2015 and 95g/km in 2020. The UK new car market saw sales-weighted average CO₂ emissions fall to 128.3g/km in 2013. In the same year, 63.3 per cent of new car registrations met the EU's 2015 CO₂ target of 130g/km and so were not liable for Vehicle Excise Duty in year one. In addition, 3.3 per cent of the UK market is now below the EU's 2020 target of 95g/km. Average new car CO₂ emissions in the UK have fallen faster than the other EU member states⁶². This was the first time emissions fell below 130g/km, an important milestone as it marks the achievement of the pan-European 2012-2015 target.

The UK market is shifting to lower CO₂-emitting cars. In addition to legislative requirements, increasing fuel prices are causing vehicle buyers to choose on the basis of fuel economy, particularly for commercial vehicles and vehicle manufacturers are obliged to respond. By 2020, it is possible small compact cars will achieve 75-80g/km even without hybrid technology and mid-sized cars (eg Focus/Mondeo) may be around 100g/km routinely. Even large sport utility vehicles may be around 150g/km, with the use of hybrid engines.

With the exception of Euro standards, new fuels and technology are frequently developed firstly for cars because these have the highest production volumes. This development then spreads to HGVs and buses and finally to vans, where volumes of low emission vehicles are smaller and pricing more sensitive. Vehicle manufacturers have made significant research and development expenditure in recent years to reduce emissions through the development of internal combustion engines, alternative engine technology (hybrid, electric etc) and overall vehicle design. Significant amongst these are weight saving, reduced rolling resistance and for heavy vehicles, low-rev engine calibrations. These systems are being incorporated into new vehicles as a matter of course. Many of these advances are appearing on new car ranges at the moment.

⁶² Society of Motor Manufacturers and Traders; New Car CO₂ Report 2014.

The past thirty years have seen substantial improvements in the standard of equipment offered on passenger cars (eg air bags, air conditioning and a wealth of electronic equipment). Manufacturers recognise this and are taking drastic steps to remove weight from their vehicles and reduce rolling resistance (the frictional forces that must be overcome by the engine) to save fuel and reduce CO₂ emissions. Engine manufacturers, particularly in the heavy duty sector, are also producing engine calibrations that mean that engine peak torque is delivered at very low engine speeds. This has brought about reductions in fuel consumption in recent years. Now a number are bringing about further reductions in engine rpm for their Euro VI engines, which is offsetting any fuel consumption penalty arising from the necessary exhaust after-treatment. These modern vehicles require specially adapted transmissions and driver training to get the best out of them.

Stop-start systems are also increasingly commonplace, alongside energy recovery systems. Stop-start shuts down the engine whilst the vehicle is stationary, to save fuel, whilst energy recovery describes a range of systems from alternators that free-wheel when a lot of power is required from the engine to drive the vehicle (eg hard acceleration) and re-engage when less power is required, to sophisticated flywheel energy storage, as being developed for some buses.

Other hybrid and electric vehicle technologies

Currently there are a number of hybrid and electric vehicle technologies available that are in use as road vehicles or in development by major vehicle manufacturers across the UK and worldwide. These technologies are currently available in a number of road vehicles already present in the market and increasingly being licensed for use as private hire services in London and the same or similar technologies are being incorporated into the new zero emission capable taxis in development by manufacturers. The drive train technologies are based on the principles set out below:

Categories of Electric Vehicles:

1. Electric Vehicle (EV) / Battery Electric Vehicle (BEV) – powered solely by energy stored in a battery. A pure EV/BEV powered vehicle is not a hybrid as only has a single method of propulsion.
2. Hybrid Electric Vehicle (HEV) – vehicle powered by two or more power sources with one being electricity. Usually with the electric motor working in a

parallel with a conventional internal combustion engine delivering power to a single drive train.

3. Plug-in Hybrid Electric Vehicle (PHEV) – hybrids that can charge their batteries from an external source to supplement on board charging and regenerative braking. Utilised in parallel hybrid vehicles with an increase in pure EV range.
4. Range Extended Electric Vehicles (REEV) – Electric powered vehicle with a generator powered by an Internal Combustion Engine that supplements the electrical propulsion system and extends the vehicles all electric range. Most current REEV's also incorporate a plug in facility to enable use of charge point and to reduce reliance on the ICE.

Series and Parallel Hybrids

Apart from the pure EV category listed above, the remaining Hybrid vehicles, including the REEV class of vehicle, configure the components of the hybrid system in one of two ways, series or parallel.

Series

In series operation the output from the internal combustion engine (ICE) is used to generate electrical power, instead of driving the road wheels, by means of an alternator and rectifier combination producing Direct Current Voltage (DCV). The electricity generated is combined with that of the battery via an electronic controller. The controller compares the demand from the driver, the drive wheel speed and the torque delivery available from the electric motor and decides what portion of each source, battery or ICE generated electricity, is required to meet the driver demand. This energy is supplied to the electric motor to supply propulsive force to the road wheels.

The controller also monitors relevant operating parameters such as emissions, battery status and any driver selected parameters including driving in pure battery mode, pure battery mode during city driving or battery mode below a selected speed range etc. The controller also switches the motor/generator into regenerative charge mode during braking and deceleration.

The advantage of this system is that the ICE can be run at an optimised speed to generate the required power for the electrical system therefore increasing MPG and reducing emissions due to an almost steady state throttle. The ICE can also be turned off if the system decides there is sufficient stored charge in the battery to meet driver demand. If applied to a Plug in Hybrid Electric Vehicle (PHEV) the available pure EV mode can be extended as the battery charge is not solely reliant on onboard ICE and regenerative charging.

This is the usual arrangement for the Range Extender Electrical Vehicle (REEV) an example being the Vauxhall Ampera.

Parallel

With the parallel hybrid configuration both sources of motive power, ICE and Electric motor, are coupled together on a parallel axis to drive the road wheels. However the torque supplied by the electric motor and the ICE must be matched. This is achieved by passing the supplied motive force through several gear boxes before driving the road wheels. Normally the electric motor sits between the ICE and the final drive transmission where torque differences are reduced.

The electronic controller on this system monitors the driver demand and similar parameters to the series system. This controller supplies mechanical motive force from either the ICE or the electric motor to the road wheels to give optimum efficiency. The system may also, should the driver and system requirements demand, provide a combination of both mechanical and electric drive to the road wheels.

Parallel hybrid systems may also be subdivided into either ICE dominant systems or electric motor dominant systems. An example of a parallel system on a road vehicle is the Toyota Prius where the electric motor is primarily used to support the ICE in certain load/driver demands and to allow a low speed low range pure EV mode.

The parallel system can also be used in a PHEV vehicle where the charging of the onboard battery is not reliant solely on the onboard charger and regenerative braking cycles of the vehicle.

Both variants, plug in and non plug, increase the average MPG and reduce vehicle emissions with PHEV having an extended pure EV range.

Appendix 4: Proposed amendments to the requirements for vehicles new to licensing as taxis in London from 1 January 2018

From 1 January 2018:

All taxis new to licensing must be zero emission capable. The 15 year age limit would remain for these vehicles. It is proposed a zero emission capable taxi must be:

Capable of emitting maximum 50g/km CO₂.

Manufacturers that have registered an interest or are already developing zero emission capable taxis have indicated to TfL they will achieve this requirement and may actually be exceeded.

Capable of zero emissions for a minimum range of 30 miles (48km).

With the bulk of licensed taxi work operating predominantly within a potential zero emission zone/s they must be capable of operating within this area for extended periods whilst in pure EV mode.

Petrol only (where appropriate) to meet current and relevant Euro standard (Euro 6 from 2018)

As of 2014, some manufacturers are already producing Euro 6 compliant vehicles, though not legislated in this sector until September 2015. With that in mind it is reasonable to require all range extender engines to be compliant with the current and relevant euro standard. This will be to the benefit of passengers as new standards of build quality and passenger amenities are introduced.

Appendix 5: Proposed amendments to the requirements for vehicles new to licensing as PHVs in London

From 1 January 2018:

The requirements for vehicles new to licensing as PHVs will vary according to the age of the vehicle when presented for licensing. This will replace the current five year introductory age limit. The ten year age limit would remain in place and all other vehicle requirements would remain unaffected.

Newly manufactured	Second-hand
As determined by date of first registration with the DVLA at time of licensing and not more than 18 months from that date.	Not less than 18 months old as determined by date of first registration with the DVLA at time of licensing
Capable of zero emissions for a minimum range of 30 miles and 50g/km CO ₂	Compliant with the ULEZ emissions standards (Euro 6 diesel and Euro 4 petrol)

Newly manufactured PHVs

The zero emission capable requirement only applies to newly manufactured vehicles. A newly manufactured vehicle is determined by date of first registration with the Driver and Vehicle Licensing Agency (DVLA) or date of vehicle manufacture (unless they meet the zero emissions capable criteria above). A zero emission capable PHV must be:

1. Capable of zero emissions for a minimum range of 30 miles **and capable of emitting maximum 50g/km CO₂**.
 - For example, the use of plug-in hybrid technology (PHEV) battery electric technology (BEV) or equivalent
 - A 30 mile range is already available on certain makes and models of vehicles popular within the private hire industry. By 2018 it is expected even more vehicle models will meet this requirement, including vehicles for the chauffeur and executive services market.
 - This range is considered appropriate to allow PHVs to pick up and drop off within a potential zero emission only zone/s as many PHVs spend considerable amounts of time outside the central London area. In addition,

as all private hire journeys must be pre-booked through a licensed private hire operator there will be opportunity to plan journeys and factor in time, between bookings, to charge vehicles.

2. Euro 6 only for any internal combustion engine range extender (ICE, current and relevant emissions standard: Euro 6 from 2018)
 - As of 2014, some manufacturers are already producing Euro 6 compliant vehicles – it is reasonable to assume all REEV will be fitted with current emission standards range extender engine in 2018.

Second-hand PHVs

The following requirement only applies to second-hand vehicles. A second-hand vehicle is considered to be not less than 18 months old as determined by date of first registration with the Driver and Vehicle Licensing Agency (DVLA) or date of vehicle manufacture (unless they meet the zero emissions capable criteria above). These must be:

1. Compliant with the ULEZ emissions standards (Euro 6 diesel and Euro 4 petrol). This is instead of the existing five year introductory age limit, which would be discontinued from 2018.

Appendix 6: Supporting funding and infrastructure for zero emission capable taxis and private hire vehicles

Specific purchasing grants for zero emission capable taxis and PHVs

As part of a £500m package of measures to support the development and use of ultra low emission vehicles (ULEVs), the OLEV has announced that substantial funds will be made available to local authorities who commit to supporting a step change in cleaning up the taxi fleets in their areas.

The Government recognises that taxis provide a direct means of demonstrating the benefits of ULEVs to passengers, and could encourage them to consider ULEVs when they next buy a car. The Mayor and TfL are in discussion with the OLEV to ensure that London's taxi and private hire vehicle owners and drivers are able to benefit from the Ultra Low Emission Taxi Scheme and, therefore, the new zero emission capable taxis are affordable.

Plug-in vehicle purchasing grant

Currently government support in the form of the Plug-in Vehicle Grant is available to reduce the higher initial cost. This provides a subsidy of:

1. 25%, up to £5,000, towards the cost of an electric car
2. 20%, up to £8,000, towards the cost of an electric van

The Department for Transport has a list of eligible cars and eligible vans. The grant is automatically deducted from the retail price when an eligible vehicle is purchased, so there is no additional paperwork to complete, and purchasers don't pay the full retail price upfront and then have to reclaim the benefit.

For both the car and van grant, minimum warranty terms apply and pre-registration conversions are eligible. The van grant applies to vehicles with a gross weight of 3.5 tonnes or less, and performance criteria including a minimum range of 60 miles for fully electric vans (10 miles for plug-in hybrids) and a minimum top speed of 50 mph.⁶³ This grant applies to many vehicles that can be licensed as private hire vehicles within London and would meet the ZEC private hire proposed requirements.

⁶³ Energy Savings Trust

Rapid charging infrastructure

There has been considerable interest from private companies to deliver rapid charging facilities for commercial vehicles in London, including taxi and private hire vehicles.

TfL will be exploring this area in more detail with relevant stakeholders including the taxi and private hire trades, London boroughs, OLEV, UK Power Networks.

Appendix 7: Summary of the ULEZ proposal

ULEZ: TfL buses and taxis

- dealt with through licensing and procurement

What if I am a London Buses operator?



All double deck TfL buses operating in central London will need to be hybrid and Euro VI (or near equivalent for New Routemasters). Subject to further feasibility, these vehicles will then operate zero emission in some specific focus areas.

All single deck TfL buses operating in central London will operate zero emission at all times (eg electric).

What if I am a taxi driver?



A new requirement will be introduced for taxis new to licensing in London from 1 January 2018.

All taxis will need to be zero emission capable (50g/km CO₂ + min zero range 30 miles).

The maximum age of a non zero emission capable taxi will be reduced to 10 years old from 2020 (irrespective of date of licensing) to reduce the oldest, most polluting vehicles. Zero emission capable taxis will retain a 15 year age limit.

What if I am a private hire driver?



A new requirement will be introduced for private hire vehicles (PHVs) new to licensing in London from 1 January 2018.

All newly manufactured PHVs will need to be zero emission capable (50g/km CO₂ + min zero range 30 miles). If they are not new and never been licensed in London before, then they need to be ULEZ compliant (Euro 6 diesel / Euro 4 petrol).

PHVs will be liable for the ULEZ charge like any other car or van (ie if entering the zone then comply or stay and pay - see opposite). The 10 year age limit will remain the same.

ULEZ: Commercial and private vehicles

- subject to emissions requirement enforced by cameras

What choice do the public and businesses have?

Upgrade or switch to a compliant vehicle by 2020

For frequent users it is cost effective to upgrade their vehicle. Larger operators also have the ability to move vehicles within their fleet.



Euro VI



(<6 years old in 2020)



Euro 6 (diesel) (< 4-5 years old in 2020) or Euro 4 (petrol) (<13-14 years old in 2020)



Euro 3 (<13 years old in 2020)

Stay and pay a ULEZ charge



£100 daily charge



£12.50 daily charge



Adapt their journey

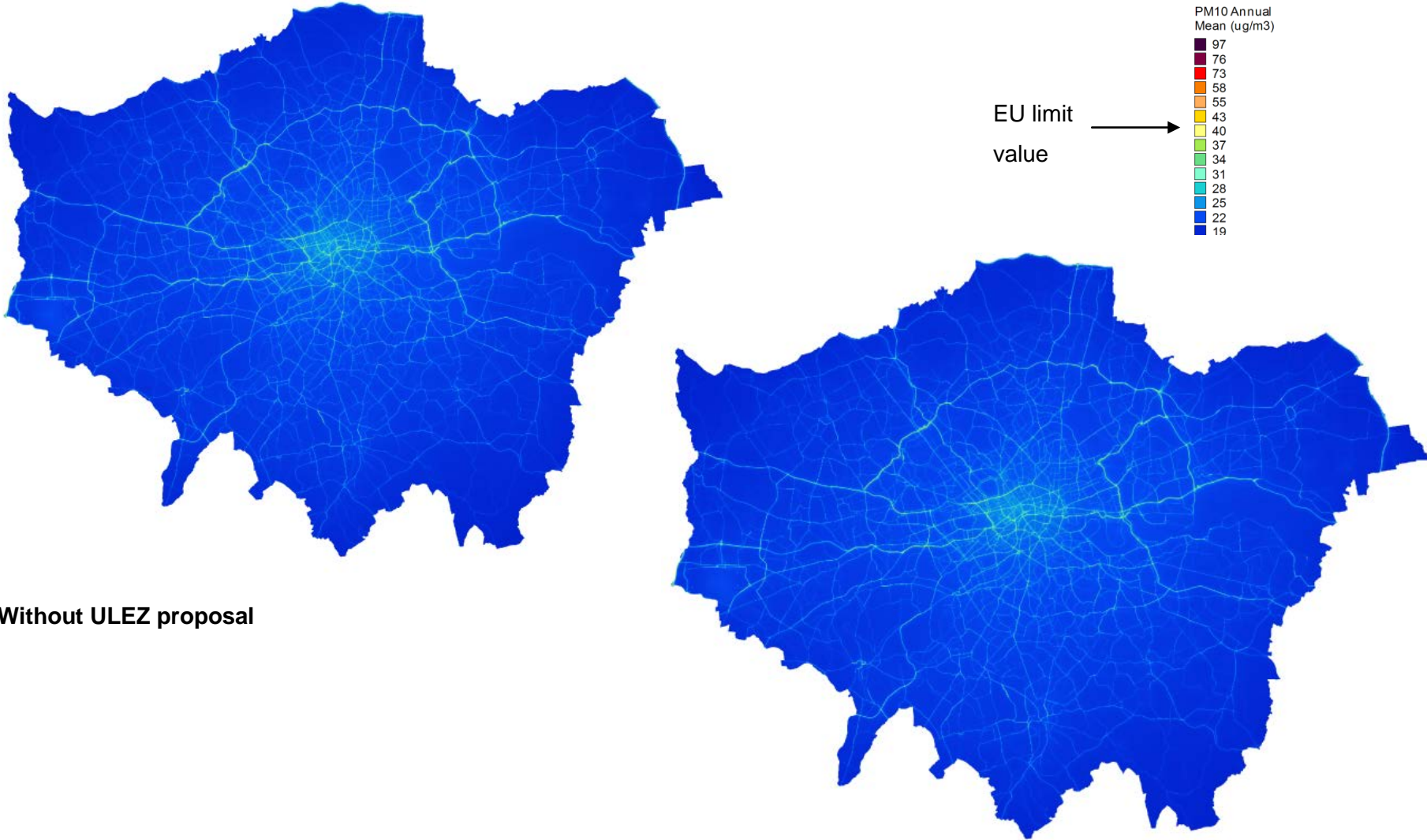
A proportion of drivers will instead change route or destination, change mode or reduce the amount they travel.

The ULEZ is projected to achieve up to a 51% reduction in NOx from road transport in central London. This is achieved as follows...



⁶⁴ Corrected on 29 October 2014

Appendix 8: Impact of the ULEZ proposal on PM₁₀ concentrations

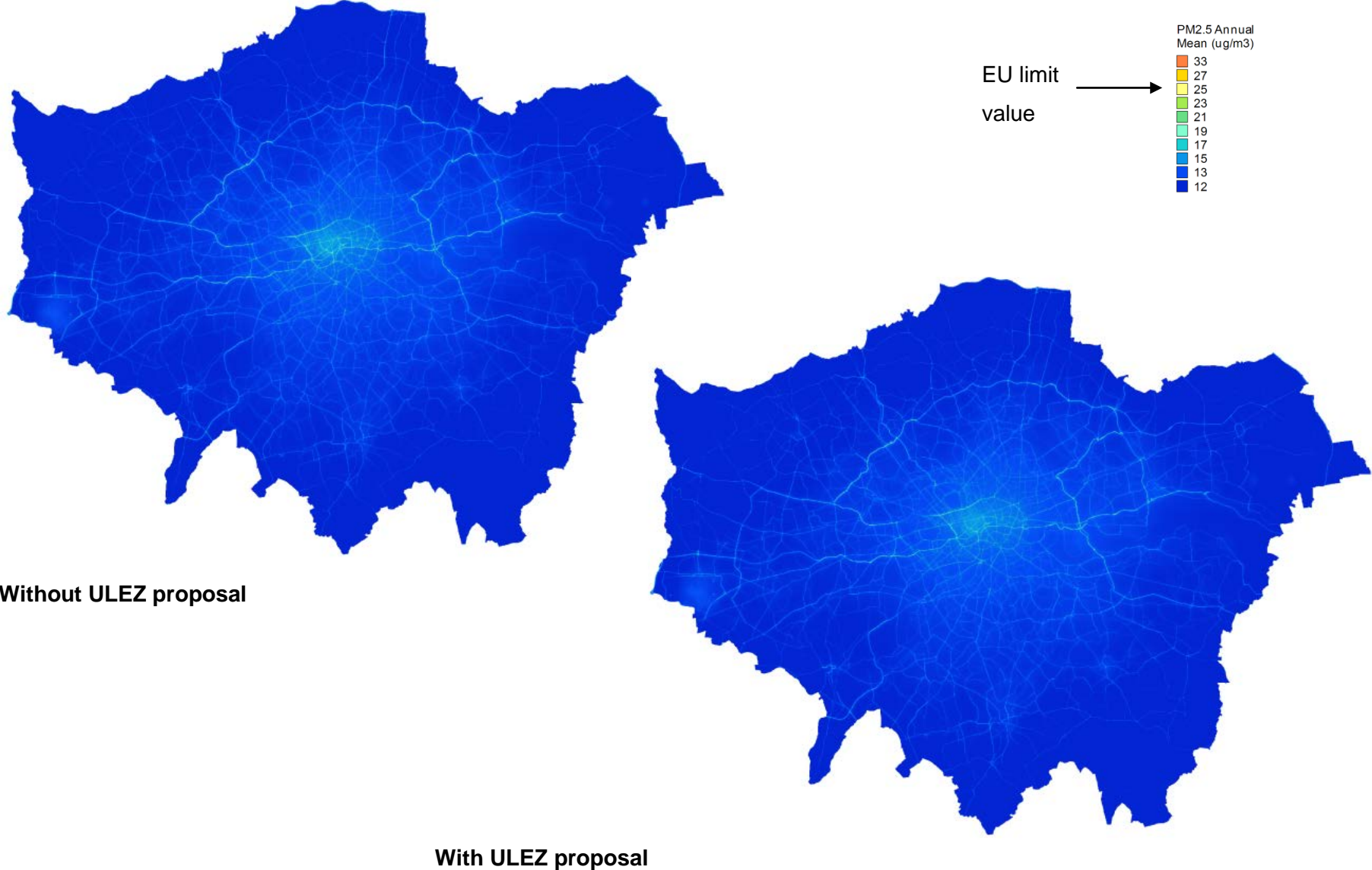


Without ULEZ proposal

With ULEZ proposal

In 2020, a 14% reduction in road transport PM₁₀ emissions in central London

Appendix 9: Impact of the ULEZ proposal on PM_{2.5} concentrations



Without ULEZ proposal

With ULEZ proposal

In 2020, a 21% reduction in road transport PM_{2.5} emissions in central London

Appendix 10: Impact of the ULEZ proposal on vehicle kilometres⁶⁵

Car	Change in km	of the remaining kms	
		compliant	non-compliant
CCZ	-5%	95%	5%
IRR	-1%	84%	16%
Inner	-1%	80%	20%
Outer	0%	78%	22%

Van / Minibus	Change in km	of the remaining kms	
		compliant	non-compliant
CCZ	-5%	85%	15%
IRR	-2%	65%	35%
Inner	-1%	56%	44%
Outer	0%	51%	49%

HGV	Change in km	of the remaining kms	
		compliant	non-compliant
CCZ	-2%	98%	2%
IRR	0%	76%	24%
Inner	0%	76%	24%
Outer	0%	71%	29%

Coach	Change in km	of the remaining kms	
		compliant	non-compliant
CCZ	-4%	94%	6%
IRR	-1%	73%	27%
Inner	-1%	73%	27%
Outer	0%	68%	32%

⁶⁵ Excludes residents vehicles so numbers differ to those presented earlier in Table 16