TACKLING POLLUTION AND CONGESTION

Why congestion must be reduced if air quality is to improve

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EXECUTIVE SUMMARY

This report examines the Government's plans to tackle poor air quality. The key conclusion is that while it is essential to clean up diesel vehicles, it is also crucial that congestion and the continual decline in urban traffic speeds across the UK is tackled.

Congestion is not just a drag on the economy, it kills. Halving average city traffic speeds leads to a 50% increase in NOx emissions from larger vehicles[1].

The World Health Organisation calculates that people in the UK are 64 times as likely to die of air pollution as those in Sweden and twice as likely as those in the US[2]. Poor air quality causes 40,000 to 50,000 early deaths in the UK and the cost of these health impacts is estimated at £20 billion every year[3].

Government is under serious pressure to tackle what has become a public health emergency. It has already lost two court battles, and it is being taken to the High Court for a third time because of "major flaws" in its new draft Air Quality Plan[4].

The consultation on the draft Air Quality Plan closes today (15th June 2017). This report, which outlines Greener Journeys' response, will demonstrate that measures to mitigate congestion, combined with the cleanest vehicles, must be at the heart of Government strategy. If Clean Air Zones (CAZs) are to be successful their scope must extend to diesel cars, and they must maximise opportunities for modal switch from car to clean public transport.

Urban traffic speeds are falling by on average 2% every year[5], causing NOx emissions to rise

Traffic congestion in the UK's largest cities is 14% worse than it was five years ago, and in the last year alone has deteriorated by 4%[6]. Falling traffic speeds drastically worsen air quality. Morning peak traffic average speeds in central London have fallen from 16 kmph in 2006 to 12 kmph in 2016[7], causing a 10% increase in NOx from diesel cars and vans, and a 25% and 27% increase for buses and trucks.

Government has recognised the need to tackle congestion, but its proposed strategies of removing speed humps and traffic light sequencing will not address the root of the problem. 75% of traffic congestion is caused by excess traffic[8]. Congestion will only be solved by reducing the number of vehicles on the road, which will require demand management and some measure of car restraint.

Improving traffic flow can lead to dramatic reductions in NOx emissions across all vehicle types. Huge reductions in emissions can be achieved by improving city bus

[1] Low Carbon Vehicle Partnership, 2017
[2] World Health Statistics, Monitoring Health for the SDGs, World Health Organisation, 2017
[3] Every breath we take: the lifelong impact of air pollution, Royal College of Physicians, 2016
[4] Environmental lawyers Client Earth announced the new legal challenge on 31st May 2017
[5] Department for Transport Congestion Statistics 2017
[6] TomTom June 2016
[7] Travel in London Report 9, Transport for London 2016
[8] Travel in London Report 9, Transport for London, 2016

speeds. For Euro VI diesel buses, which will be compliant in CAZs, NOx emissions are more than halved by increasing average speeds from 6 kmph to just 8 kmph.

Diesel cars are the single biggest contributor to NOx levels, responsible for 41% of all NOx emissions from road transport[9]

As the biggest contributor to NOx levels diesel cars should comply with CAZ standards. However, Government's CAZ hierarchy[10] identifies buses and taxis as priority vehicles to target, followed by HGVs then vans and only then (possibly) cars. This is actually in the reverse order of NOx contribution.

Yet Government's new Air Quality Plan says that without further action, over 70% (31 out of all 43) of the UK zones will still not be compliant in 2020, largely because "real world" emissions from Euro 6 cars, and Euro 5 and Euro 6 light goods vehicles, are all higher than expected.

There are serious contradictions in the new draft Plan. The Government has said local authorities should only introduce charging CAZs if they are unable to identify "equally effective alternatives" for bringing NOx levels down to within the European limit values. However, the technical report makes clear that only charging CAZs are expected to achieve the compliance of zones in the shortest time possible.

Government needs to show leadership. Handing responsibility for all the tough political decisions to local authorities will not be sufficient. Policy interventions must be based on reducing emissions per passenger, rather than emissions per vehicle. This means tougher action on diesel cars.

The quickest and most cost-effective solution to our air quality epidemic is to put the bus at the centre of the strategy

Progress in clean diesel bus technology has dramatically exceeded diesel car technology. Real world testing of Euro VI diesel buses demonstrates a 95% reduction in NOx emissions compared with Euro V[11]. Currently a journey by a Euro 6 diesel car emits 10 times the per passenger NOx of a comparable journey by a Euro VI diesel bus.[12]

Measures to encourage modal switch from car to bus can be transformative. Bus priority measures can deliver 75% fewer emissions per bus passenger km than for car passengers[13]. And buses also reduce congestion. A fully loaded double decker bus can take up to 75 cars off the road.

Putting buses at the centre of air quality strategy would support UK manufacturing. At least 80% of urban buses sold in the UK are built in the UK[14]. And Government

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[9] Low Carbon Vehicle Partnership analysis of NOx emissions from road transport based on NAEI 2014 data
[10] A: Buses, coaches and taxis; B: Buses, coaches, taxis, and heavy goods vehicles; C: Buses, coaches, taxis, and HGVs and light goods vehicles; D: Buses, coaches, taxis, and HGVs, LGVs and cars
[11] The Journey of the Green Bus, Low CVP 2016
[12] Low Carbon Vehicle Partnership 2017 analysis using COPERT Factors at 25km/h average speed, using average passenger loading (DfT)
[13] Professor Peter White, University of Westminster 2015
[14] Society of Motor Manufacturers & Traders, 2016

financial support for bus retrofitting provides 15 times as much value for money as scrappage allowances for diesel cars[15].

Changes in the composition of traffic means that speeds will continue to fall with serious impacts for the economy

Congestion is rising. On current trends, the average traffic speeds in our major conurbations are projected to fall from 16.5 mph in 2016 to just 11.9 mph in 2030[16]. While it may be anticipated that there will be a significant reduction in the emissions from the vehicle fleet by 2030, the congestion problem – with all the associated wider social and economic costs and aggravation for road users – will significantly deteriorate.

Given that fuel duty has been frozen for seven years, oil prices are at record lows and low emission vehicles are exempt from VED, it is clear that vehicle traffic will continue to grow. To make matters worse, the mix of the vehicle fleet is changing with a much higher proportion of vans on the road. In 2016 vans made up 15% of all traffic, compared with 9% in 1985[17].

The change in the composition of traffic reduces the self-regulatory effect of rising congestion. With cars, lower speeds make it less attractive to drive. With vans, lower speeds mean more vans are required to maintain service levels as each van does less mileage. This means there may not be a floor to traffic speeds, and vehicles traveling at walking pace will become the norm unless action is taken.

Strategy must focus on reducing emissions per passenger and on moving people not vehicles

If we are to ensure the success of CAZs in our cities, strategy must focus on moving people efficiently not vehicles, and the role of the bus must be maximised. If buses are viewed as a problem, the downward spiral caused by congestion which has already resulted in 10% fewer bus passengers every decade[18] will accelerate. Those without a car, many of whom are on low incomes, will be more severely disadvantaged and marginalised.

CAZs present the opportunity to make our towns and cities more pleasant places to shop, work and socialise, with clean air, safe streets, priority for pedestrians and cyclists, and fast, efficient and affordable public transport.

To ensure the success of CAZs, policy makers must base decisions on the evidence, not on political expediency; address head on the issue of diesel cars; and recognize the importance of encouraging the switch to more sustainable transport.

[15] Improving Air Quality in Towns and Cities, Greener Journeys 2017
[16] Analysis based on Department for Transport Road Congestion Statistics 2017
[17] Society of Motor Manufacturers & Traders May 2016
[18] The Impact of Congestion on Bus Passengers, Professor David Begg 2016

RECOMMENDATIONS

1. **Policy focus on reducing emissions per passenger**
2. **Diesel cars must comply with CAZ standards**
3. **Support for bus retrofit to Euro VI standard**
4. **Demand management measures to reduce traffic**
5. **Modal switch from car to sustainable transport**

1. THE SCALE OF OUR AIR QUALITY CHALLENGE

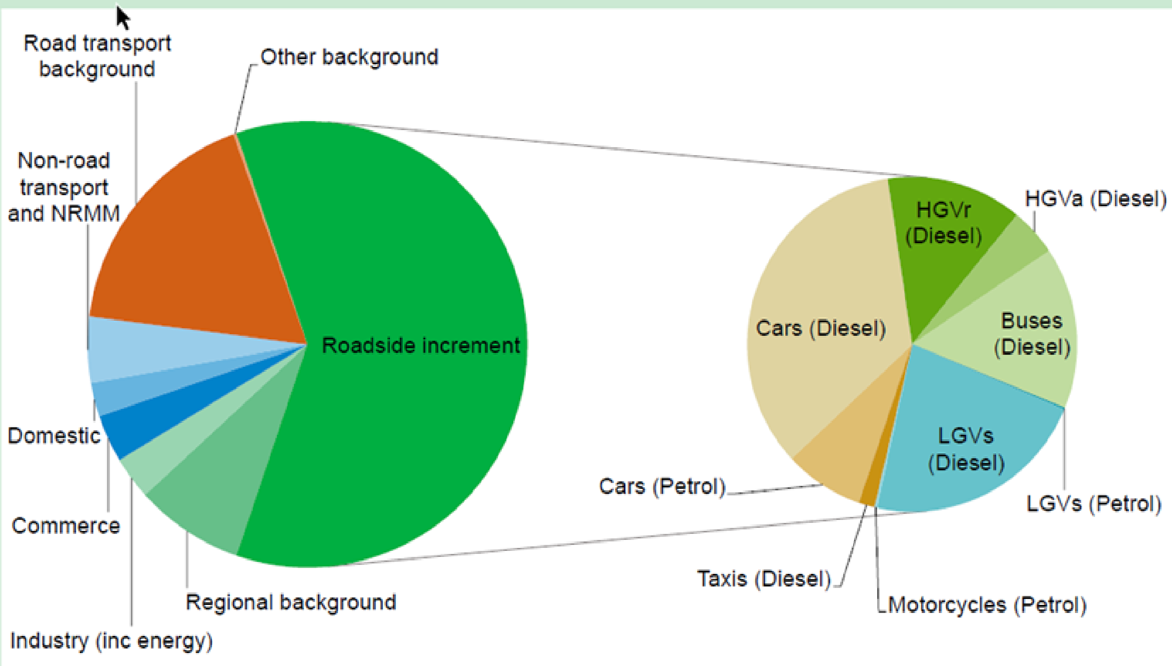
1.1 Diesel cars are the biggest contributor to roadside NOx

The Government's new draft UK Air Quality Plan published in May 2017[19] provides the latest evidence on the scale and causes of our air quality crisis. Across the UK, road transport is responsible for 80% of the roadside NOx levels.

With the latest comprehensive review of the real emissions of cars and vans, the report shows that diesel cars are the single biggest contributor to roadside NOx emissions (Page 7 fig 3a).

Diesel cars are responsible for 41.01% of NOx emissions from road transport[20].

Figure 3a: Breakdown of UK national average NO_x roadside concentration into sources, 2015



Note: The 'Roadside increment' in the large pie chart is the estimate of the proportion of NO_x roadside concentrations contributed by local traffic, which is shown in greater detail in the smaller pie chart. NRMM = Non-Road Mobile Machinery; LGV = Light Goods Vehicles; HGVr = Rigid Heavy Goods Vehicles; HGVa = Articulated Heavy Goods Vehicles.

1.2 New draft Plan says 31 zones will not be compliant in 2020

Thirty-seven of the UK's 43 air quality assessment zones currently fail to comply with the limit on nitrogen dioxide concentrations. Under previous projections published in 2015, the Government expected that eight zones would remain non-compliant in 2020 in the absence of further action.

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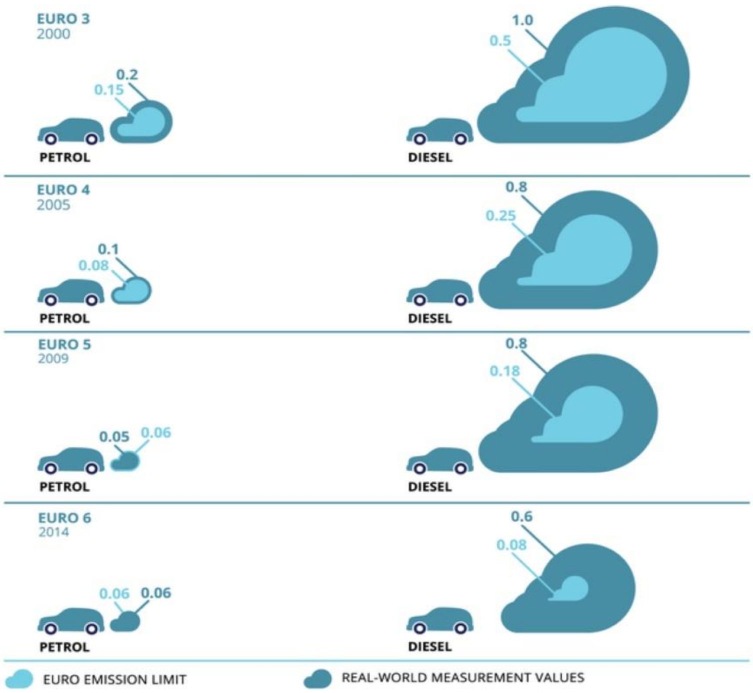
[19] Tackling nitrogen dioxide in our towns and cities: A consultation, Defra/DfT/Scottish Government, Welsh Government, Northern Ireland Government, May 2017

[20] Low Carbon Vehicle Partnership analysis of NOx emissions from road transport based on NAEI 2014 data

In its new draft plan, Government has increased the estimate of non-compliant zones in 2020 to 31. This is largely because "real world" emissions from Euro 6 cars, and Euro 5 and Euro 6 light goods vehicles, are all higher than expected (Whilst this new model uses the latest information on car and van emissions, it still acknowledges that if the Euro Standards continue to be ineffective the situation will deteriorate even further). The chart below which appears in the new draft Air Quality Plan (Page 5, Figure 2), shows that real world emissions for cars have proven to be many times higher than lab tests.

Figure 2 - Comparison of nitrogen oxides emissions for different car Euro standards, by emission limit and real-world performance (grams/kilometre)



Following the various car emissions testing scandals, the public have lost faith in the car manufacturers' own claims. Tests of diesel cars last year found that almost all of Britain's most popular diesel cars exceeded limits for safe levels of pollution during on-road driving, with toxic NOx emissions up to 14 times higher than claimed[21].

By contrast, the rigorous testing requirements for bus manufacturing means that an equivalent of the Volkswagen emissions testing scandal would be inconceivable in the bus sector. Real world testing of the latest Euro VI diesel engines demonstrates a 95% reduction in NOx emissions compared with their older Euro V counterparts[22].

It is also worth noting that proposed labelling of cars with AQ levels will have little impact unless the label is accompanied by some form of restriction on car access. Just telling people one car is 100mg NOx and another is 75mg will make almost no difference to purchasing because it has no impact on household budgets. The key

[21] Department for Transport, 2016
[22] The Journey of the Green Bus, Low CVP 2016

benefit of the fuel economy/CO2 label has been to give cost comparison data for tax or running costs of a vehicle.

1.3 Impacts of poor air quality on the nation's health are severe

A report recently published by the World Health Organisation revealed that people in the UK are 64 times as likely to die of air pollution as those in Sweden and twice as likely as those in the US[23].

The severe health impacts of poor air quality are well documented. Pollution causes 40,000 to 50,000 early deaths a year[24]. The Royal College of Physicians has linked air pollution to cancer, asthma, strokes, heart disease, diabetes, obesity and dementia. Children, the elderly and the vulnerable in society are most at risk. In young children, air pollution can cause asthma and stunt lung growth by up to 10%[25].

The cost of these health impacts is estimated at £20 billion every year[26], and they fall most heavily on the poorest. The impacts of poor air quality are especially inequitable, as those who produce the least emissions suffer the most. Drivers commuting in diesel cars produce six times as much pollution as the average bus passenger, yet bus passengers suffer far more from pollution in our cities than those travelling in cars[27].

This is a clear violation of the core principle of environmental justice: those who contribute the most to air pollution in our cities are the least likely to suffer.

1.4 Clean Air Zones (CAZs) are the most effective approach

The technical report accompanying the new draft Air Quality Plan shows that charging CAZs are the most effective measure for tackling poor air quality.

The analysis shows that £600 million would be required to implement CAZ for all vehicles types across the 27 Zones. This would deliver almost twice the NOx saving of scrapping every pre-Euro 6 car and van, which would cost £60 billion.

A total of 27 charging zones are identified (hierarchy ranging A, B, C, D[28]). While the 27 CAZs have not been named, the technical report recommends that 4 Type A, 3 Type B, 5 Type C and 15 type D zones (which includes cars) will be needed to achieve compliance. The report highlights that 15 cities will have to ban or charge older cars. And 20 will have to ban vans older than 2016.

1.5 The need for more evidence based policy recommendations

There is a mismatch between the recommendations set out in the Government's draft Air Quality Plan, and the evidence set out in its accompanying technical report. Government has said that CAZs may be in two forms: non-charging and charging.

[23] World Health Statistics, Monitoring Health for the SDGs, World Health Organisation, 2017
[24] The EFRA Air Quality Select Committee Inquiry, 2016
[25] Every breath we take: the lifelong impact of air pollution, Royal College of Physicians, 2016
[26] Every breath we take: the lifelong impact of air pollution, Royal College of Physicians, 2016
[27] Environment International Today, University of Surrey 2017
[28] A: Buses, coaches and taxis; B: Buses, coaches, taxis, and heavy goods vehicles; C: Buses, coaches, taxis, and HGVs and light goods vehicles; D: Buses, coaches, taxis, and HGVs, LGVs and cars

Government has said local authorities should only introduce charging CAZs if they are unable to identify “equally effective alternatives” for bringing NOx levels down to within the European limit values. However, as the technical report makes clear, only charging CAZs are expected to deliver a concentration reduction of sufficient size to achieve the compliance of zones in the shortest time possible.

It is difficult to avoid the conclusion that politically difficult decisions have been delegated to local authorities.

Moreover, although diesel cars are the single biggest source of roadside NOx emissions, Government’s CAZ hierarchy[29] identifies buses and taxis as priority vehicles to target, then HGVs then vans and only then (possibly) cars. This is actually in the reverse order of NOx contribution.

This also raises the question of whether we need four different classes of zone. It would reduce uncertainty and confusion if there was just one class of zone applied to all vehicles universally. An additional risk is that a Class B CAZ (including HGVs as well as buses and taxis) may actually increase NOx emissions as it may see operators move from HGV to LGVs (vans) instead, consequently increasing both congestion and NOx.

The Government’s focus on emissions per vehicle rather than emissions per passenger presents a distorted picture and provides insufficient foundation for effective policy interventions. Policy must be based on reducing emissions per passenger. This means tougher action on diesel cars.

[29] A: Buses, coaches and taxis; B: Buses, coaches, taxis, and heavy goods vehicles; C: Buses, coaches, taxis, and HGVs and light goods vehicles; D: Buses, coaches, taxis, and HGVs, LGVs and cars

2. CONGESTION IS MAJOR CONTRIBUTOR TO POOR AIR QUALITY

2.1 The link between congestion and pollution

Congestion has been steadily increasing in all our major cities. Traffic congestion drastically worsens air quality. In nose-to-tail traffic, tailpipe emissions are four times greater than they are in free flow traffic[30].

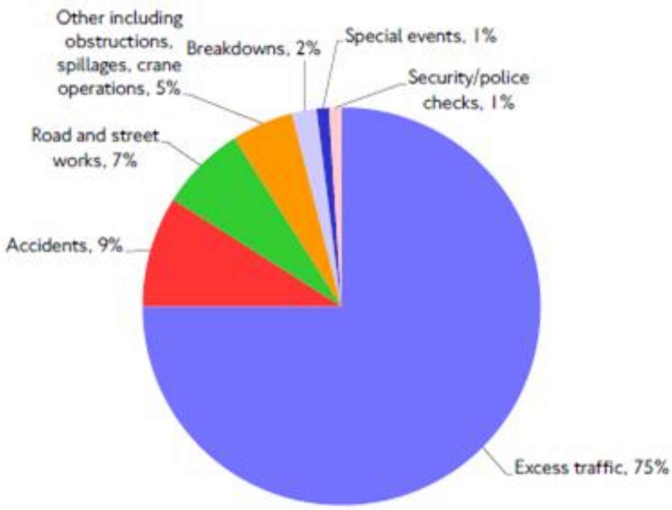
Improving air quality is not just about getting rid of older, more polluting vehicles, it is about reducing the number of vehicles in congested urban areas where the air quality problem is most acute.

Government has recognized the link between congestion and pollution, and the importance of speeding up traffic flows to reduce NOx emissions. However, its focus is on removing speed humps and traffic light sequencing[31]. This misses the key cause of congestion and slower traffic speeds: too many vehicles chasing too little road space.

2.2 The main cause of congestion is excess traffic

TfL estimate that 75% of traffic congestion is caused by excess traffic with only 7% down to road works[32].

Figure 6.10 Estimated contribution of various factors to road traffic congestion.



Whenever the latest congestion statistics are released there is a tendency for the public and the media to blame road works, traffic calming, speed restrictions, pedestrian priority, cycle lanes and bus lanes. The overwhelming cause of congestion however is that there are too many vehicles on the road.

When Government responds to congestion statistics by stating how much it is investing in the road network to increase capacity, it fails to appreciate that 80% of

[30] Environmental Factors in Intelligent Transport Systems, IEE Proceedings, M.C. Bell 2006
[31] Tackling nitrogen dioxide in our towns and cities: A consultation, Defra/DfT/Scottish Government, Welsh Government, Northern Ireland Government, May 2017
[32] Travel in London Report 9, Transport for London 2016

UK congestion is in urban conurbations[33]. There is not a road building solution to this problem.

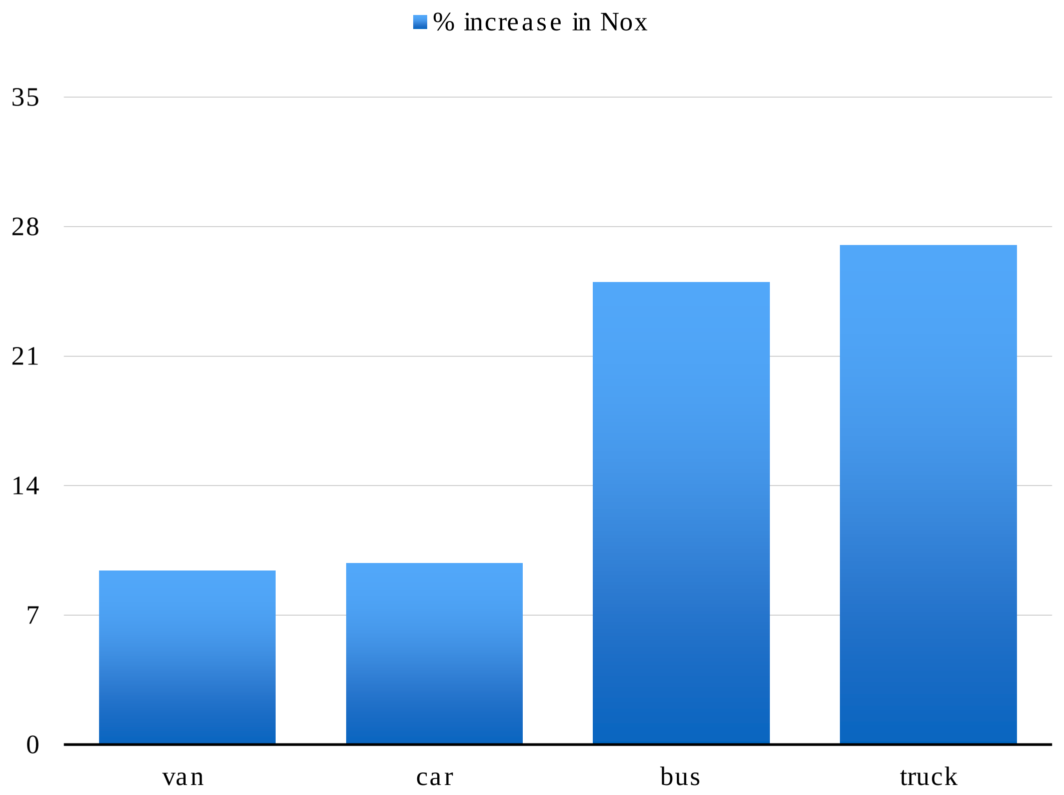
It would be much more accurate and informative if the Government response were to conclude that the only real solution to congestion – road pricing – is not politically deliverable. As the referendums in Edinburgh and Manchester demonstrated, the public have so far been hostile to the concept of road pricing. Government should then make it clear that without road pricing congestion will continue to get worse.

There is a recognition even within the industry, that car use must be reduced. The European President of Ford recently said that cities must have fewer cars on their roads to ease congestion and free up alternative forms of transport.

2.3 Correlation between traffic speeds and NOx emissions

There is a clear correlation between urban traffic speeds and NOx emissions. Congestion is a major contributor to deteriorating air quality. In central London morning peak traffic speeds have fallen from 16 kmph in 2006 to 12 kmph in 2016[34]. The chart below shows the impact this had on NOx emissions from different diesel vehicles:

% increase in NOx emissions caused by fall in traffic speeds 2006-2016 (Euro V/5)[35].

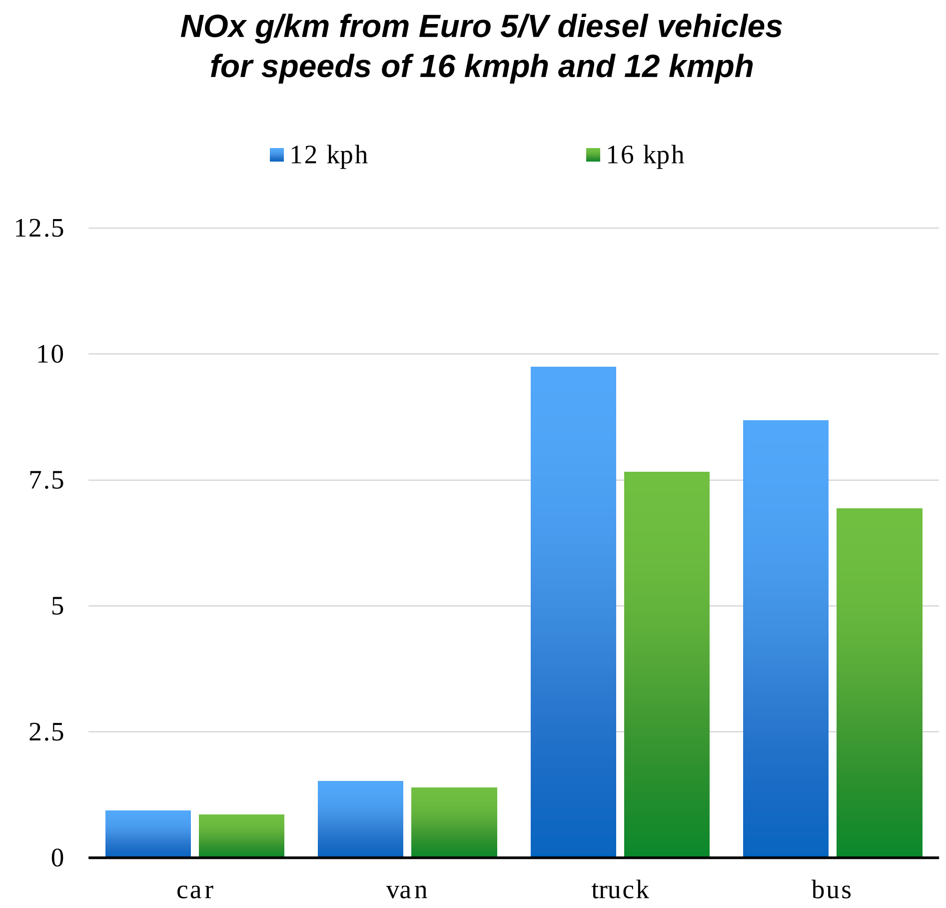


[33] Commission for Integrated Transport, Paying for Road use, 2002
[34] Travel in London Report 9, Transport for London 2016
[35] ANALYSIS of traffic speed data as supplied in Travel in London Report 9, Transport for London 2016, and NOx emissions data as supplied by Low Carbon Vehicle Partnership 2017

2.3 Falling traffic speeds increase NOx emissions

The chart below illustrates the grams of NOx per km travelled (NOx g/km) from Euro 5/V diesel vehicles operating at 12 kmph and 16 kmph[36]

When speeds fall from 16kpmh to 12 kmph there is almost a 10% increase in NOx from diesel cars and vans, and a 25% and 27% increase for buses and trucks:



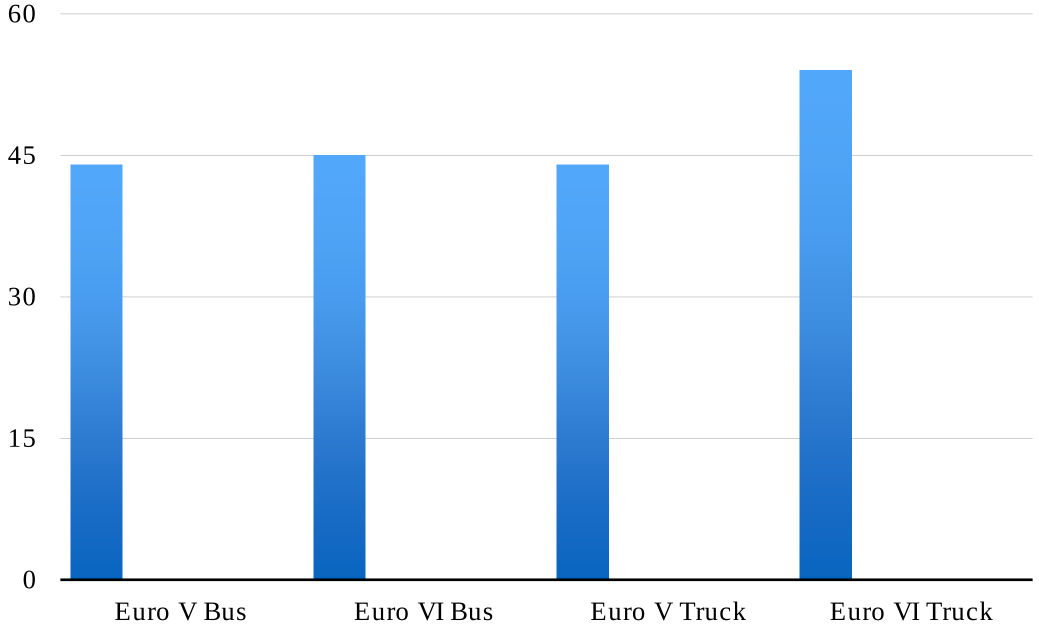
[36] Low Carbon Vehicle Partnership, 2017

NOx g/km

	2006 (16kmph).	2016 (12kmph)
Diesel car Euro V (1.4-2.0).	0.854.	0.938
Diesel van Euro 5 NI-II (<3.5tn).	1.39.	1.52
Diesel Bus Euro V EGR (15-18tn).	6.93.	8.68
Diesel HGV rigid truck Euro V EGR (20026tn).	7.66.	9.74

The chart below illustrates that halving urban traffic speeds leads to a 50% increase in NOx emissions from diesel buses and trucks:

% increase in NOx g/km for speeds falling from 20 kmph to 10 kmph[37]



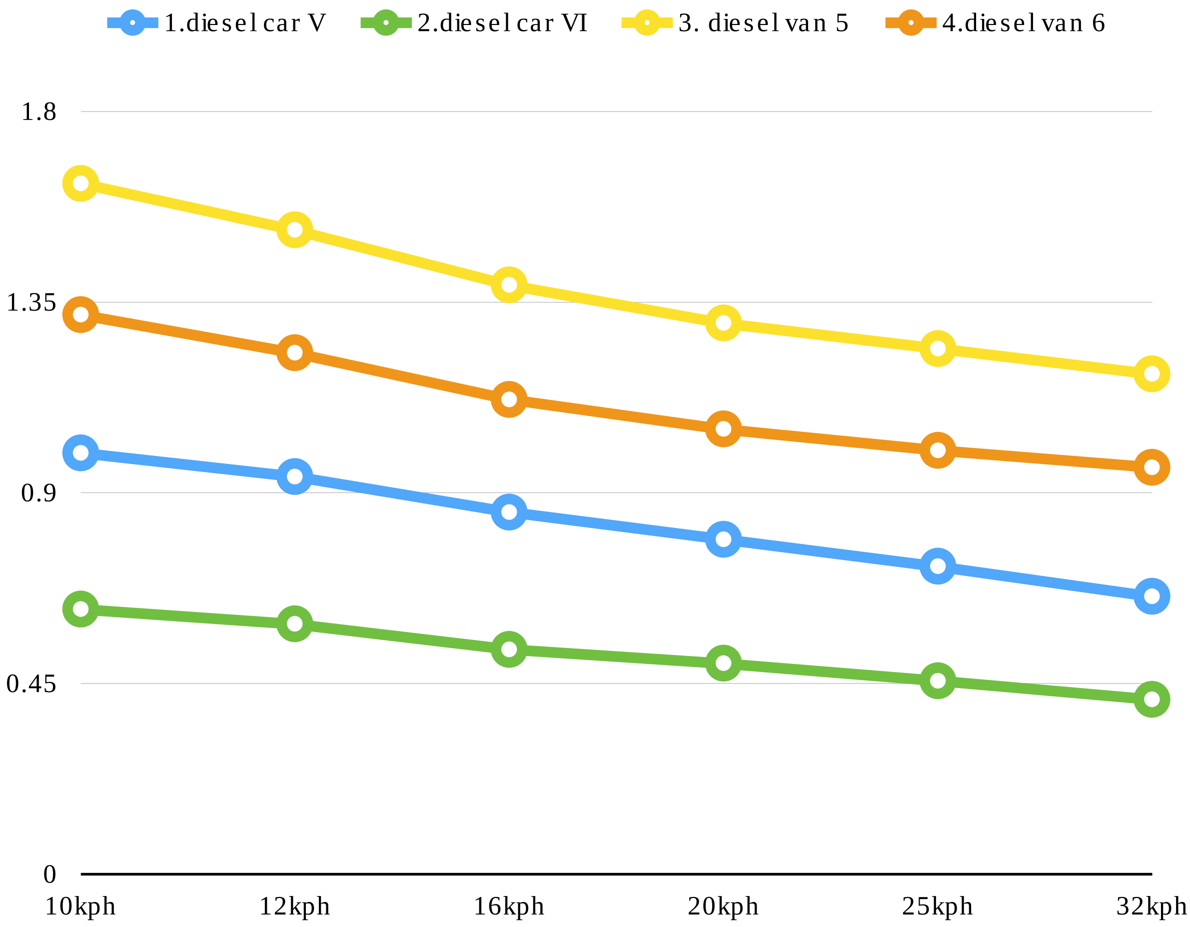
2.4 Improvements in traffic speeds reduce NOx emissions

Improving traffic flow leads to a reduction in NOx emissions across all vehicle types and categories, with particularly notable reductions in NOx to be achieved for buses and trucks.

The following charts illustrate the dramatic fall in NOx emissions which can be delivered with even modest increases in vehicle speeds:

[37] Low Carbon Vehicle Partnership 2017

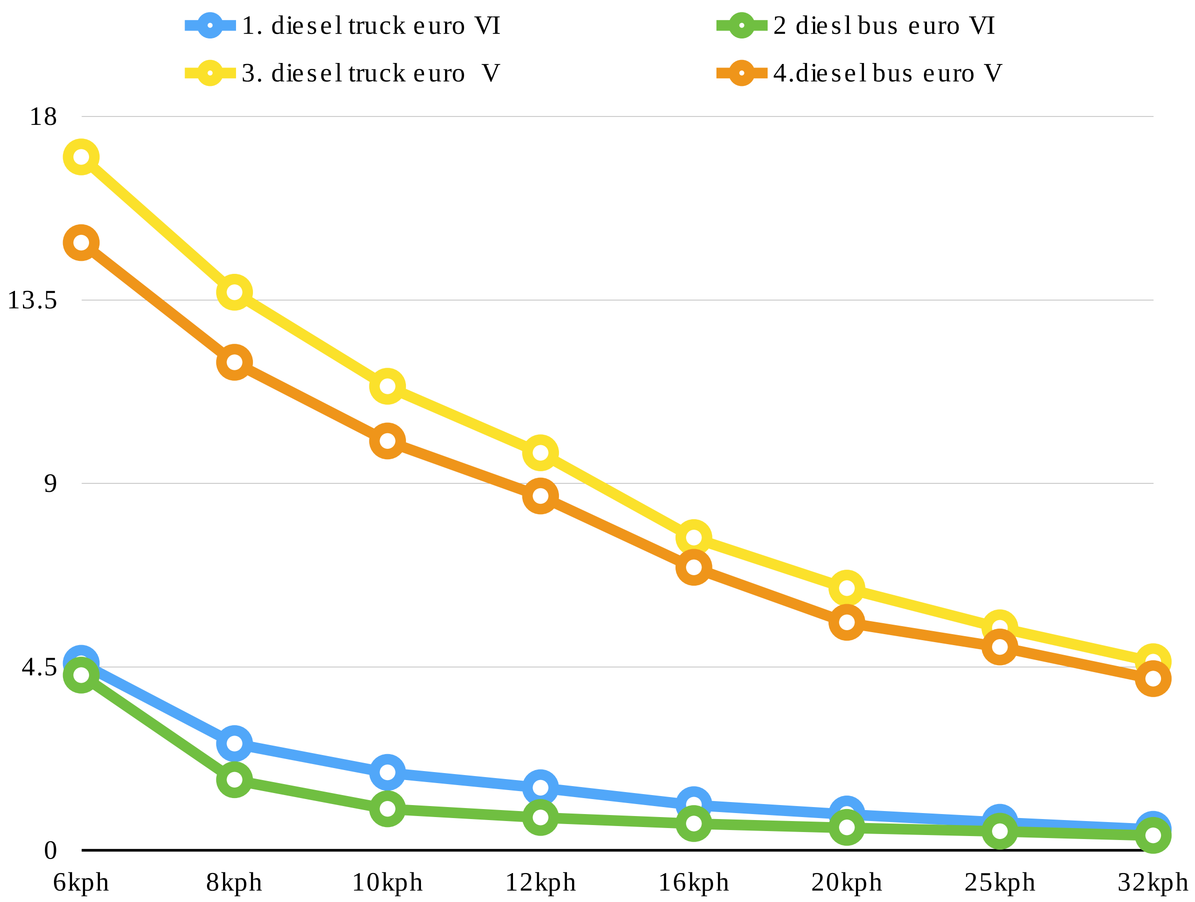
NOx g/km at different speeds for diesel cars and vans[38]



[38] Low Carbon Vehicle Partnership 2017

1. Diesel car Euro V (1.4-2.0I)
2. Diesel car Euro VI 2017-2019
3. Diesel van Euro 5 N1-II (less than 3.5t)
4. Diesel van euro 6: up to 2017 N1-II (less than 3.5t)

NOx g/km at different speeds for buses and trucks[39]



[39] Low Carbon Vehicle Partnership, 2017

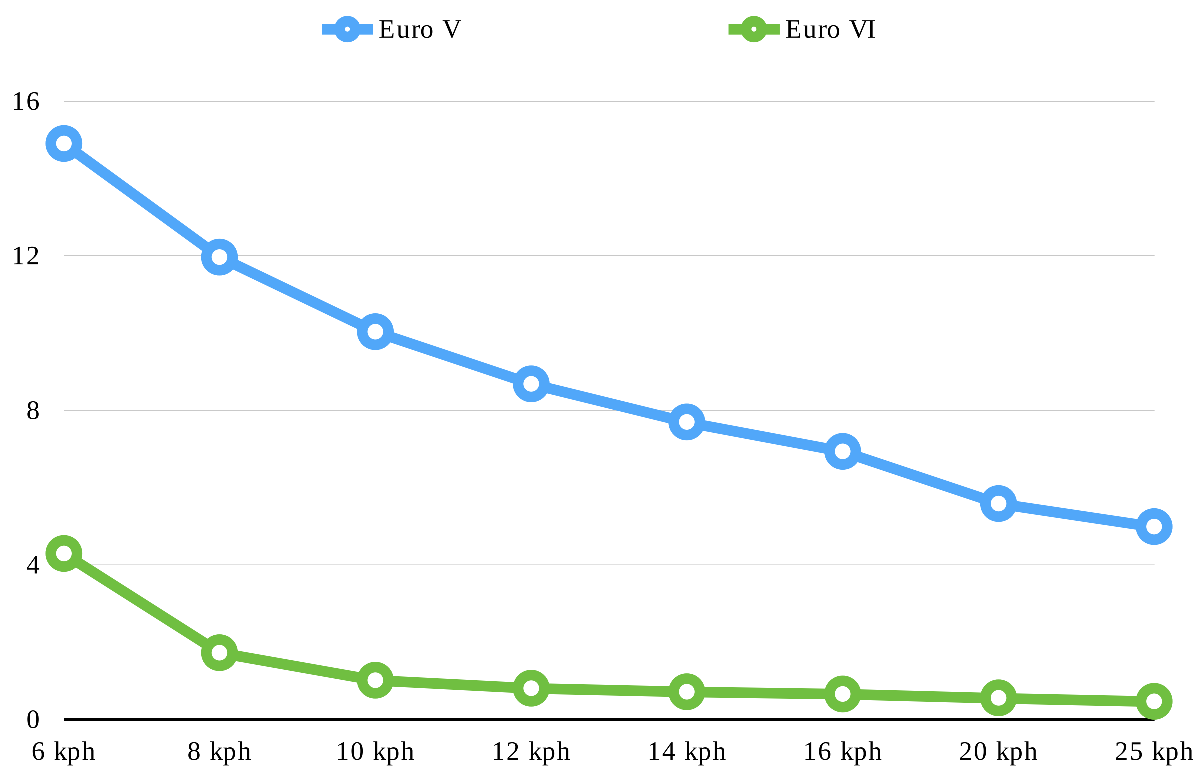
1. Diesel HGV rigid truck euro VI (20-26t)
2. Diesel Bus Euro VI (15-18t)
3. Diesel HGV rigid truck Euro V EGR (20-26t)
4. Diesel bus Euro V EGR (15-18t)

2.5 Bus priority measures facilitate reductions in NOx emissions

As the above evidence demonstrates, it is not just the vehicle type and category that determines roadside NOx levels, it is the average speed at which vehicles are able to travel. There is a clear imperative to improve urban traffic speeds as well as clean the fleet.

Particularly notable reductions in emissions can be achieved by improving bus flow. The chart below highlights that even for the most up to date Euro VI bus, NOx emissions are more than halved by increasing speeds from 6 kmph to 8 kmph:

NOx g/km at different speeds for Euro V and Euro VI buses[40]



This shows that if you combine the cleanest diesel buses (Euro VI), which will be compliant in CAZs, with improved urban bus speeds you achieve dramatic improvements in air quality.

Effective bus priority can help protect bus passengers from congestion and deliver massive improvements in air quality.

[40] Low Carbon Vehicle Partnership 2017

Euro V buses travelling at 6 kmph results in 14.9 NOx g/km. If speeds can be increased to 12 kmph this would result in 8.68 NOx g/km, a reduction of 52% in harmful emissions. For new Euro VI buses, which will be compliant in Clean Air Zones, the reduction in NOx emissions as speeds improve is even more dramatic as speeds improve. At 6 kmph they produce 4.29 NOx g/km, while at 12 kmph they emit only 0.8 NOx g/km - a reduction of 81%.

3. CONGESTION CONTINUES TO RISE

3.1 Equilibrium speeds

It would have been viewed as very unlikely 20 to 30 years ago for traffic speeds to fall to almost walking pace in some of our towns and cities. This is because congestion is one of the main constraints on traffic volumes. It was thought by transport planners and policy makers that cities would settle around an equilibrium traffic speed.

If speeds fall below acceptable levels road users change their behaviour: they will change the time of their journey; for optional trips, they might decide either not to travel or to switch to public transport, walking or cycling. The advent of internet shopping and video communications encourages more people to say at home if journey times are too long.

In the 1970's it was believed that almost regardless of the transport polices pursued traffic speeds would settle at around 18 km per hour[41]. If they fell below this level road users would adapt their behavior, which would lead to a reduction in the demand for road space.

If the urban transport authority improved traffic speeds by getting motorists out of their cars and onto public transport, or by building new road capacity, this would improve traffic speeds in the short term. However, this improvement in traffic speeds would eventually attract more vehicles onto the road and traffic speeds would fall back to the "equilibrium" level.

The "equilibrium speeds" theory implies there is a floor below which traffic speeds will not fall. However, the evidence of the last few decades indicates that the floor keeps lowering, and congestion continues to increase.

3.2 Traffic speeds keep falling

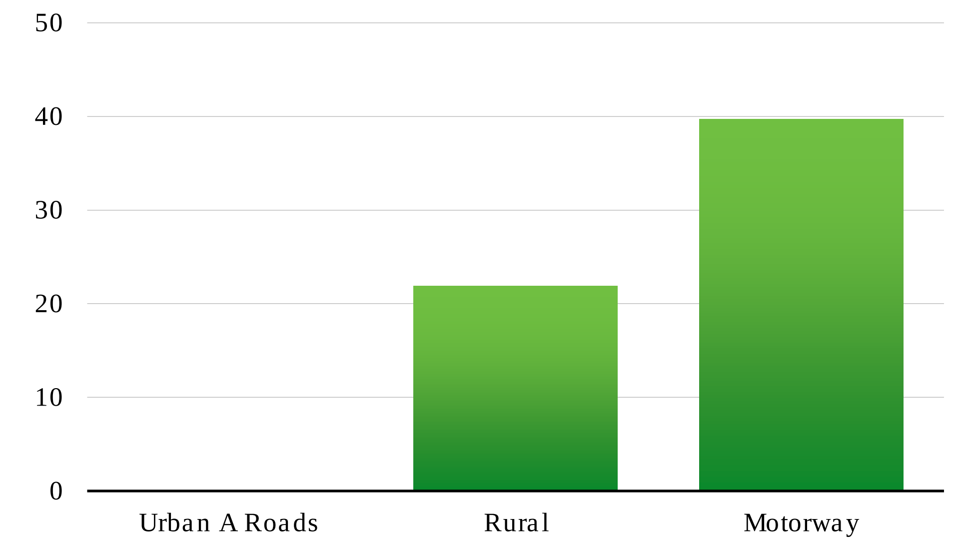
Department for Transport data shows that traffic speeds for A roads across England have been falling by on average more than 1% per annum[42].

There has been no change in traffic volumes on urban A roads over the last 20 years (1996-2016).[43] This compares with a 22% growth in traffic on rural roads and 38% growth on motorways. This would suggest that we reached saturation point on urban roads 20 years ago and that congestion became the main constraint on traffic volumes. To an extent this fits in with the theory that traffic is self-regulating.

The chart below demonstrates that urban A road traffic volumes have remained static:

[41] Great Cities and their Traffic, Michael Thompson, 1977
[42] Traffic Growth GB: 2011 to 2016, Department for Transport
[43] Traffic Growth GB: 2011 to 2016, Department for Transport

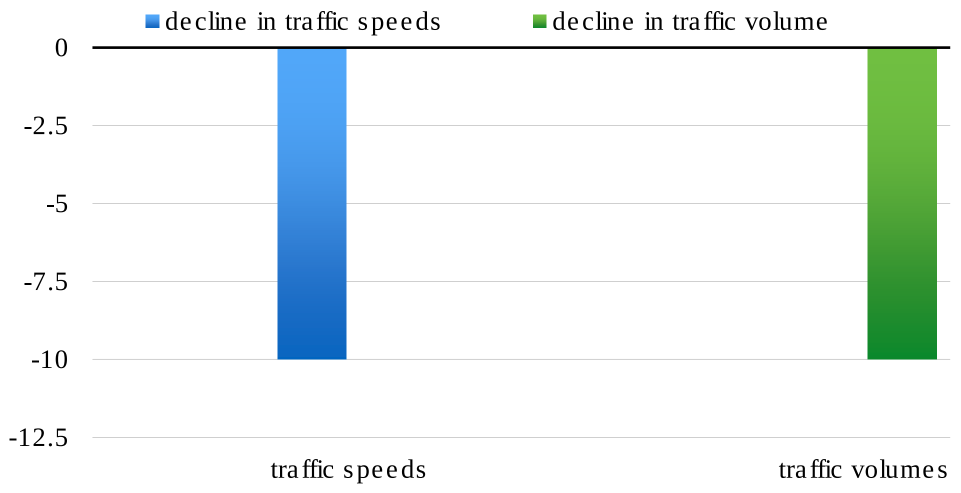
% Change in traffic volumes over the last 20 years[44]



However, while urban traffic volumes have remained static, congestion and delays have increased. Traffic congestion in the UK's largest cities is 14% worse than it was five years ago and in the last year alone has deteriorated by 4%[45].

In London, congestion has been rising while traffic volumes have been falling. The chart below shows the change in traffic speeds and traffic volumes in Greater London since 2000. Since 2000 there has been a 10% reduction in traffic volumes across Greater London while average traffic speeds are down by just over 10%:

Decline in traffic speeds and traffic volumes in Greater London since 2000[46]



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[44] Traffic Growth GB: 2011 to 2016, Department for Transport
[45] Tom Tom, June 2016
[46] Travel in London Report 9, Transport for London, 2016

There is a free flow speed to traffic which usually is determined by the speed limit. The main cause of falling average traffic speeds is too many vehicles for the road space available. Transport for London estimate that 75% of congestion is caused by too many vehicles[47].

There are two main causes of the reduction of available road space: the supply of road space has been declining; and, the changing composition of traffic, which is having a profound impact on traffic speeds across the UK.

3.3 Supply of road space has been declining

There has been an increase in road works across towns and cities in the UK. In London, there has been a 360% increase in scheduled road works since 2012[48]. Some caution with this figure is needed as it uses the year of the London Olympics as the benchmark (TfL were very successful in minimizing road works that year). So, while road works in the capital have been increasing this statistic is likely to be an overestimate.

Successful cities have also been reallocating road space from movement space to people/exchange space, and in the case of London more cycle lanes. This is a trend which we can expect to continue, and therefore the amount of road space available for the movement of vehicles is likely to shrink still further.

80% of UK congestion is in urban conurbations, and 40% in Greater London alone[49]. There is scarce opportunity to increase road capacity without knocking down houses and building over much sought after green space.

The pressure now, and in the future, is how to make our cities more people friendly by reallocating road space from the movement of people and goods to exchange or people space[50]. This has already happened in London, which is one of the reasons why congestion in the capital has become so acute in recent years.

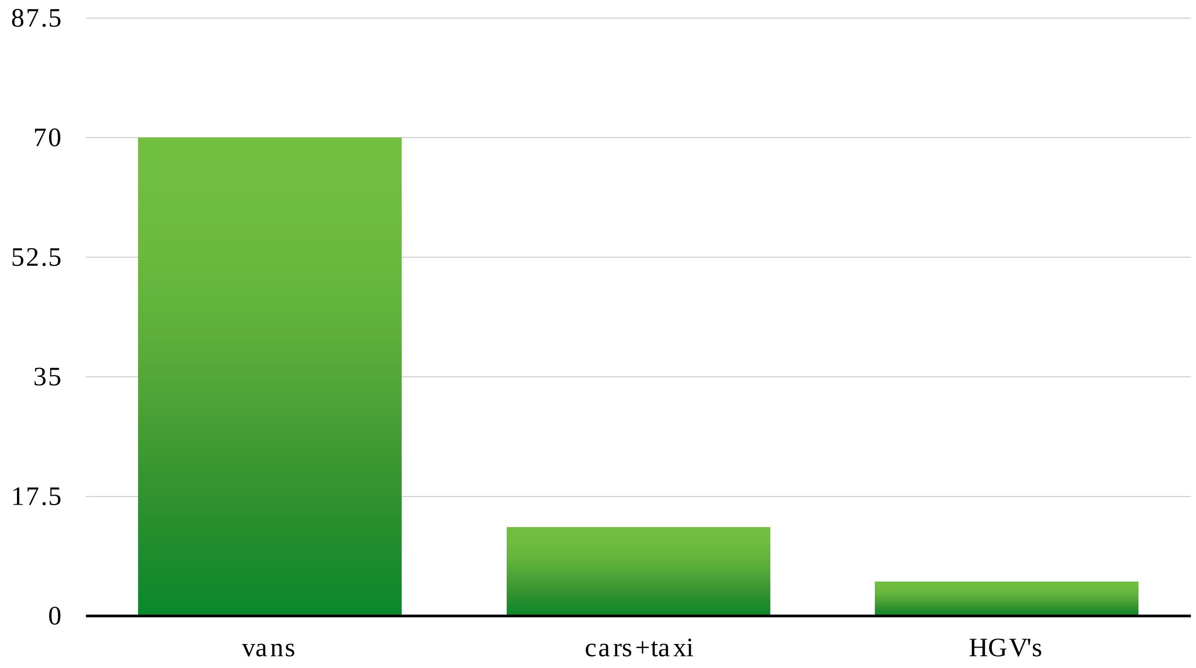
3.4 Composition of traffic has been changing

The traffic mix is changing with vans (LGVs) increasingly accounting for a larger proportion of total traffic.

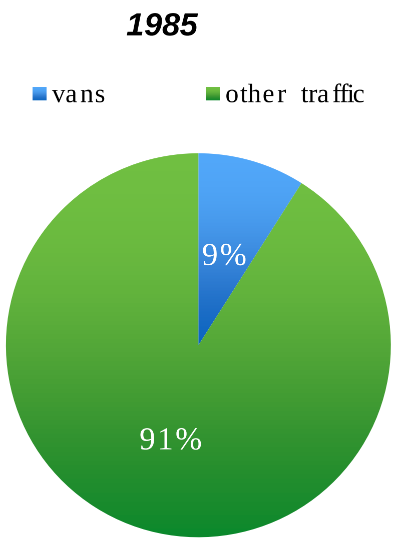
In the last 20 years LGV miles increased by 70%, compared with a growth of only 13.5% for cars and taxis and 5.4% for HGVs. In 2016 vans made up 15% of all traffic, compared with 9% in 1985.

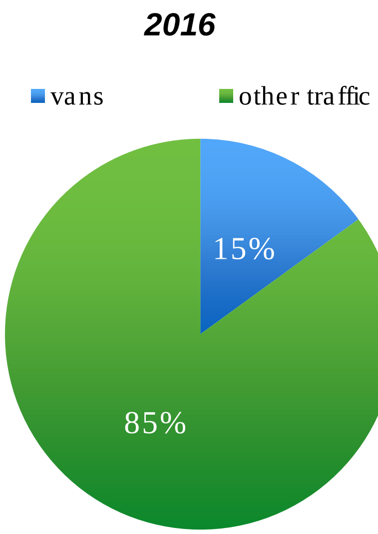
[47] Travel in London Report 9, Transport for London, 2016
[48] Inrix DATE 2017?
[49] Commission for Integrated Transport, Paying for Road use, 2002
[50] Mayor of London's Roads Task Force 2015

% growth in traffic over last 20 years (Vehicle miles)[51]



Van traffic makes up around 15% of all traffic compared with 9% in 1985[52]





[51] Reference???

[52] Society of Motor Manufacturers & Traders, May 2016

The Department for Transport points to three factors driving the growth in van traffic: growth in internet shopping and home deliveries; changes to car and van taxation rules making vans more attractive for some people; and, businesses switching from HGVs to LGVs to save operating costs.[53]

The growth in vans is outstripping growth in all other vehicle types. We can expect this trend to continue as online shopping continues to grow fueling the growth in deliveries.

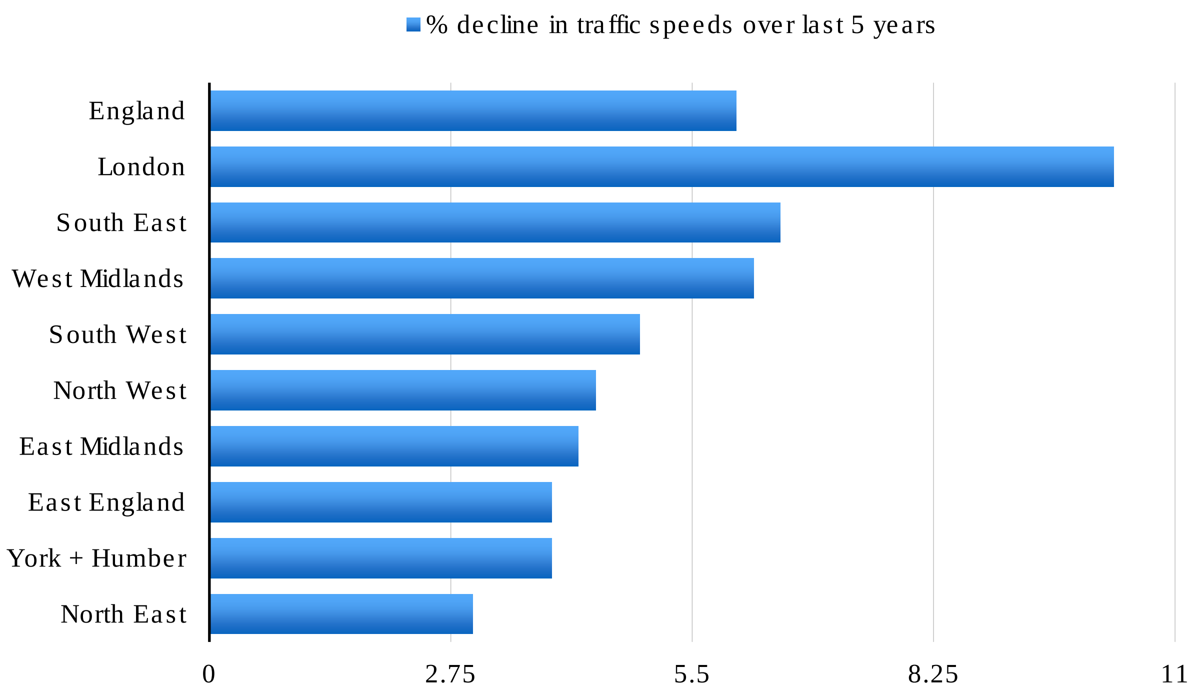
As the mix of traffic becomes increasingly oriented towards vans, with cars accounting for a smaller proportion of total traffic, congestion becomes less of a regulator on traffic volumes. With increasing focus on “just in time” and “next day” deliveries, more congestion results in *more* vans on the road if service levels are to be maintained.

The change in the mix of traffic, with vans accounting for a higher proportion of general traffic, means that the floor to traffic speeds is being lowered.

3.5 Congestion is not just an urban problem

While urban traffic speeds have been steadily declining, the same can be said of speeds across the local A road network. The table below shows that the biggest decline in average speeds over the past five years occurred in Greater London (10%) followed by the West Midlands (6.2%) and the South East (6.5%):

% decline in average vehicle speeds during weekday morning peak for local A roads by region (Sept each year) over last 5 years[54]



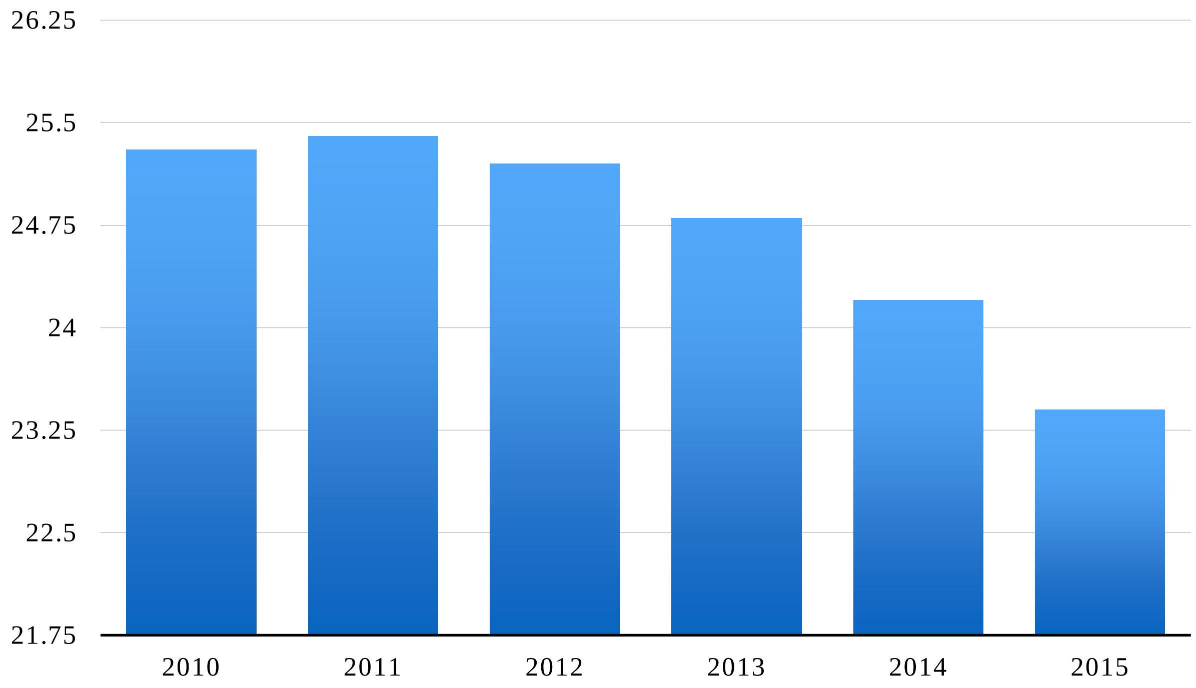
[53] Traffic Growth GB: 2011 to 2016, Department for Transport
[54] Congestion and Reliability Statistics 2016, Department for Transport

Across England local traffic speeds have been falling by on average more than 1% per annum. This is similar to the trends for declining bus speeds across the UK identified in *The Impact of Congestion on Bus Passengers*[55].

Because of the change in the mix of vehicle traffic, congestion will be less effective in regulating the volume of traffic. This means that there is less likely to be a floor below which traffic speeds don't fall.

In the last four years vehicle speeds have declined by around 8% on locally managed A roads. There is little reason to assume that this decline in average speeds of around 2% per annum will not continue barring a major economic downturn.

Average speed (mph) on locally managed A roads (weekday morning peak) Comparison for September each year[56]



Traffic delays

Since 2014 the Department for Transport has been monitoring average delays to traffic. It compares free flow speeds (based on speed limit) versus actual speeds. Average speeds have decreased steadily since the start of the statistics in 2014. The average delay on local A roads in England is 46 seconds per mile. This has increased by 8.6% over the last two years. Over the same period traffic on the A road network has increased by 3.8%.

[55] "The Impact of congestion on bus passengers" Greener Journeys Report, Begg, 2016.
[56] Congestion and Reliability Statistics, Department for Transport

If the trends in delays over the last two years continues then we can anticipate traffic delays almost doubling over the next decade. As the road network becomes more congested a given increase in traffic volumes will result in a disproportionate increase in delays. It is the decline in reliability of the road network which gives most cause for concern. Users of Urban A roads need to leave an average of 200% additional time on individual road sections to ensure they arrive on time.[57]

3.6 Projected decrease in traffic speeds to 2030

The chart below shows the projected decrease in average daily speeds across the whole local A road network for regions in England. This includes both rural as well as urban roads:

Projected average Traffic speeds (mph) on local A roads English regions[58]

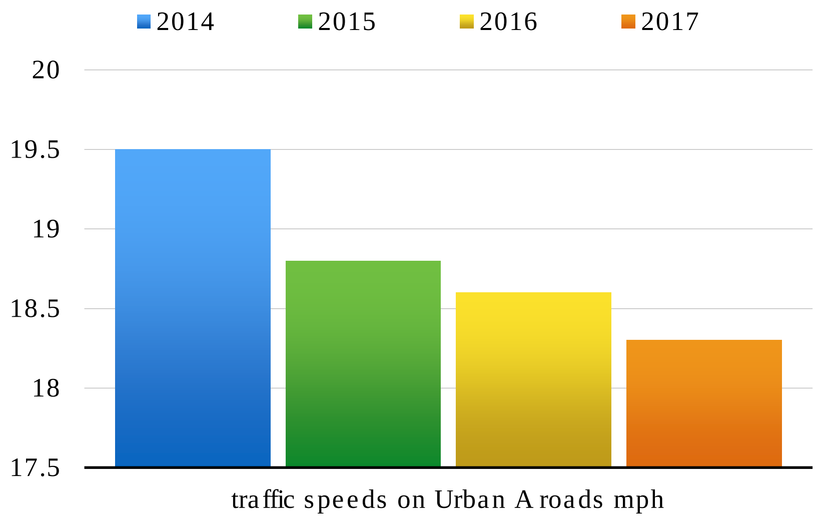
Region	2016	2030	% Decline
England	25.2	20.7	18
Inner London	11.9	8.2.	31
North West	23.1	20.0	13
West Midlands	26.1	21.2	18.6
Yorks & Humber	26.0	23.0	11.7
South East	28.1	22.6	19.5
South West	28.6	24.4	14.7
North East	29.6	26.9	9
East England	30.8	27.2	11.7

If we just look at Urban A roads we can see that speeds are lower and the decline is faster. Official data on urban A road traffic speeds is available for the last three years. If we compare March each year we see that speeds have been declining by more than 2% every year[59]:

[57] Analysis of travel times on Local A roads, England, Department for Transport 2017
[58] Analysis based on data supplied in "Average speeds by region" Department for Transport (2016)
[59] Department for Transport Road Congestion Statistics 2017

March 2014	19.5 mph
March 2015	18.8 mph
March 2016	18.6 mph
March 2017	18.3 mph

Urban A Roads average traffic speeds (mph)[60]



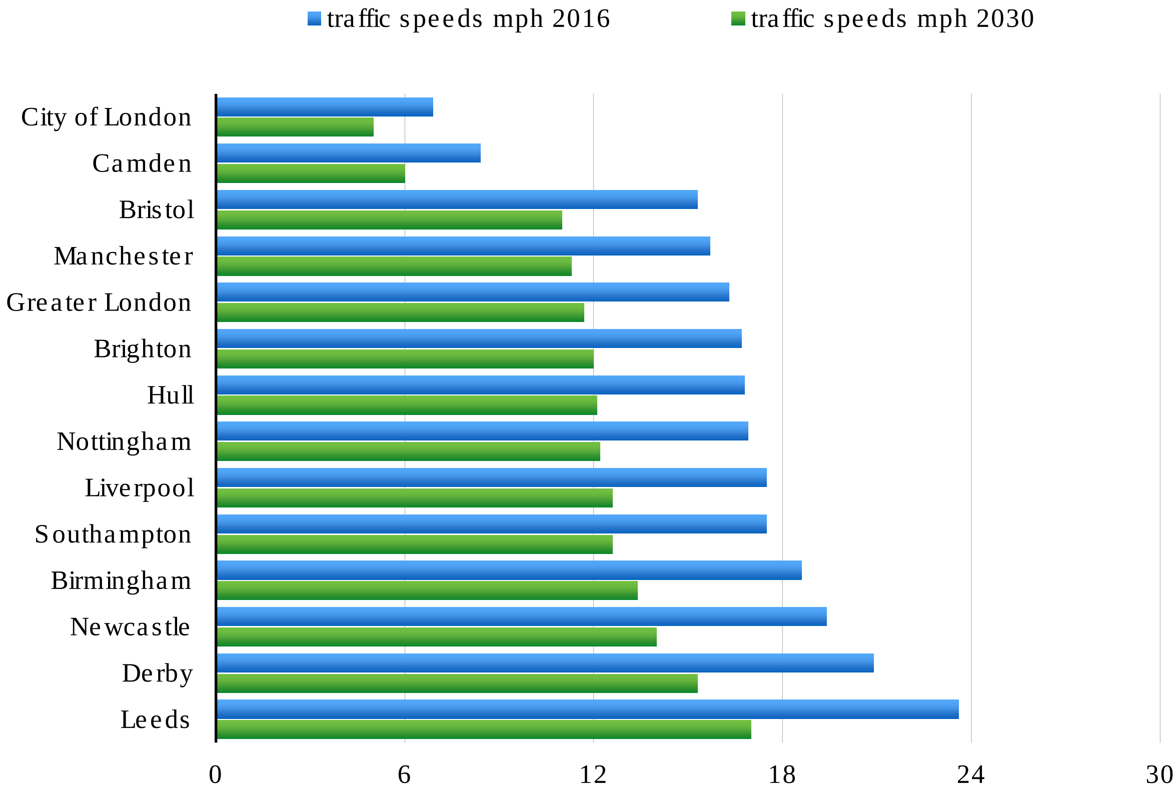
If this trend continues until 2030 speeds will fall by almost 5 mph to just over 13 mph on urban A roads. This data underestimates how acute the decline in speeds has been in city centres during peak times, as it looks at average speeds across the 24-hour cycle across the entire urban conurbations in the UK.

If we look at what has been happening in English cities we can see that as one would expect average speeds are lower than the wider regional averages. If the current trends continue we will see on average a 28% decline in speeds by 2030.

Projected average Traffic speeds (mph) on local A roads English cities[61]

City	2016	2030
City of London	6.9	5
London (Camden)	8.4	6
Bristol	15.3	11
Manchester	15.7	11.3
Greater London	16.3	11.7
Brighton	16.7	12
Hull	16.8	12.1
Nottingham	16.9	12.2
Liverpool	17.5	12.6
Southampton	17.5	12.6
Birmingham	18.6	13.4
Newcastle	19.4	14
Derby	20.9	15.3
Leeds	23.6	17

[60] Department for Transport Road Congestion Statistics 2017
March 2014 19.5 mph
March 2015 18.8 mph
March 2016 18.6 mph
March 2017 18.3 mph
[61] Analysis based on data supplied in "Average speeds by region" Department for Transport (2016)



In the last year alone, traffic speeds have declined by 15% across the City of London from 8.1 mph to 6.9 mph. While parts of London had the slowest traffic in the UK in 2016, for both Bristol (15.3 mph) and Manchester (15.7 mph) have slower speeds than Greater London (16.3 mph).

Again, it must be noted that this is average 24-hour data from across the city geography. Clearly evening and night time traffic speeds will pull up the average.

If the trend for urban traffic speeds to decline by just over 2% per annum continues until 2030 then for the 14 cities above average speeds will fall by 4.6 mph from 16.5 mph (2016) to 11.9 mph.

While it may be anticipated that there will be a significant reduction in the emissions from the vehicle fleet by 2030 the congestion problem, with all the associated wider social and economic costs and aggravation for road users, will remain.

4. MITIGATION MEASURES

4.1 Strategy must focus on moving people not vehicles

We must tackle congestion if we are to improve air quality in our major cities, and ensure that our towns and cities maximise their economic potential. The strategy must focus on moving people not vehicles, and on making the best use of available vehicles and road space.

Government's exclusive focus on emissions per vehicle rather than emissions per passenger presents a distorted picture and provides an inadequate foundation for effective policy interventions.

Policy interventions must be based on reducing emissions per passenger. This means tougher action on diesel cars; ensuring the cleanest and most efficient bus operation across the country; and, measures to encourage modal switch from car to public transport, cycling and walking.

4.2 Diesel cars should pay as well as other vehicles to enter CAZs

Government policy has stopped short of tackling one of the biggest root causes of air pollution: increasing use of private diesel cars. In its 2016 draft CAZ Framework, Government crucially did not require the first five CAZs (Birmingham, Leeds, Nottingham, Derby and Southampton) to cover private cars[62].

In its new draft Air Quality Plan published in May 2017[63] Government clearly identifies diesel cars as the single biggest source of roadside NOx emissions. However, its hierarchy of charging Clean Air Zones (A, B, C, D)[64] identify buses and taxis as the priority categories of vehicle to target, then HGVs then vans then (possibly) cars, so actually in the reverse order of NOx contribution.

Diesel cars are responsible for 41.01% of NOx emissions from road transport. Buses contribute just 7.83% of NOx emissions[65]. Diesel cars must comply with CAZ standards. The focus should not just be on buses, taxis, lorries and vans.

4.3 Buses must be at the centre of strategy to improve air quality

The quickest and most cost-effective solution to our air quality epidemic is to put the bus at the centre of the strategy.

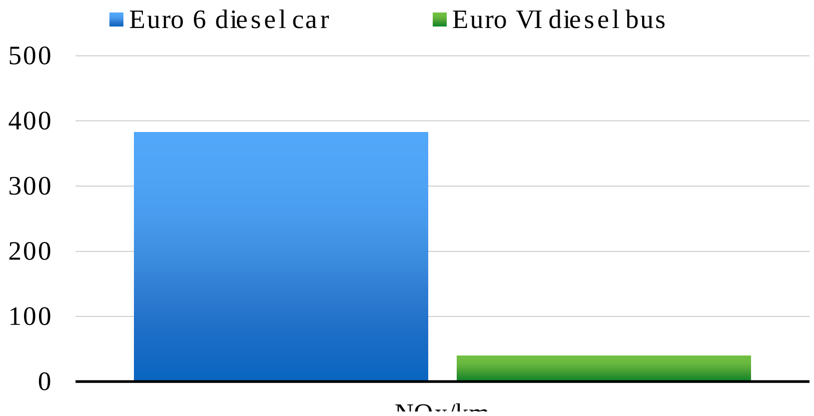
Progress in clean bus technology has exceeded car technology

The UK's bus sector has made very significant progress in introducing low emission, efficient technologies over the last decade. Currently a journey by diesel car, even a Euro 6 one, emits 10 times the per passenger NOx (383mg NOx/km) of a

[62] Draft Clean Air Zone Framework, DEFRA & DfT, 2016
[63] Tackling nitrogen dioxide in our towns and cities: A consultation, Defra/DfT/Scottish Government, Welsh Government, Northern Ireland Government, May 2017
[64] A: Buses, coaches and taxis; B: Buses, coaches, taxis, and heavy goods vehicles; C: Buses, coaches, taxis, and HGVs and light goods vehicles; D: Buses, coaches, taxis, and HGVs, LGVs and cars
[65] Low Carbon Vehicle Partnership analysis of NOx emissions from road transport based on NAEI 2014 data

comparable journey by Euro VI bus (40mg NOx/km)[66]. The NOx emissions from a Euro VI bus passenger are even lower than a Euro 4 petrol car passenger (43mg NOx/km).

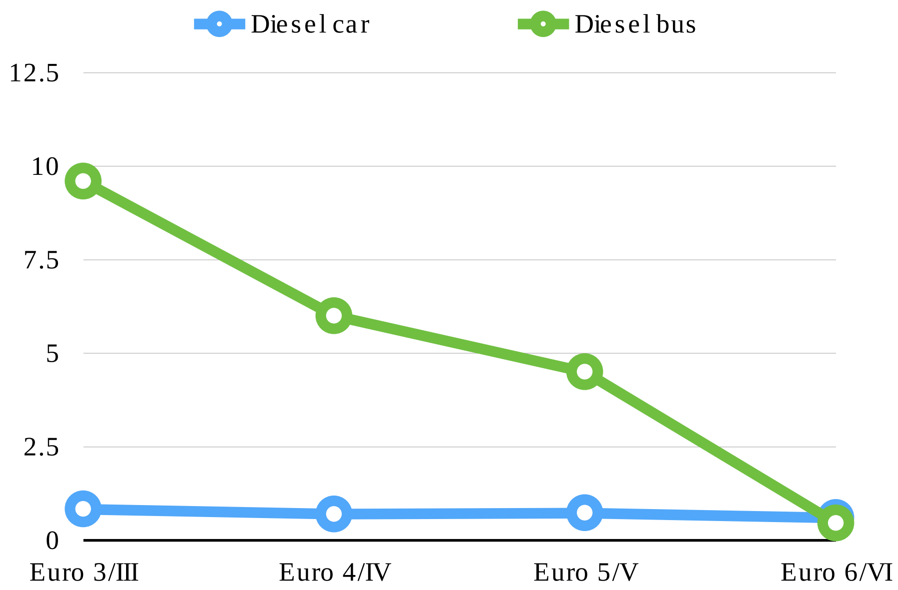
Euro 6 diesel car emits 10x more NOx pass/km as a Euro VI diesel bus



Source Low CVP Analysis based on COPERT Emissions Factors

Since 2004, NOx emissions from diesel buses have been reduced by a factor of 20, but emissions for diesel cars have reduced by less than a third. In 2016, emissions from a Euro VI diesel bus are less than from a Euro 6 diesel car, but a bus has 15 times the carrying capacity of a car.

NOx emissions at 25 kph for urban driving NOTE This is per vehicle before allowing for pass/ km



Source Low CVP Analysis based on COPERT Emissions Factors

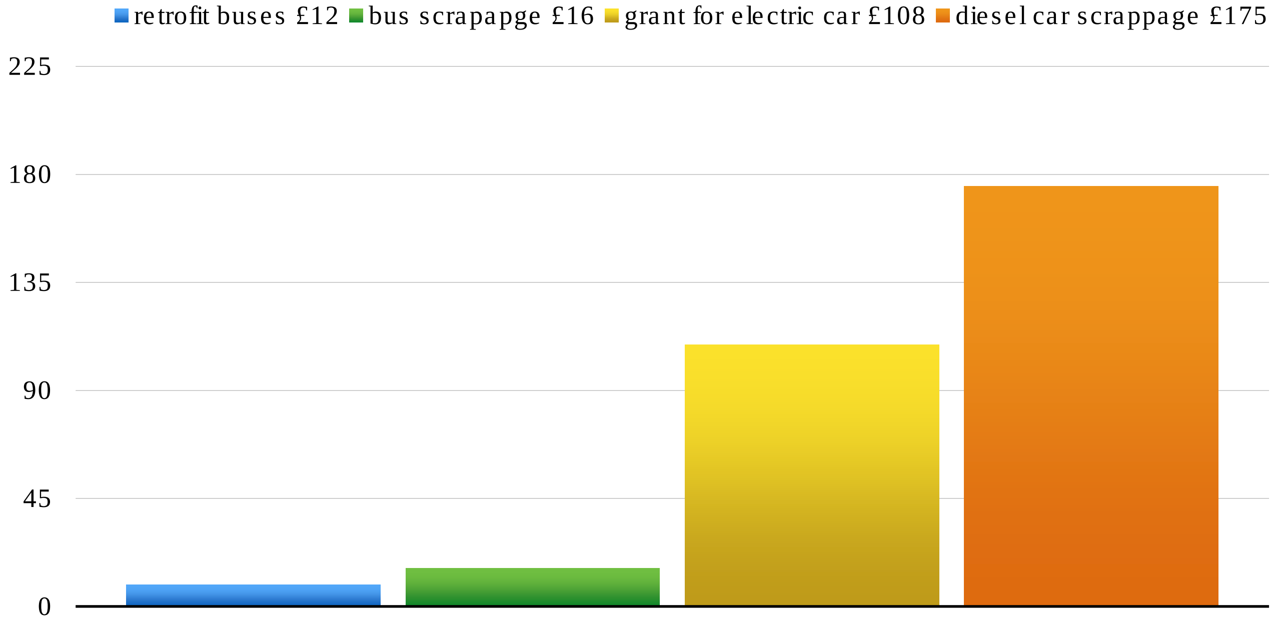
[66] Low Carbon Vehicle Partnership 2017 analysis using COPERT Factors at 25km/h average speed, using average passenger loading (DfT)

Modern diesel buses are a major success story. Real world testing of the latest Euro VI diesel engines demonstrates a 95% reduction in NOx emissions compared with their older Euro V counterparts[67]. Moreover, the rigorous testing regime for bus manufacturing means that an equivalent of the Volkswagen emissions testing scandal would be inconceivable in the bus sector.

Investing in clean buses delivers the best value for money

Retrofits for buses are proven to deliver Euro VI emission performance and are reliable with direct monitoring already in place. Government financial support for bus retrofitting provides more than 15 times as much value as scrappage allowances for diesel cars to convert to Euro 6 or electric, and 11 times as much value from a bus scrappage scheme compared with diesel car scrappage. The table below shows how much it would cost the Treasury to save 1kg of NOx per annum from different policies. The bus options of retrofit and scrappage allowance offer much better value for money than a diesel car scrappage scheme or grants for electric cars.

Cost (£) to Treasury for saving 1kg of NOx



Assumptions: Retrofit costs £17,000 and lasts 5 years the cost is £12 kg of NOx saved.

Scrapping a Euro III bus and replacing with Euro VI saves 600kg NOx per year. If the Euro III bus is 13 years old and has two year life expectancy its book value would be around £20,000. I'm assuming it was purchased for around £150,000 in 2004 which means it depreciates at £10,000 p.a. over its 15 year life span. Assume the bus scrappage allowance is equal to book value cost per kg of NOx saved = £10,000/600 = £16.

Grant for electrics car is £4,500 and has a 10 year life at a cost of £108/kg saved.

If a Euro 3 diesel car is scrapped at £2000 and replaced with a new Euro 6 model and lasts 10 years the cost is £175/kg.

So the cost to the Treasury in terms of NOx saved is 15 times more expensive for diesel car scrappage than retrofitting buses, and 11 times more expensive than a bus scrappage scheme. The bus options offer much better value for money. Source: Low Carbon Vehicle Partnership 2017

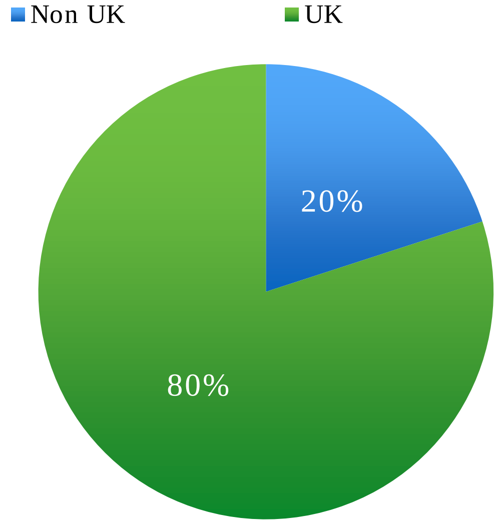
[67] The Journey of the Green Bus, Low CVP 2016

Investing in bus supports UK manufacturing

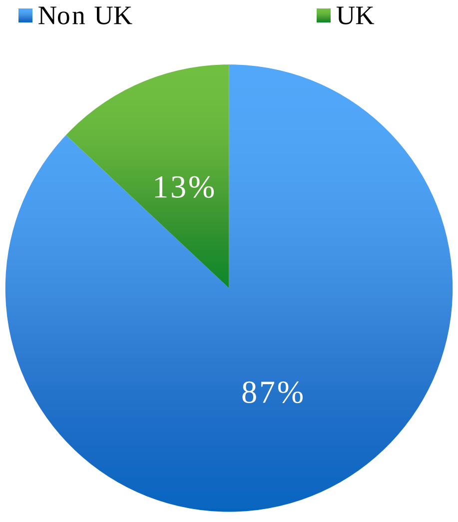
Bus manufacturing is adopting new clean and ultra-low emissions technology much quicker than car manufacturing. Ultra-Low Emissions Vehicles (ULEVs) already account for twice the proportion of the bus fleet as they do for the car fleet[68].

Putting buses at the centre of our air quality strategy would also support UK manufacturing. At least 80% of urban buses sold in the UK are built in the UK, but only 13% of the 2.6 million cars sold in the UK are built in the UK[69].

80% of buses sold in the UK are built in the UK



13% of car sold in the UK are built in the UK



[68] Low Carbon Vehicle Partnership, 2017
[69] Society of Motor Manufacturers & Traders, 2016

Bus priority measures reduce emissions and congestion

Measures to encourage modal switch from car to bus can be transformative. Bus priority measures can deliver 75% fewer emissions per bus passenger km than for car passengers[70].

Bus priority is not only a successful measure to improve air quality but it also effectively tackles congestion, with one bus moving 10 times as many people as a car (based on average vehicle occupancy for both). A fully loaded double decker bus could take up to 75 cars off the road.

Bus priority measures also enable more effective management of road space and speed up journeys offering high value for the taxpayer. Effective investment in bus infrastructure can generate up to £7 of net economic benefit for every £1 invested[71].

4.4 Future Scenarios

There is an optimistic and a pessimistic scenario for the future health and prosperity of our towns and cities resulting from the introduction of CAZs. The pessimistic scenario will only unfold if policy makers at national and local levels base decisions on political expediency rather than evidence; if they fail to address head on the issue of diesel cars; and if they fail to appreciate the importance of the bus to society and maximise its role in reducing emissions.

Optimistic Scenario

Our town and city centres become more pleasant places to shop, work and socialise, with clean air, safe streets, priority for pedestrians and cyclists, and fast, efficient and affordable bus services. CAZs are part of a wider urban and national strategy to tackle both air quality and congestion.

Buses are recognised as an integral part of the solution and not put at a competitive disadvantage compared with cars, especially diesel cars which emit 10 times as much NOx per passenger km using the latest technology. This means if buses are charged to enter the CAZ for non-compliance, then so are diesel cars.

There is a modal shift away from the car to more sustainable forms of transport: Cars use roads more inefficiently than other modes of transport and limit the number of people who can move in a city with a fixed amount of movement space available. The more vibrant, healthy, prosperous cities are those which have a higher percentage of people travelling by sustainable modes.

We achieve a virtuous circle of falling costs, higher bus frequencies, lower fares and higher patronage. If we can improve bus accessibility 20% from this scenario this would result in a **7.2% reduction in social deprivation**, a 5.6% increase in people with increased income, a 5.4% increase in employment, a 2.4% increase in adult skills and a 1.4% increase in students attending post-16 education[72].

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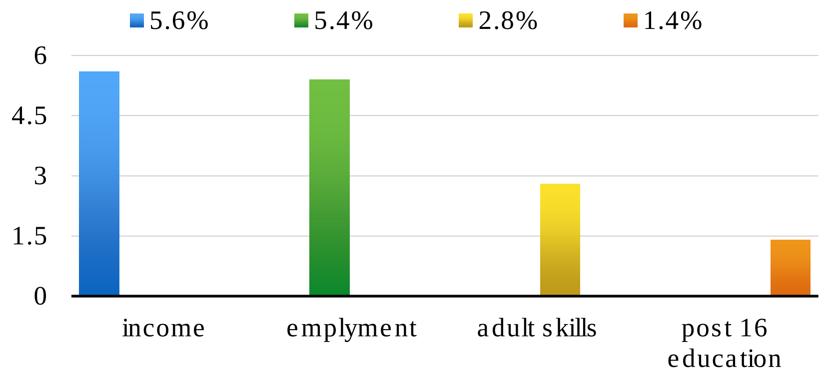
70 Professor Peter White, University of Westminster 2015
71 An Economic Evaluation of Local Bus Infrastructure Schemes, KPMG 2015
72 Professor David Begg analysis of University of Leeds, ITS 2016 Report



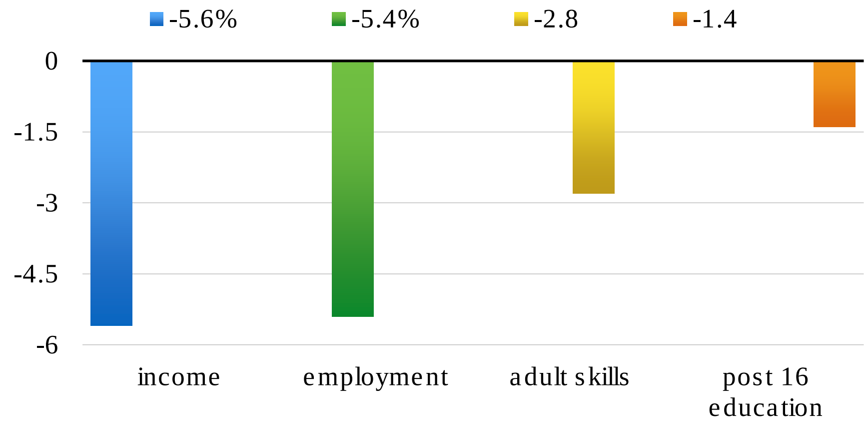
Pessimistic Scenario

Our towns and cities suffer from increasing levels of congestion and our air quality targets are not met. The downward spiral caused by congestion which has already resulted in 10% fewer bus passengers every decade[73] accelerates.

Buses are viewed as a problem and not part of the solution. Buses which don't meet the CAZ standards are charged and diesel cars which also fail to meet CAZ standards are not charged. Some areas don't allow retrofitting which significantly increases the cost of bus operations, leading to high fare increases and service reductions to pay for the new vehicle fleet.

This leads to a vicious downward spiral of rising costs, higher fares, service cuts and lower patronage. This in turn results in more cars on the road, more congestion and more pollution. Those without a car, many on low income, are severely disadvantaged and marginalised.

If we assume bus accessibility declines by 20%[74] this would result in a **7.2% increase in social deprivation**, a 5.8% decrease in income, a 5.4% decrease in employment, a 2.8% decrease in adult skills, and a 1.4% decrease in students attending post-16 education[75].



[73] The Impact of Congestion on Bus Passengers, Professor David Begg 2016
[74] This is a conservative estimate based on the modelling in the pessimistic scenario
[75] Professor David Begg analysis of University of Leeds, ITS Report 2016

5. CONCLUSION & RECOMMENDATIONS

Tackling congestion must be at the heart of Government's strategy for improving air quality. If CAZs are to be successful in cutting harmful emissions their scope must also extend to diesel cars which are the biggest contributor to NOx levels.

Rising congestion means that urban traffic speeds are falling across the UK, causing NOx emissions to increase disproportionately. Halving urban traffic speeds leads to a 50% increase in NOx levels.

Massive reductions in emissions can be achieved by improving bus flow. Even for the most up to date Euro VI diesel buses, which will be compliant in CAZs, NOx emissions are more than halved by increasing average speed from 6 kmph to just 8 kmph.

Buses must be an integral part of the solution in CAZs. Since 2004, NOx emissions from diesel buses have been reduced by a factor of 20, whereas emissions for diesel cars have only reduced by less than a third. A fully loaded double decker bus can take 75 cars off the road.

Measures to reduce congestion will also tackle one of the biggest constraints on economic growth. On current trends, the average traffic speeds in cities are projected to fall from 16.5 mph in 2016 to just 11.9 mph in 2030.

While it may be anticipated that there will be a significant reduction in the emissions from the vehicle fleet by 2030 the congestion problem, with all the associated wider social and economic costs and aggravation for road users, will remain.

RECOMMENDATIONS

1. **Policy focus on reducing emissions per passenger**: interventions must be evidence based and reduce overall emissions not just emissions per vehicle

2. **Diesel cars must comply with CAZ standards**: the focus must not just be on buses, taxis, lorries and vans.

3. **Support for bus retrofit to Euro VI standard:** buses must be an integral part of the solution and priority given to greening the bus fleet.

4. **Demand management measures to reduce traffic**: including measures such as road pricing; workplace parking levy; city centre entry restrictions.

5. **Modal switch from car to sustainable transport**: including investment in bus priority; targets for bus speeds; improving public transport interchanges.

APPENDIX I – CAZs and bus economics

The Greener Journeys report: ***Improving Air Quality in Towns and Cities***, April 2017 included analysis by Prof Begg on the implications of CAZs for bus economics. The main conclusions from this analysis are set out below:

i) Purpose of bus economic analysis

The purpose of the analysis was to estimate the impact on bus passengers resulting from two different scenarios: replacing the non-compliant fleet with new Euro VI vehicles; and, retrofitting vehicles to the new Euro VI standard.

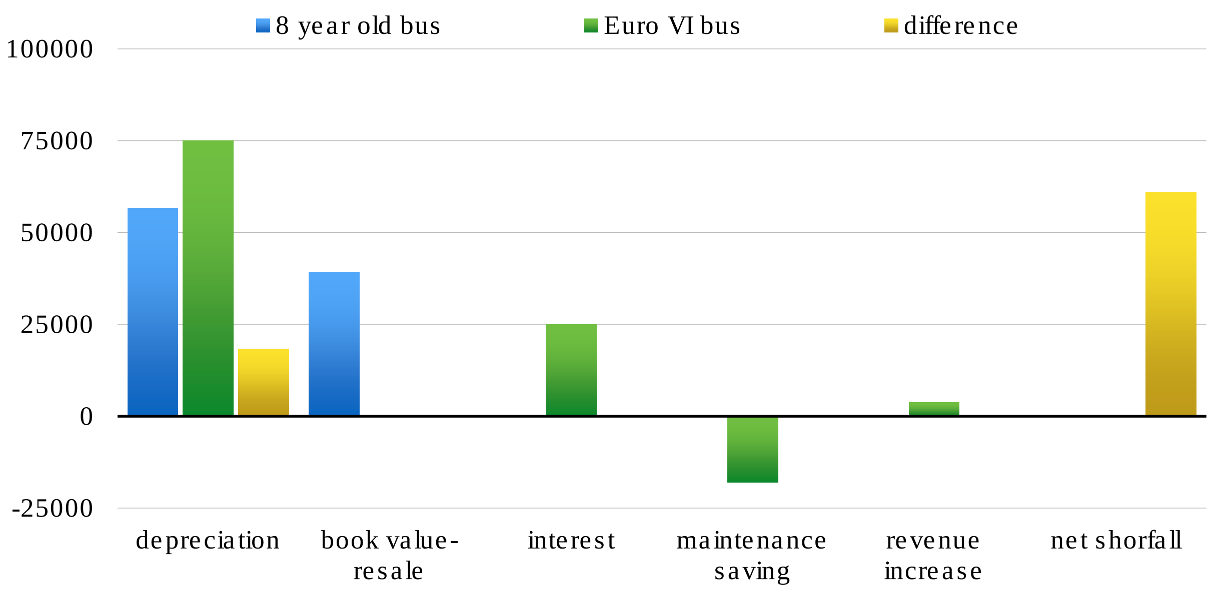
The cost impacts for one bus were estimated; then the cost impacts for bus operations in a whole metropolitan region were estimated (the impact on the balance sheet was modelled over a 5-year period). A forecast was then produced on the increase in fares and/or decline in service frequencies that would be required, and the resulting decline in patronage, assuming the extra costs were recovered through the fare box.

ii) Replacing non-compliant buses

Whilst the aspiration to move from diesel to electric/hydrogen is widely shared, it is not logistically possible to replace this number of vehicles within such a short time frame.

In the immediate term, Euro VI buses will deliver the seismic reduction in NOx and other harmful emissions that is required. This can be achieved by investing in new vehicles or retrofitting existing vehicles to Euro VI standard. The chart below shows the cost implications of replacing a vehicle.

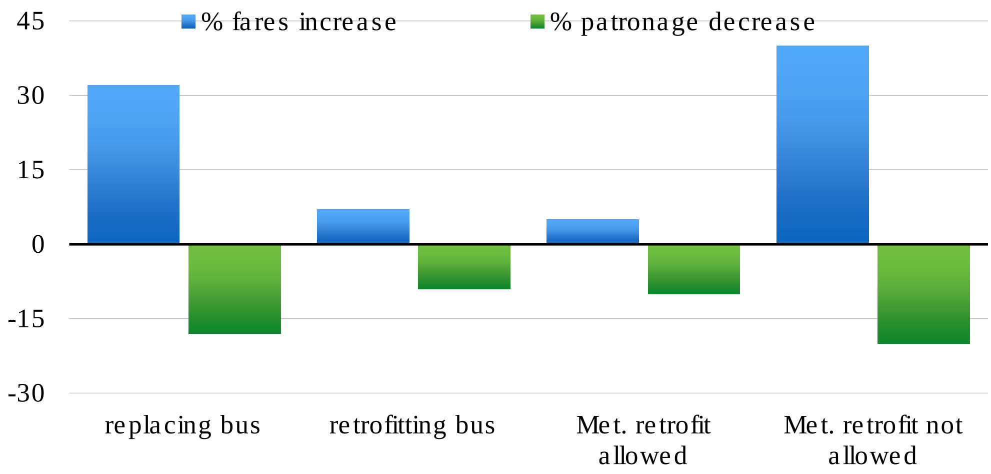
Five-year financial impact (£) from replacing 8-year old bus with new Euro VI



iii) Why retrofitting is essential

If retrofitting diesel buses so that they meet the very clean Euro VI standards is not supported, then the impact on the bus sector and bus passengers will be dramatic.

Impact on fares and patronage from the One Bus Model and Metropolitan Region Case Study



Even fare increases of much less magnitude than the high end 40% shown in the table above are not a realistic commercial proposition. A more likely response from bus operators would be to cut service levels and reduce the number of buses they operate. Our metropolitan case study is based on real data. It is based on a business as usual scenario and takes cognizance of the number of new vehicles and retrofits that are planned between now and 2020.

In our metropolitan case study area 50% of the bus fleet, in the wider city region, travel into the city centre where the CAZ is located. Of these buses 50% are non-compliant. Rather than replace this number of buses, and incur unsustainable cost increases in such a short space of time, operators would be more likely to reduce service levels.

If they don't replace any of the non-compliant vehicles and cut service levels by 50% this would result in a 25% decline in patronage (frequency elasticity of demand = -0.5). They would be unlikely to cut service levels by 50%, more likely would be a combination of fares increase, service level cuts and the purchase of new vehicles.

While fare increases and service level cuts normally lower the barrier to entry for new operators coming into the market, and for this reason are often rejected by the incumbent operators as a viable commercial proposition, a CAZ significantly increases the barrier to entry by imposing a high capital cost for entry to the market. It will penalise the smaller operators in particular but also any operator who will find it difficult to raise the capital.

A CAZ which does not permit retrofitting would damage the bus sector. A CAZ which bans diesel would severely damage the sector in what would be a perfect storm of declining patronage resulting from online shopping and relatively low motoring costs, coupled with relentless increase in congestion which is pushing up bus costs and on its own is reducing patronage by 10% every decade.[76]

[76] The Impact of Congestion on Bus Passengers, Begg 2016