Tracks
Transport • Policy • Practice

Environmental quality, climate change and transport innovation

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Contents

1. Executive summary

1.1 Introduction

The Tracks work on transport is taking place at a time when huge technological changes have begun, but the results of those changes, even in the short term, are as yet unclear. What this report does is to explore the nature of the change which will occur, the possible futures that may create, and how to influence the impact on travel behaviour. Of course travel is derived from social and economic activity but it also has a strong influence on that activity, most obviously in terms of land use planning, but also much more widely, for example in terms of industrial production and international commerce. It is an area where change can happen, and be made to happen, relatively quickly. This makes it an attractive option for addressing issues such as pollution and carbon emissions.

Many of the inputs to change are now familiar:

- Automation, from handling containers to driverless cars, lorries and buses
- Use of personal smartphones to replace personal car ownership through 'Mobility as a Service' (MaaS)
- Changes in the way our cities and their intellectual capital work (and play)
- Understanding of the major health impacts of travel – beneficial through walking and cycling, life shortening through air pollution and road accidents.

There are also potential social issues which have already made themselves apparent through the rise of so-called populism. A key example is the contrast between the vigorous new hi tech start-ups (such as 'Silicon Roundabout' in East London) and the areas across the country which have suffered from the loss of manufacturing. The latter has high profile examples such as making steel, cars or ships but extends further to everything from batteries to plastic bags. In addition, the developments in communication technology have also made it possible to integrate labour inputs into UK based operations from distant parts of the world. A well-known example is customer call centres, but in transport's case, computer modelling is undertaken for UK firms in parts of the world where skills are available at cheaper rates than in the UK or Europe.

All of this is having, and will continue to have, a major impact. However, there can be no absolute prediction of the exact outcomes. What can be identified is which policies are likely to guide these impacts in specific directions. For example, if electric cars make motoring cheaper and less polluting, could demand rise and cause more congestion, particularly in urban areas? How would the Government cope with a £30-40 billion reduction in income through loss of fuel taxes? Will the changes taken together result in more inequality or less?

Meanwhile some significant trends can already be identified. These include:

- The fall in driver licence holding among young people
- The rise in cycling in some urban areas, particularly in London
- The innovation and success of behavioural change programmes such as the Local Sustainable Transport Fund and workplace travel plans
- The impact of internet shopping with a strong rise in van traffic
- The rise of multi-modal travel apps which include new forms of travel offers such as Uber.

It is also worth noting that the rise in rail passenger use over the last decade was completely unpredicted by most transport forecasters and that strong growth continues today. The loss of coal traffic to power stations has masked a strong performance by rail freight in other sectors, particularly from the ports. The rail network is now seriously short of capacity.

1.2 Transport, technology and climate change

In relation to carbon, the long-term aim of zero vehicle emissions is feasible but misses the point. Carbon dioxide continues to have a warming impact for around a century. Thus the more that is emitted in the short term, say up to 2025, the more draconian action will be required to reduce emissions between 2025 and 2040. It should not be tonnes of carbon but carbon tonne years that are counted. This would refocus attention on what we do now and in the next decade.

For this reason the politically convenient dependence on a far distant target should be replaced by a realistic combined approach of introducing low emission vehicles but with a strong element of demand management as soon as possible, both for transporting people and goods.

The starting point for this project is to set out what the current transport forecasts are and how they are constructed, Department for Transport (DfT) for example produces traffic forecasts to 2040. It is then important to assess how they might change if different policies were pursued and if technology radically changes within their timescale. The latter is extremely likely in any case. Fortunately, the DfT have moved from fixed forecasts towards a range with different assumptions about how people travel. We have thus been able to ask the question 'What would make the lower traffic forecasts come about?' using the parameters in the DfT scenarios.

The conclusions in this report are that the combination of road traffic stabilisation in the period up to 2030, plus significant improvement in average vehicle emissions (much slower to improve than new vehicle emissions alone) could achieve the independent targets set for carbon reduction by the Government's statutory advisory body, the Committee on Climate Change (CCC). While it might be possible to achieve the same reductions with modest growth in road traffic rather than stability, this would need policies to be strengthened and some new policies to be introduced. This is clear in the CCC's latest report to Parliament. There remain areas of uncertainty, such as the impact of biofuels on reducing carbon, the ability of the car industry across the world to move fast enough to electric or hydrogen powered vehicles, and if developed countries can create the infrastructure required (whether charging systems or hydrogen stations). There are clear signs that technological change is gathering pace but it must be seen in the context of existing vehicles (over 31 million in Britain) and the annual sales of about 2.5 million. Of the latter, not all of them replace high emission vehicles but instead add to the total as second or third cars. To make the point, many cars that were sold two years ago will still be used in 2030. This report makes some detailed calculations as to what our realistic expectations should be of a technological approach. The conclusion is that demand management must play a key role and do so as quickly as possible.

Fortunately a great deal of work has been done in two areas: sustainable transport in its own right and technological innovation both for autonomous vehicles (AVs) and MaaS. This report suggests that decisions taken now about how these are implemented in future, and how market signals to encourage low carbon vehicles are created, could make the achievement of carbon reductions more effective and more certain. They would do so working with the direction of the new technologies and support the achievement of their wider social and economic benefits. A summary of the policies which are included in the report and possible outcomes is set out on the following pages.

1.3 Policy inputs for carbon/congestion

M is first 10 years, L is 10 to 25

Bulk freight

M LRUC (lorry road user charging) leading to better utilisation on trunk hauls

M Creation of new GB rail freight network with longer trains and consistent gauge

M Motorway connected depots (Strategic Road Freight Interchanges)

M Use of SRFI/SRdFI/Gateways to transfer freight to zero emission HGVs

L Larger HGVs + platoons Motorways only (contingent on LRUC)

Retail distribution

M Increasing use of electric vehicles

M Short haul electric HGVs from road/rail depots

M/L 3D printing (all levels)

Local delivery

M Specific new electric fleet for areas other than highly rural

M 3D printing (mid to low levels of complexity)

M/L Home 3D printing*

M Drones (mainly on-road working from vans)

Car tech

M Connected autonomous cruise control on motorways*

L Connected semi-autonomous vehicles majority all roads*

L Autonomous and connected vehicles majority*

M Increase in hybrid vehicles*†

L All electric vehicles dominant in the fleet*†‡

Notes:
*Opportunity for tax incentives/disincentives, but potential distributional issues

†Power connectivity issues in urban areas

‡Peak power supply issues

Road tech

M Use of data to control routeing – extend smart motorways tech and coverage

M/L Extend active signal control across all urban areas

M/L Develop comprehensive system for parking space booking/management

Land use

M/L Encourage densification (planning, rates, use of site area to determine parking places)

M/L Localisation (rates, planning)

M/L Closer links between housing and public transport (Smart Growth etc)

M 5G and broadband expansion

Direct demand management: national

M Revisions to first year Vehicle Excise Duty (VED) to encourage low emission choices

M/L Road user charging (integrated into AVs from the start)*

M National multi-modal e-fares

M Parking space charge above minimal levels

M Move in expenditure from road capacity to technology infrastructure and road maintenance

Direct demand management: local

M/L Active Travel (health benefits from non-motorised modes)

M/L New governance for transport in the conurbations combined with per capita funding increases for public transport and for developing mass transit

M/L MaaS extension to urban areas outside major cities (includes car share, Uber, PT info, via smartphones)*

M/L Development of new rural transport packages using new technologies in different ways, such as a wider spectrum of shared transport services and a MaaS rural approach

M/L Local workplace parking levies linked to mass transit funding (as Nottingham)

Measuring carbon emissions

M Realistic assessment of loss of tax revenue versus emission reductions

L Carbon content charge to include international transport

Overall outcomes

1) Less congestion and overall more predictable and plannable car journeys

2) All the benefits from lower emission vehicles captured and not eroded by traffic growth

3) Freight system makes significantly higher reductions in carbon emissions than is possible under 'business as usual'.

4) Car use extended while personal ownership falls

5) Road transport becomes safer

6) Road travel time may become more usable

7) Improved facilities for, and increases in, walking and cycling and use of mass public transport in urban areas

8) New rural travel opportunities without owning a car

9) National short-term growth in traffic followed by stabilisation in about 2030 and then modest reduction to a level around that of 2015 by 2040. Rigid HGVs may show a small increase within this picture

10) Loss of fuel tax revenue compensated by user charges for connected autonomous vehicles (CAVs) and LRUC.

Areas for concern

1) Electricity distribution network issues in areas of potential high and peaked demand

2) Distributional issues – both from user charging and high cost of new vehicles.

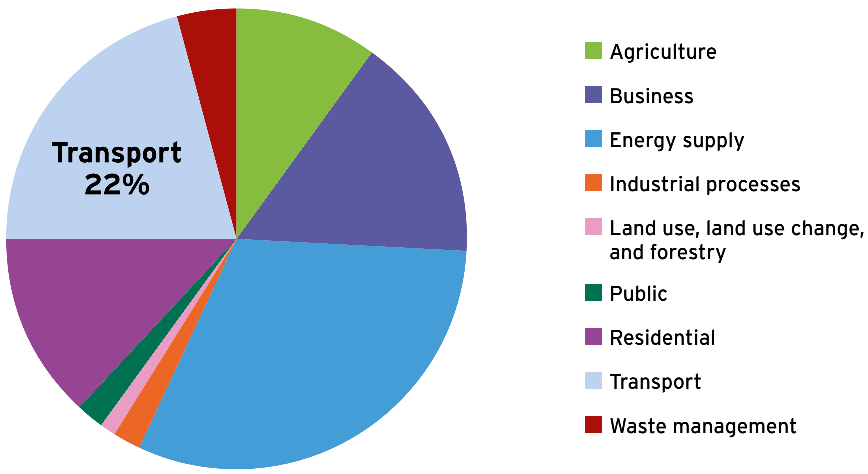
2. Context for reducing carbon emissions

2.1 Transport's contribution to national emissions

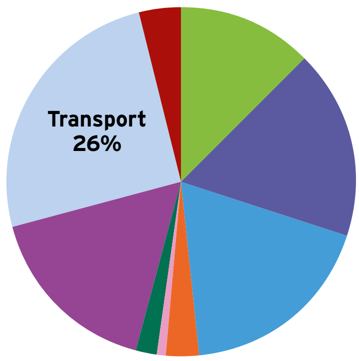
To put carbon contributions in a national context, transport emissions are significant, as shown in the charts below, all of which are from Department of Energy and Climate Change (DECC) forecasts for all greenhouse gases.[1] They also show how transport's share is predicted to rise. They are by source and only include direct emissions from transport. The real figures should include emissions resulting from the production of the fuels used, which is part of the UK overall figures below. This would increase the transport share by about a fifth, to 26 per cent in 2015.

It should also be noted this does not include emissions from international transport, in particular from aviation with an origin or destination outside the UK (the vast majority). This would increase transport's share significantly to 36 per cent in 2015.[2] This report does not consider international aviation or shipping, although policies to address their emissions were set out in the 2008 MTRU Report.[3]

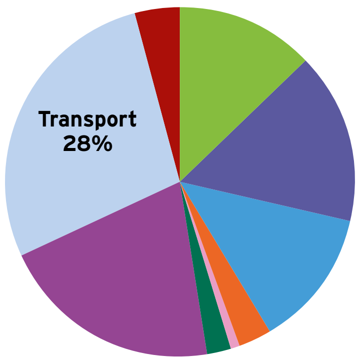
Figure 2.1: UK greenhouse gas emissions 2015



2025

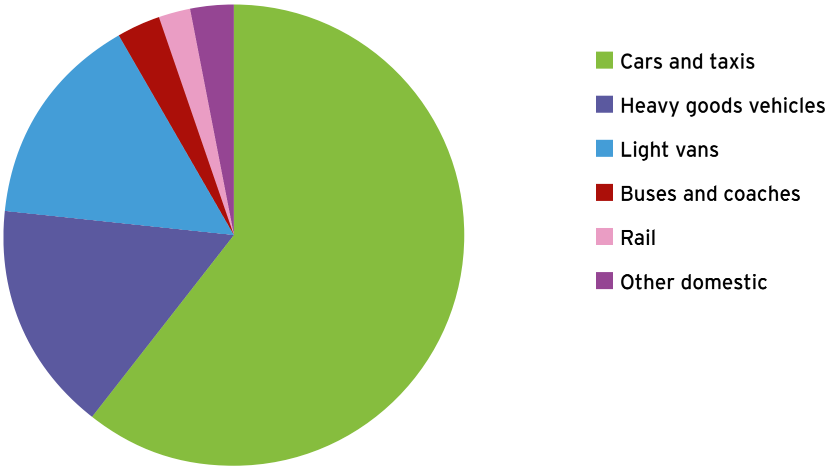


2035



Within transport the contribution varies between different vehicle types as shown below.

Figure 2.2: Domestic transport emissions 2014

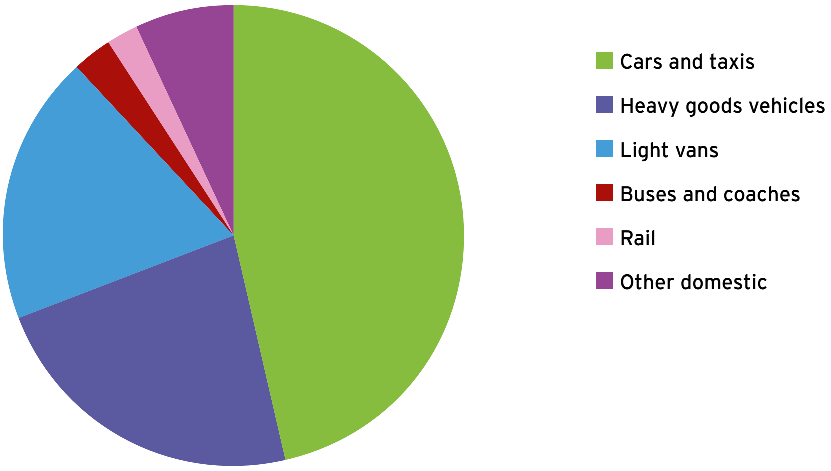


Source: Table ENV0201 (TSGB0306), from 'Greenhouse gas emissions by transport mode, United Kingdom: 2004-2014', December 2016

Note: Other domestic includes aviation totally within the UK

However, the rapid improvement in the efficiency of cars, and the predicted improvements in vans, mean that these proportions are predicted to change. This report uses a slightly more cautious approach to the improvements in car efficiency than those preferred by the CCC but even using these, the rise in importance of HGVs is very clear. This has major implications for HGV policies and is covered in detail later in this report. The prediction for shares in 2030 is set out below.

Figure 2.3: Domestic transport emissions 2030



Source: as Chart 2.2 but adjusted to CCC desired outcomes

The HGV figures are subject to some uncertainty and not provided by HGV type. This category varies between 3.5 tonnes gross vehicle weight and 44 tonnes. The fuel consumption and thus their emissions are clearly very different. For example, heavier vehicles used for bulk transport use much more fuel overall, although they are used in less congested conditions than smaller HGVs and light vans which are used for distribution and deliveries.

There is data available for the distance travelled by the largest HGVs and the smaller rigid HGVs and this shows how the largest and the smallest categories dominate. The heaviest articulated vehicles now account for over half of all HGV traffic and thus considerably more than half of the carbon emissions. This was also shown in the recent MTRU study[4] for the DfT analysing motorway counts and will be further considered later in the freight section. Overall more than 10 per cent of all transport emissions are likely to be from articulated HGVs and this could rise to over 15 per cent by 2030.

Table 2.1: GB traffic from HGVs

Billion vehicle kilometres		
Rigid 2 axle	**8.5**	Up to 18 tonnes gross vehicle weight (gvw)
Rigid 3-4 axle	**3.8**	Up to to 32 tonnes gvw
Articulated 3-4 axle	**1.1**	Up to 26 (3 axle) and to 38 tonnes gvw*
Articulated 5 axle	**4.9**	Up to 40 tonnes gvw
Articulated 6 axle	**8.5**	Up to 44 tonnes gvw*
Total	**26.8**	***Subject to individual axle weight and distribution conditions**

Source: Heavy goods vehicle traffic by axle configuration and road category in Great Britain 2016, Table TRA 3105, DfT April 2017

Because of its importance the specific issue of HGVs is considered in detail in Section 9 of this report.

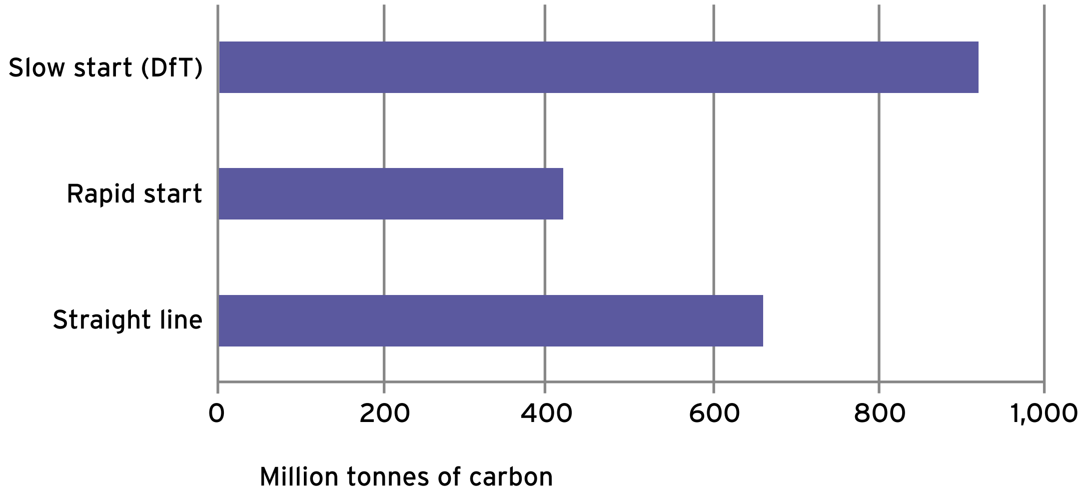
2.2 Using the right measurements: carbon or carbon years?

One of the key aims of this project is to assess how to reduce the climate change impact of the transport sector, using the widely accepted time horizon of 2050 as a benchmark date for success or failure. It must be noted that the real impact is related to, but not the same as, reducing emissions by a certain amount by that date. Because the greenhouse gases emitted by transport continue to have an impact over decades, it is the total amount emitted between now and any target date, and when it is emitted, that really matters. Thus a tonne of carbon dioxide emitted now will continue to contribute to climate change into the next millennium. The true measurement should be carbon dioxide tonne years, not just tonnes. Thus a tonne emitted now will contribute 33 tonne years of warming between now and 2050, a tonne emitted in 2040 will only contribute ten. This is the reason that the ‘everything will be fine when all cars are electric in 2050’ assumption is technically flawed. Correcting this flaw leads to far greater emphasis on short and medium-term actions to achieve reductions.

This issue was set out clearly in the 2007 and 2008 MTRU reports on climate change[5] and is reflected in the use of time budgets rather than distant targets by the CCC.

This can be illustrated by the way the rate of reduction of greenhouse gases has a dramatic effect on the total emissions over the next 40 to 50 years. The analysis contained in the 2008 MTRU report, reproduced as Figure 2.4 on page 10, shows the total amount of emissions over a given period for different rates of reduction. It is this which determines the level of climate change, not a target, however tough, which is decades away.

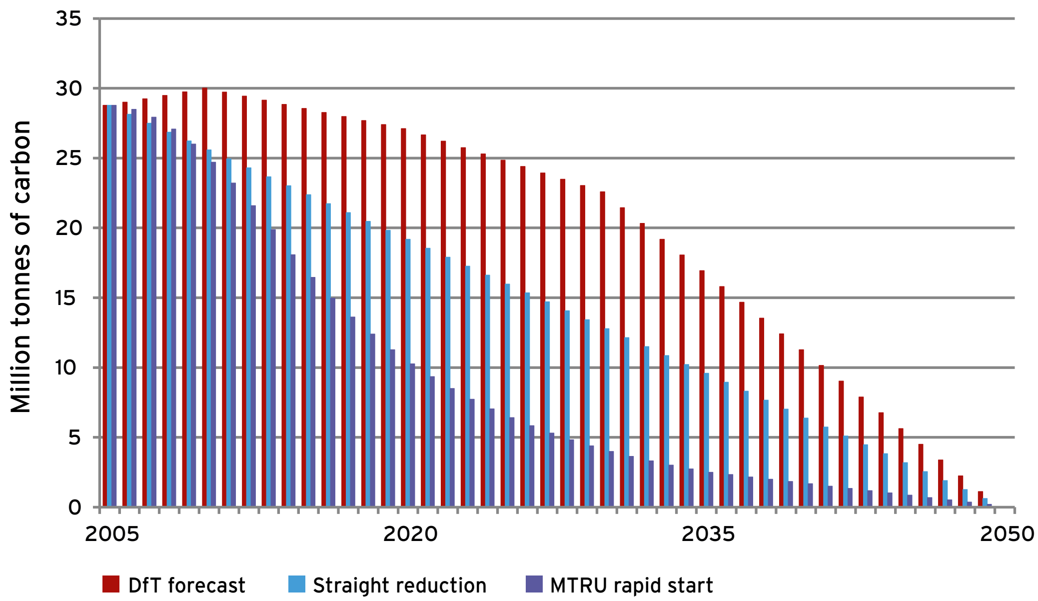
Figure 2.4: Total carbon deficit 2005-2050



Source: MTRU based on DIT and DEFRA data

This has major implications for transport because changing travel behaviour can start to make a difference to greenhouse gas emissions quite quickly – in a short timescale of five to ten years. The 2008 report set out clearly what rate of progress is needed and how far this from current expectations. This is reproduced as Figure 2.5 below.

Figure 2.5: Excess emissions from transport over 60% target



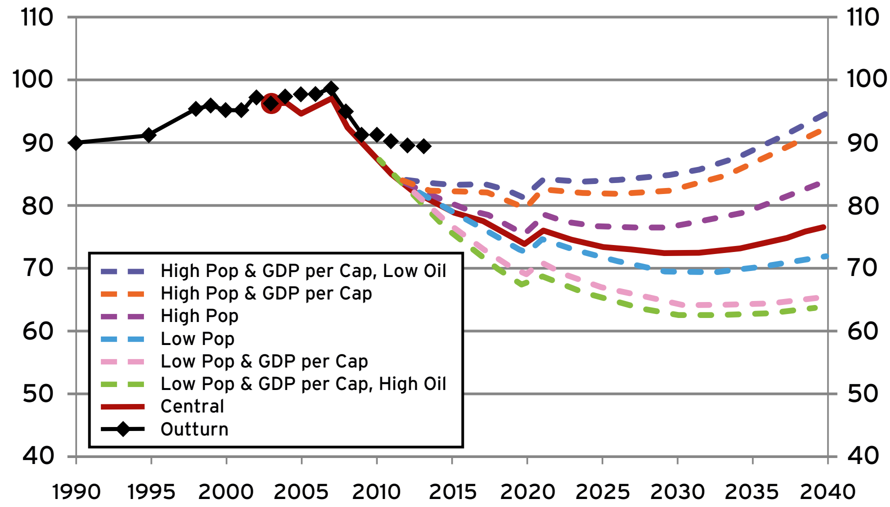
Data from DfT, DEFRA, MTRU

Chart copyright MTRU

2.3 Recent performance

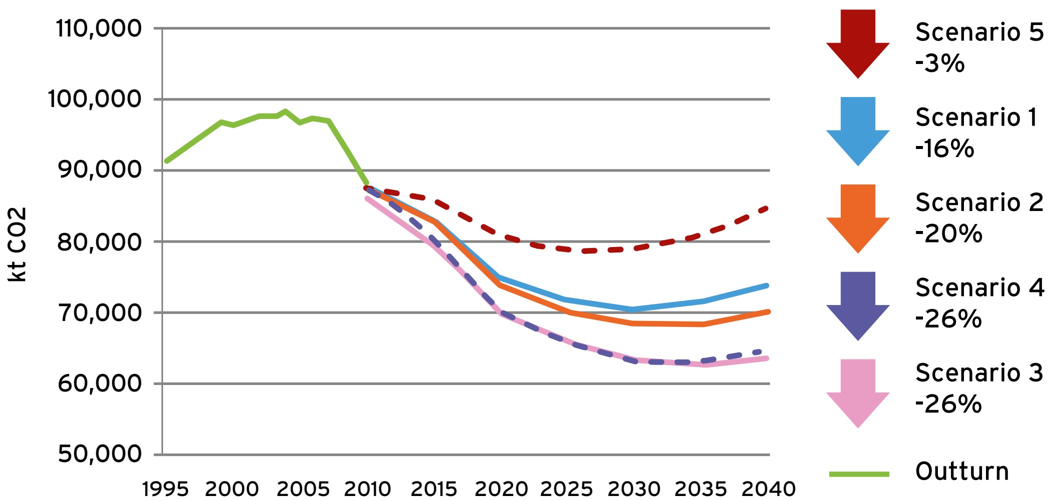
Data is now available between 2005 and 2014 and it is clear that the outcome has been far closer to the DfT forecast, rather than the preferred route to a low emissions transport sector. This is illustrated by the chart below, which uses DfT and DECC data to update the emissions forecast issued by the DfT for 2010. These are in tonnes of carbon dioxide not carbon, otherwise the data is compatible. The impact of the recession can be seen: until that point the carbon emissions were actually rising not falling. In 2015 it appears that emissions have again risen slightly but equivalent data is not available.

Figure 2.6: England all roads CO_2 ($mtCO_2$) forecasts



The most recent DfT forecast still uses a 2010 base year but as can be seen below, is in line with the DfT estimates above, but without updating the actual outcome to show the lack of carbon reduction.

Figure 2.7: CO_2 road traffic emissions (kt CO_2)



The overall picture is that carbon emissions from road transport have only fallen since 2007 as a result of the recession not Government policy. While this provided a short carbon respite, albeit at great social cost, the need for action as the economy recovers has again become urgent.

2.4 Key factors for change

The outcome in terms of total emissions depends on two factors: vehicle efficiency and distance travelled. In broad terms the figures above show that the improvements in vehicle efficiency (mainly from cars) have been balanced by a growth in all road traffic. Focussing on cars as the largest single source, it is clear that progress has been made – new cars today on average produce a third less carbon than in 2000. However, even that rate of progress will not provide sufficient improvement to deliver the carbon reductions required to achieve Government targets.

2.5 Level of reduction required

A useful indicator for carbon reduction is the advice provided by the CCC. It is an independent, statutory body established under the Climate Change Act 2008 whose 'purpose is to advise the UK Government and Devolved Administrations on emissions targets and report to Parliament on progress made in reducing greenhouse gas emissions and preparing for climate change'.[6]

Its latest report to Parliament has the following headlines:[7]

- UK greenhouse gas emissions are about 42 per cent lower than in 1990, around half way to the 2050 commitment to reduce emissions by at least 80 per cent on 1990 levels
- Although good progress has been made to date, that progress is stalling. Since 2012, emissions reductions have been largely confined to the power sector, whilst emissions from transport and building stock are rising
- Effective new strategies and policies are urgently needed to ensure emissions continue to fall in line with the commitments agreed by Parliament.

In light of the importance of the total amount emitted between now and the target date, rather than achieving a distant target, the CCC uses five year carbon budget periods, during which a certain amount of carbon emissions are permitted. A key for this report is their aim for a 44 per cent reduction on 2015 levels of emissions by the carbon budget period 2027-32. They point out that this will be very challenging and list areas where action will be needed if emissions are to be kept within budget.[8] The key actions are set out below:

- Stretching standards for new car and van carbon dioxide beyond 2020
- Policies to deliver a high uptake of electric vehicles to around 60 per cent of new car and van sales by 2030
- Align fiscal elements (e.g. Vehicle Excise Duty) with new car and van emission targets
- Implement policy to deliver 8 per cent of sustainable biofuels by energy to 2020
- Policies to support emissions reduction from HGVs
- National and local policies to reduce demand
- A plan for UK aviation emissions at around 2005 levels by 2050.

Either strengthening of existing policies, or the adoption of new policies, is required in all of these areas if the budget is to be met. This provides a clear direction and agenda for the contents of this report.

3. Reducing carbon through vehicle technology

3.1 Impact of lower new vehicle emissions on national totals

Using a UK wide fleet model[9] the impact of reduced emissions from new cars on total carbon emissions has been calculated, using two different traffic forecasts for 2025 and 2030, based on two of the DfT scenarios published in 2015. For this report, these are also varied to reflect different policy assumptions, for example to achieve a reduction of 5 per cent in demand (the CCC target), and to reflect new work by the DfT on the potential impact of freight transfer to rail. Demand is driven in the forecasts by growth in population, assumptions about how many trips people and goods make, how long the trips are and which mode is used.

DfT Scenario 1 uses historic data for trip making – in other words the current trend for falling trips and distance is halted (see Chart X in the main report). It also assumes a continuing direct link between economic growth and travel and a central assumption for future GDP.

Scenario 3 continues the current trend for reduced trip making (with a slight increase in trip length), and also assumes the direct link between GDP and travel, and the same central GDP forecast.

In addition, work has been undertaken to vary the DfT scenarios to assess the impact of further demand management of light and heavy goods vehicles and other domestic transport (rail, air etc). These have been compared to the CCC target of a 44 per cent reduction on 2015 levels of emissions by the carbon budget period 2027-32. This includes an allowance for bio fuels as well as the 5 per cent reduction in demand.

The approach set out in this report would move the forecast towards Scenario 3, with some additional reductions from the non-car road sector. The outcomes for cars are similar to the CCC demand reductions.

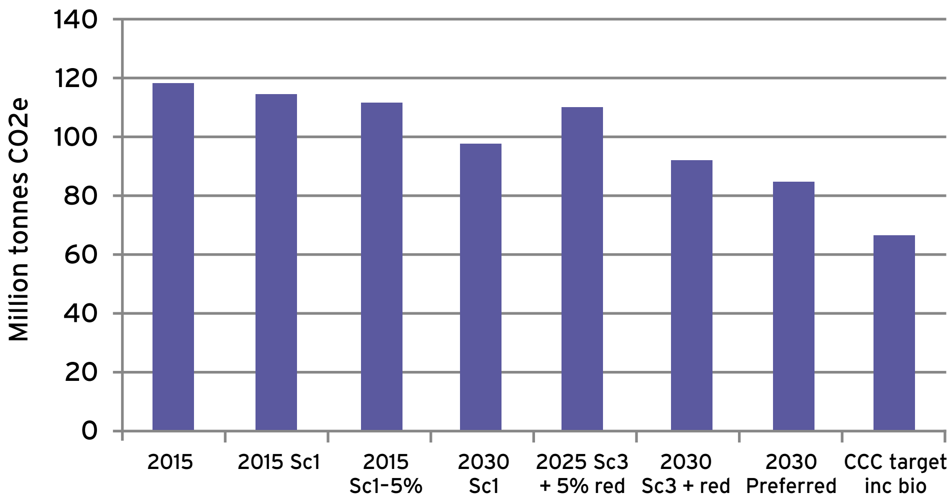
Under Scenario 1, the DfT's base option supplied to the CCC, the forecast does not reproduce the savings required, even allowing for biofuel substitution. It is clear that further demand management options are required which include HGVs as well as cars and vans.

Under Scenario 3, modified by MTRU to include further demand management and freight transfer, the forecasts still do not meet the CCC target. The addition of an allowance for bio fuels could bring it closer, but this in itself has land use impacts, especially for agriculture. Allowance for significant amounts of eco driving for cars and HGVs explains the rest of the difference between the figures in this report and the CCC estimate with all policies in place. The impact of additional electricity requirements has not been considered in detail in this report, nor the issue of how real world average fuel consumption varies from that assumed in the models. For example, the widespread use of hybrid vehicles would reduce fuel consumption in urban areas but has far less impact on long distance driving, accounting for about two thirds of all traffic. Half of this is on motorways where hybrid vehicles can use as much and sometimes more fuel than modern diesels. The key benefit for urban areas from hybrids is improved air quality and this is considered in an accompanying piece of research.

The results for the different scenarios are set out in the charts below. The key conclusion is that, without action to control demand, vehicle technology will not deliver the CCC target reductions.

Figure 3.1 shows the overall carbon dioxide emissions for different scenarios, Figure 3.2 shows the breakdown by vehicle type for the same scenarios.

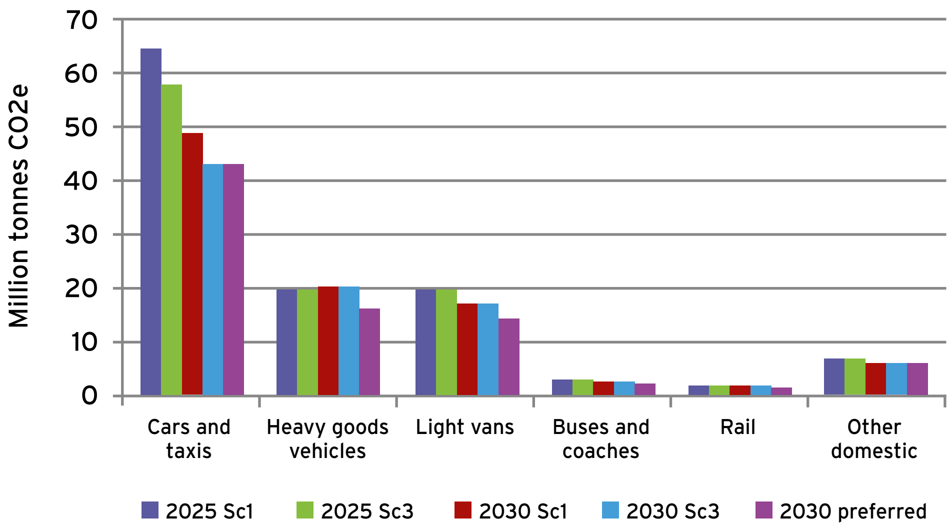
Figure 3.1: Annual carbon forecasts



Source: DfT Scenario forecasts; transport statistics tables ENV0201, TRA3105, MTRU calculations

Note: includes all modes

Figure 3.2: Carbon emissions by vehicle type



Source: DfT Scenario forecasts; transport statistics tables ENV0201, TRA3105, ENV0104, MTRU calculations

In terms of compatibility, the DfT carbon forecast for both scenarios for 2030 is about 5 per cent lower than that produced by the modelling for this report. This is almost certainly due to the assumption of very significant improvements in average vehicle efficiency which are inputted from outside the National Traffic Model. The DfT predicted fall in emissions from 2010 to 2015 did not materialise and suggests that these assumptions were over optimistic.

3.2 Policy required for vehicle technology

There is one obvious policy which is related to a rapid improvement in vehicle efficiency which is to influence consumer choice at the point of sale. The proposal here applies mainly to carbon rather than air quality, which will be dealt with in more detail in a separate report. However, it is clear that to deal with this, local charging regimes could be implemented, with revenue being used to support alternatives to the use of polluting vehicles, such as public transport ticket discounts.

The key issue is that the current regime is very weak in terms of influencing consumer choice. This is much more important than the annual charge and was one of the measures from the 2008 carbon report which was adopted in principle and then refined by the Treasury and the DfT.

The problem can be seen in that there is very little pressure to choose a low carbon vehicle rather than a medium carbon vehicle. To borrow election terminology, this is the key battleground. For example, choosing a car with a 76-90 gms/km rating instead of 131-150 only costs £100 extra in terms of the first year tax. This is verging on imperceptible, given the total cost of the vehicle. This is clear from Figure 3.3 and Table 3.1 on page 16. The table compares the current (April 2017) rates for first year VED and what this report proposes as an alternative. This is applied in two stages to give purchasers a heads up and allow for more low carbon cars to come to market.

The manufacturers agree with this, for example the Society of Motor Manufacturers and Traders (SMMT) said this year:[10]

> "Industry was disappointed with the lack of consultation when these new bands were announced in the Summer Budget of 2015, and believes they are less encouraging of ultra-low emission vehicles, such as plug-in hybrids and offer no incentive to used car users to choose lower emitting options. As such, the VED changes could work against the incentives available from Government to purchase these vehicles."

To illustrate the point, we have used the same average the application of a gms/km groups as the DfT, but the application of a gms/km on a continuous basis would be preferable. Constant figures of 10 and 15 gms/km are used to produce Table 3.1.*

*This is adjusted for 2018 to favour very low emission vehicles with emissions in the 1-90 range

One advantage of such a policy is that it would provide a short term boost to compensate tax losses on fuel sales, and a stronger incentive for all electric cars as well as low carbon vehicles. It would be straightforward to apply a diesel surcharge, for example 10 per cent to the first year VED. Thus it would not affect existing owners.

Beyond 2020 the system should respond to the rapidly growing number of very low and zero emission vehicles and encourage this trend. Thus we suggest that the gms/km rate is increased as well as being applied on a continuous basis without grouping the charge into bands as now. If this approach is not accepted, the bands will have to be changed so that the lower bands are divided further. For example the 1 – 50 category would become 1 – 25 and 26 – 50.

Other fiscal measures could be used through the company car system and local air quality zones. The latter are the subject of a separate Tracks report.

Figure 3.3: First year VED: current and proposed

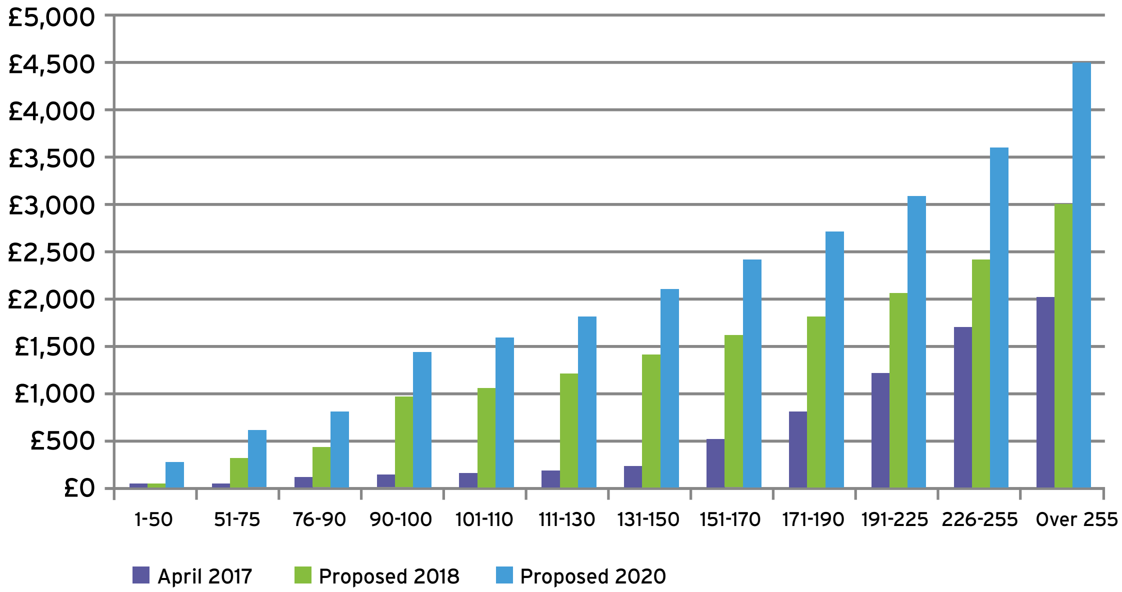


Table 3.1: First year VED: current and proposed

Current (2017)		Proposed		
CO_2 emissions (g/km)	Petrol (TC48) and diesel cars (TC49)	2018	2020	Difference to 76-90 car 2020
0	£0	0	0	-£800
1-50	£10	£25	£250	-£550
51 - 75	£25	£310	£600	-£200
76 - 90	£100	£415	£800	£0
91 - 100	£120	£950	£1,425	£625
101 - 110	£140	£1,050	£1,575	£775
111 - 130	£160	£1,200	£1,800	£1,000
131 - 150	£200	£1,400	£2,100	£1,300
151 - 170	£500	£1,600	£2,400	£1,600
171 - 190	£800	£1,800	£2,700	£1,900
191 - 225	£1,200	£2,050	£3,075	£2,275
226 - 255	£1,700	£2,400	£3,600	£2,800
Over 255	£2,000	£3,000	£4,500	£3,700

Source: Government VED rates, MTRU calculations

3.3 Reducing carbon by reducing road traffic

The improvements to vehicle technology will need to be delivered to achieve the CCC targets. However there are four important areas of uncertainty.

The first is the ability within the next few years to produce sufficient very low emission vehicles to make a major impact on new car sales. The second is that there may be asymmetric use of less efficient vehicles for longer trips. The third is whether purchasers will choose the most efficient vehicles in the type of vehicle they want to buy (for example second car, family car). The fourth is whether there will be a change in the type of vehicle chosen, for example there has been a recent move to multi-purpose vehicles.

In view of the results from the model and discussions with the CCC, this report takes the view that the only way in which sufficient progress can be made on carbon reduction in short and medium term is to focus on reducing road traffic. The reasoning behind this is twofold. First, most of the disadvantages of travel, such as congestion, inequalities in access, air pollution, noise and carbon emissions, are directly related to the level of use of the road transport network. Second, as referred to earlier in this report, the DfT has produced modelled futures which can be varied according to a few key parameters, and these in turn can be encouraged or produced by different policy approaches.

Thus, rather than deriving a set of policies from the high level objectives, we have focussed on achieving the key aim of reducing traffic. This enables us to relate the objectives to the DfT scenario forecasts and thus produce a new most likely forecast which is nevertheless within their range of predictions. Thus we have assumed that the operational objectives are:

1. To reduce the number of car trips per person in line with recent trends
2. To support national economic growth without directly increasing road transport
3. To ensure income per head can rise without directly increasing road transport
4. To address freight transport more directly than in the DfT scenarios which are more passenger focussed.

Of course the policies will have other impacts, but the emphasis on traffic leads to policies which address this issue in a more direct manner.

4. Environmental quality, climate change and transport innovation

4.1 Introduction

Transport is a field where change has always occurred but recent years have seen the beginning of a large scale transformation both of public attitudes and policies, and of technology. The former has led to a range of behavioural change, for example young people no longer see learning to drive and owning a car as a 'rite of passage', and in London the level of cycling is growing faster than most planners would have believed even five years ago. The passenger use of rail nationally continues to grow in a way which was not predicted, and for rail freight, despite loss of traffics such as coal, some routes from ports have greater demand than there is capacity to carry it. Awareness of environmental quality, particularly air pollution and the scandal of 'dieselgate', has become a key factor, and the idea of creating urban quality (including walkability) is widespread.

In technological terms the picture can be divided between the transport systems, such as vehicles and networks, and the behavioural change brought about by factors which include internet based information generally and the smartphone in particular. The latter has led to some new transport services, but it has also opened up areas where in the past travel opportunities did exist but were hard to access. This has been focussed on urban areas, for example in London many people already use cars when they need them without owning them and may step out of the door without knowing which public transport route they will use – their phone will let them know. The development of the idea of MaaS has been the transport practitioners attempt to name such access changes.

On the vehicle side the picture is one of rapid development of autonomous technology, for cars, buses, vans and HGVs, and of electric cars, although the take up is still low. However, vehicle technology has muddied the waters, leading to a rise in diesel use to reduce carbon without understanding the detrimental impact on air quality. This has been accompanied by a complete technical failure in terms of real world emissions (both carbon and air pollution). Manufacturers' quoted fuel consumption for cars has been known to be very unreliable for some time* but Governments were slow to act. What was less expected was the extreme nature of the misleading figures for exhaust pollution. It was known that the tests were not robust, but the extent of the efforts made to reduce official impacts was a surprise. It is important to note that hybrid vehicles are not immune from the problems with stated emissions. For example they are often significantly worse in terms of carbon emissions on longer journeys.

*The Which analyses over a long time series are very useful on this

Lying behind this is the wider context of the need to address climate change and the lack of decisive action to achieve the required level of reductions in emissions. It must be remembered that greenhouse gases persist in the atmosphere for decades – and means that missing targets now means that more drastic actions will be needed later. In transport, over reliance on the magic bullet of electric vehicles is building up a carbon deficit which will need to be addressed, and which will spill over into other sectors unless further action is taken in the short to medium term. For example, the sales of electric vehicles are still very low, and replacing the existing stock would take 15 – 20 years, even if all cars sold today were to be electric.

The result of this lack of active engagement has been a failure both to meet carbon reduction and air quality targets, and to reduce congestion. In particular, the carbon budgets set out by the CCC, including the fifth budget (2028–32) represent a major challenge for transport.

There have been other major changes in technology influencing transport, both in terms of vehicles (private or public) and access to them, mainly through smartphones. The trials of autonomous road vehicles (ARVs) for passengers or freight are proceeding and will have a range of impacts, some of which may be problematic. For example, their use in urban areas could cause serious problems in terms of congestion and impact on bus travel. A parallel problem is already an issue with Uber in London, and Uber has just become one of the key players in autonomous technology. Others are emerging and trials are already starting in cities throughout the world. Smart booking of parking may go against this trend (there are already parking apps available which cover space occupation and regulations).

By contrast, in rural areas ARVs may provide improved accessibility and link up with the recent growth of car clubs. On the strategic network, autonomous technology is likely to lead to more efficient use of road space and to provide the building blocks for a form of user charging. The latter will become critical as electric vehicles become more widespread with the Government potentially losing £30 billion in fuel taxes.

Finally it is worth commenting on the dramatic change in governance that is being proposed by Government. The re-introduction of transport authorities for major conurbations, with the potential to link up land use and transport planning (at least to some degree), and the rapid development of such authorities in other areas, means that a review of how the changes above may impact on transport planning and spending in future is overdue.

In summary, it is clear that, if carbon budgets are to be met, and towns and cities are to become healthy, attractive places to live and work actions should be taken:

1. To address the issues of air quality, carbon emissions and urban form in the short to medium term (up to 20 years)
2. To set a framework to manage demand for carbon intensive transport in the short to medium term
3. Within that to set a framework for the use of new technology which ensures the potential benefits are captured and that the pitfalls are avoided
4. To identify priorities for investment both in infrastructure and how that infrastructure is used (such as investment in information, access to services and charging).

The starting point for this project is to set out what the current transport forecasts are and how they are constructed, the DfT for example produces traffic forecasts to 2040. It is then important to assess how they might change if different policies were pursued and if technology radically changes within their timescale. The latter is extremely likely in any case. Fortunately the DfT have moved from fixed forecasts towards a range with different assumptions about how people travel.

These assumptions are very broad brush, such as how many trips will people make and how long will they be, or how much will the economy grow and the population grow. However, they can be used to reflect the changes considered in this report and this forms a major part of this study. The next section looks at this in more detail.

This project focusses on the impacts of different forecasts on carbon emissions and congestion, a parallel project considers the impact on air quality.

4.2 Transport, communications and traffic forecasting: a very different future for travel

Transport is often seen as a 'derived demand' and in many cases fulfils a need for communication as well as physical movement. The two are connected and one can act as a substitute for the other, obvious examples are the improving 'telepresence' approach to meetings, use of webinars for education and training, creation of virtual social spaces such as Facebook and Instagram.

There are three areas where analysis is required:

1. The technology itself (not just in transport) needs to be identified and its capabilities understood – in fact we are already going some way to defining this
2. The impact on human behaviour overall needs to be understood since this will determine the demand for physical transport and the systems which deliver it
3. The social end game needs to be understood because this will impact on the nature of society and how wealth (and access to technology) is distributed.

Item 1 is a major source of attention, as will be exemplified later in this report. New trials and projects are emerging all the time, while major manufacturers are preparing to deliver some of the latest vehicle technology within five years and some is already in production. However, the nature of work is also impacted by technology in a way which we are beginning to understand, from healthcare to agriculture.

Item 2 opens up the debate to what our cities and less densely populated areas will be like, how will they function? How will we shop or learn? How quickly will the changes in work and leisure come about? On the transport specifics, will car ownership fall? Will we have more spare time and, if so, will we be able to afford to use it? Will autonomous vehicles become impractical in urban areas due to lack of space? Will the Hyperloop make HS2 look like a snail's pace? Some of these questions, especially the last, are more speculative than others, but trends are emerging. For example, the UK has created many jobs but productivity (i.e. earnings) per job is low – is there a fall in middle income employment and will it continue in developed countries?

Item 3 is receiving the least attention but is the most socially and politically important. Some technology will be ubiquitous and cheap, but some will not be. Longer distance travel in an autonomous vehicle with work and entertainment facilities, or in a high speed train with similar, may not be at a price available to all. A distributional analysis rather than a cost benefit analysis will be the key here – lessons can be learned from recent political events, and inequalities in access to the next rounds of technological change must be understood and mitigated.

Communications technology is having a major impact on human behaviour, on society and thus on transport. How can this change be handled in the context of producing forecasts for transport, carbon emissions and congestion?

4.3 Different futures

This study focusses on highways because it is here that most of the surface transport emissions are produced. The DfT has produced a new range of forecasts (2015) which are based on different scenarios. These are not policy related, but behaviour related. For example there has been a decline in car trips per person over the last decade which may or may not continue. The issue therefore is which policies would continue this trend and which would stop it. If it continues there will be less traffic than otherwise, even allowing for longer journeys. Another factor is economic growth – will it always lead to more traffic or will its impact decline? Which policies will help to uncouple economic growth from travel growth? It is possible to use the DfT scenarios to estimate the potential impact of different policy frameworks, starting from the same assumptions as at present.

There are two aspects to the forecasts needed to provide the background for this study. The first is the level of traffic and which parts of the road network it will use. The second is the behaviour of that traffic and how that will impact on the capacity needed. The first is essentially demand forecasting, the second is related to how changes in vehicle technology reduce the amount of road space needed per mile of travel. This also breaks down into two parts: connectivity (how vehicles communicate with one another) and automation (how far a human driver is needed, if at all). There can be both Connected and Autonomous Vehicles (CAVs and AVs). If autonomy is based on replacing the driver then the impact on network use may be modest. There will however be safety improvements and congestion benefits through smoothing traffic flow. If autonomy includes communication between vehicles there may be significant improvements in network utilisation (and reliability).

To illustrate this, in a scenario in which travel demand is stabilised on the Strategic Road Network (SRN), the use of CAVs will reach a tipping point where safety will improve and congestion will start to fall (these may be at different times). Improved vehicle efficiency will lead to reduced carbon emissions. In a situation where traffic is rising, carbon and congestion will still fall if the rise is less than the impact of CAVs. In a situation where traffic rises more strongly, carbon may rise in the medium term while safety may still improve and congestion may be stabilised.

Clearly the vehicle technology elements also relate to demand – if cars drive themselves will their passengers be able to work as they do now on longer distance trains? Will this change mode share for longer distance passenger journeys?

It is important to note that reducing the need for road capacity per vehicle mile is the likely outcome on the strategic road network. In urban areas this is less clear cut. If Uber cars no longer need drivers (Uber are spending heavily on achieving this aim) they may fall in cost and attract new users (some of whom will have used public transport). They (the vehicles) may also decide to circulate to avoid parking charges, or create new parking demand. There will be algorithms using real time data able to decide this.

While the timing and exact nature of change is uncertain, there is a certainty of change happening and there are already some clear major items which will alter our patterns of travel within comprehensible time scales, say by 2030 and by 2040.

4.4 Potential game changers

- Loss of £30+billion revenue from fuel tax/VAT – will this necessitate some form of road pricing, at least for the SRN?
- Increasing roll out of Mobility as a Service (MaaS) leading to lower personal car ownership (cars on call) and lower licence holding (already happening) BUT increased use by groups otherwise excluded
- Long-term 40 per cent reduction in congestion (delay time) on the strategic road network from full CAV implementation
- Earlier benefits of 10-20 per cent from lower level CAV technology (such as connected cruise control) at a 'tipping point' of CAV uptake
- Traffic generation or mode switch from the increase in useable time from drivers becoming passengers, or from reduced congestion
- Logistics efficiency can be improved – both for the deliveries to national, regional and local distribution centres and the final leg to point of consumption
- 3D printing may also alter the concentration of production for many products and impact on logistics – for example mitigating the rise in LGV home deliveries and retail distribution
- Rebalancing of the economy with some increase in manufacturing (possibly combined with more dispersed production)
- Increasing distributional inequalities will change the policy framework (e.g. bus pass vs personal fully electric CAV).

All of these are subject to different and uncertain time scales. However, focussing on the medium term to 2030, it is clear that there will be major change. Beyond this the future patterns of demand are hard to predict other than by 2040 and then 2050 travel will be very different indeed. This is only partly driven by technology, although this change is as great as any of the previous game changers such as railways or mass car ownership. Social change in terms of income distribution, the nature and availability of work, and the price and availability of housing will be major influences on travel demand. This will all have significant impacts on government, for example through potential loss of tax revenue, balanced by lower accident costs and lower infrastructure costs.

In the next section some of the emerging details of vehicle technology is set out, before using the DfT scenario assumptions for cars, and other sources for freight, to produce new traffic forecasts and consequent changes in carbon emissions and congestion.

Above all it should be emphasised that current patterns of demand will themselves be altered by the impact of new technology – it is not just a question of the same journeys being made by different means. This is demanding for Government – many powerful levers are in the hands of central Government including taxation (and thus new methods of charging for road use once fuel tax has fallen away). Spending is the obvious one, for example putting money into the internet bandwidth required for new technology rather than physical capacity, or changing how bus services are supported, but regulation is important too. Changing taxi and bus licensing in response to Uber and other shared services is a current example, but this should include making all AVs road user charge ready as part of their Construction and Use specifications.

5. Unpicking the reality of autonomous vehicles and their impact

There are several strands of work which lead to a better understanding of how some of the game changers identified above will impact on the future. In broad terms work is being done by:

- Vehicle manufacturers such as Ford, BMW, Tesla and others
- Transport operators and service providers, from Uber to car insurers
- Research centres such as the Transport Systems Catapult and many academic institutions
- Governments, both promoting research and also exploring what regulatory and fiscal framework will be needed.

5.1 What the car industry thinks

The realism of radically new vehicle technology in the immediate future is indicated by how car manufacturers are responding. In broad terms they have been doing a lot of research which is now entering the public domain, but also implementing elements of a driverless future, for example more sophisticated cruise control, automatic parking and lane change sensors. This is often combined with a response to MaaS, for example Ford have emphasised cycling, ride sharing and 'driver as consumer'. Their CEO pointed out in 2015:

> "Ford's semi-autonomous vehicle features available today include lane-keeping assist, adaptive cruise control, Pre-Collision Assist with Pedestrian Detection and active park assist – with Traffic Jam Assist coming."[11]

In February 2017, the new Ford Super Bowl advert[12] emphasised this approach and said they would produce fully autonomous cars by 2020.

BMW Group, Intel and Experteye are working together to produce an industry standard and to define an open platform for autonomous driving. The open platform will address the 'eyes off', 'mind off', and 'driver off' levels of automated driving and will be made available to multiple car manufacturers, as well as other industries which could also benefit from autonomous machines and deep machine learning technologies.[13] Cars are already being tested on road and a fleet of 40 is planned by the end of 2017.[14] Again production of autonomous vehicles is predicted soon, in the BMW case for 2021.

5.2 Bus and public access vehicles

Uber has been mentioned and is trialling autonomous 'come and get you' vehicles, but they are not alone. NuTonomy has six vehicles already operating in Singapore,[15] and Boston will receive them next. It must be stressed that these urban trials involve small numbers of vehicles and this important for two reasons. First the volume of road space required is already an issue in relation to existing Uber-style operations. Growth, both through generated demand and transfer from other modes could create even more problems. In addition, the average speed of these vehicles, given their sensitivity to potential dangers and avoiding pedestrians and cyclists, may (and should) be very low in urban areas. This is especially the case in shared spaces. So far we have not been able to identify any modelling which has included the behaviour of such vehicles in such a complex mixed environment (although road networks with multiple junctions have been covered).

Research is not confined to cars, the EU has been considering the impact on urban public transport in its CityMobil2 project,[16] this includes a small taxibus type vehicle which could point the way for rural demand responsive transport as well as the city context. This project considered the urban environment the most challenging for autonomous vehicles – again it may well be that such vehicles would achieve very low speeds due to the complexity of the driving environment.

5.3 UK Government response to the potential for change: CAV impact on road network

Government appears to be well aware of some of these issues and is clearly interested in the potential for economic growth from new technology, at least as much as the impact on road transport. The DfT has already commissioned research on the impact of CAV, (both cars and HGVs) on the road network.[17] This used existing road network microsimulation models but altered the behaviour of vehicles in the traffic stream to reflect changes such as smoother driving and closer headways. This produced results similar to other studies and found that delays could fall by 40 per cent if all vehicles were CAVs. As might be expected, there is a tipping point below this at which benefits start to flow (somewhere between 25 and 50 per cent). Not all possible scenarios were tested but the results have been used to provide broad estimates for this report and the table of impacts on the strategic network model is shown below. What is interesting is that around the reduction in delay there are lower benefits for average journey time, but greater benefits for reliability.

Table 5.1: SRN model results

Scenario	Average delay (s)		Average journey time (s)		Journey time variability[1] (s)	
	(s)	%	(s)	%	(s)	%
Base	35.84	-	539.79	-	20.17	-
(1) 25% CAV	36.17	+0.9%	538.49	-0.2%	19.38	-3.9%
(2) 50% CAV	33.39	-6.8%	533.62	-1.1%	17.65	-12.5%
(3) 75% CAV	29.77	-16.9%	527.72	-2.2%	15.33	-24.0%
(4) 100% CAV	23.72	-33.6%	517.77	-4.1%	10.52	-47.9%
(5) Upper bound	21.38	-40.3%	479.29	-11.2%	9.14	-54.7%

5.4 Technology research

Considering the Government's interest in the commercial potential, the Department for Business, Innovation and Skills (BIS) and the DfT have jointly committed £20 million to eight new projects to research and develop enhanced communication between vehicles and roadside infrastructure or urban information systems[18] with more to follow from the Intelligent Mobility Fund. The package shows considerable breadth in terms of mode and technology:

1. UK Connected Intelligent Transport Environment (UKCITE): a project to create the most advanced environment for testing connected and autonomous vehicles
2. Insight: a project to develop driverless shuttles with advanced sensors and control systems and trial them in city pedestrian areas, with a particular focus on improving urban accessibility for disabled and visually-impaired people
3. Tools for autonomous logistics operations and management
4. FLOURISH: this project will help develop innovative new tools to improve the understanding of user needs and expectations of connected and autonomous vehicles
5. MOVE-UK: this project will be focused on accelerating the development, market readiness and deployment of automated driving systems
6. Innovative Testing of Autonomous Control Techniques (INTACT)
7. Pathway to Autonomous Commercial Vehicles: this project will develop the monitoring of key information from the vehicle and predict safety risks based on analytics
8. i-MOTORS – Intelligent Mobility for Future Cities Transport Systems: i-MOTORS will deliver a connected Vehicle to Anything (V2X) system via a mobile platform as a proof of concept.

Of course this is relatively modest compared to the research being undertaken in the US by familiar names such as Google and Uber and by the car manufacturers in Asia, the US and Europe. While some of the technological possibilities are clear, the timescale within which they will be in everyday use and, most importantly, when they will reach a tipping point at which capacity is effectively increased, is far less certain.

These developments are seen as steps towards the rapid development of new road transport technologies, former Transport Secretary Patrick McLoughlin said at the launch:

> "These projects will help profoundly change the way we travel within years, transforming our roads by making travel a simpler experience for drivers, reducing accidents and helping traffic flow more smoothly."

5.5 MaaS and information impacts

Mobility as a Service (MaaS) is used for many different innovations in transport but at its heart it moves away from ownership towards open access to third party vehicles, whether the Uber model or car clubs. A recent report[19] summarised the impacts as:

- A smaller, more modern fleet that is used more efficiently and turns over faster
- Greater coverage in urban areas with higher demand
- Fewer trips for people who give up on vehicle ownership and opt to pay by trip
- Greater viability for the electrification of the vehicle fleet
- Demand for new street designs that emphasise pick-up and drop-off locations rather than on-street parking.

Again it is hard to predict the precise impact in urban areas but it is clear that fewer personal parking spaces will improve density, while the need to park the shared vehicles will be a new demand.

When it comes to behaviour, it is clear that car club users already show a wider range of choice of mode than car owners, and that the mix includes more cycling as well as more bus use and walking. This will also have an impact on the longer distance modes. The important effect on traffic is that MaaS is part of, and is likely to help maintain, the fall in average car trip rates per person. Policies which encourage it will support this scenario which is one of the DfT possible inputs to its forecasts.

5.6 How should the shape of change influence what we do now?

While it is not possible to translate these changes into precise numbers in specific future years for traffic by cars, vans and lorries, the overall shape of the impacts is easier to understand. For example, taking the game changers set out in Section 2 it is clear that infrastructure investment for passengers needs to move away from network capacity towards the data capacity that will be needed to operate new systems which will underpin MaaS and CAV use and ensuring that sufficient redundancy and other safety features are built in. The standardisation and regulation of these systems is not an insignificant issue.

It is also clear that any specifications and type approval for CAVs must include the ability to charge for use, this should be very cheap to build in at the early stages of development. This must also be made clear to road users up front in relation to the major fall in tax revenue from electric vehicles.

On carbon and congestion grounds, consideration should be given to incentivising take up, both of CAVs and ULEVs, for example through higher first year tax rates on those cars, LGVs and vans which do not have the new technology. It should go without saying that the testing for any advanced features, as well as emissions and air quality, must be undertaken far more rigorously than now, although this should be much easier in the case of yes/no technologies such as all-electric power and levels of connection and autonomy. The air quality crisis means that this needs to be co-ordinated with the parallel actions needed to reduce local air pollutants other than carbon.

On the freight side, there will need to be a better linkage between policies for ports, and for freight interchanges such as Strategic Rail Freight Interchanges (SRFIs). The latter has been a notable positive for Government planning policy. This is one area where physical infrastructure needs upgrading to enable longer freight trains and increasing the loading gauge for the rail freight network to carry containerised traffic to SRFIs and other freight generators.

This could easily impact on the demand for road space from HGVs.[20] This could be paralleled by more efficient use of road space by the largest HGVs, both by improving utilisation (load factors) and by the use of CAV technology for freight as well as passenger vehicles. The limiting of such vehicles to motorways and motorway connected depots, would allow some changes in terms of size and weight limits strictly limited to these roads, providing maintenance and safety issues can be addressed. There are also longer term planning implications for the sites as well as motorway connection issues.

For LGVs and vans it is hard to predict when 3D printing will have an impact and how far it will penetrate the market for domestic non-perishable goods. A parallel example of change which illustrates the point is the demand for physical newsprint – most papers are now on line where people can read them on a device or print out a piece they want to keep at home. In urban areas and even smaller settlements it seems less far-fetched to imagine local 3D print shops and extensive personal ownership (small 3D printers are already cheaper than most TVs) than a huge number of delivery drones competing for air space. This is without any restrictions on such systems which may have to be imposed due to noise pollution and safety. In rural areas there may be a role, but it is unlikely to influence the overall national picture.

On the other hand, the use of small autonomous wheeled vehicles operating from a larger van in urban areas can offer considerable advantages and time savings.

LGV (van) is the fastest growing type of traffic in Britain and is at an early stage. It should be capable of greater efficiencies if the regulatory and tax framework is set to encourage them.

In the next section we discuss the detail of the current DfT national traffic forecasts for England which, for the first time, have produced a range of scenarios which represent different outcomes based on existing trends and historical data. They are sufficiently detailed to allow for the impact of different policy packages to be estimated, at least in the next couple of decades.

One key observation is that the recent downward trend in car trips per person can either be assumed to continue, or to stabilise at the current level. The key question is which policies would encourage it to continue, and which would slow it down.

One important observation is that policies to apply demand management have been with us since the advent of limiting the number of parking spaces in new developments (PPG13)* and the environmental tax on car fuel. Both were introduced in 1993/94 after the 1992 Rio Summit. They were followed by a range of initiatives including travel planning from 1995 onwards, company car tax changes through the 90s and 00s, and the Local Sustainable Transport Fund in 2010. Is it possible that these policies actually worked? There will be arguments that population distribution and other factors such as smartphones were more important but it remains the case that some of these policies were predicted to reduce the need to travel and thus to reduce the demand for car use – for example up to 15 per cent for land use planning related to PPG13.[21]

*Planning Policy Guidance Note 13

For this reason the continuation of parking controls is an essential part of a demand management strategy, as well as supporting density of development. One proposal which would help this is a move from parking space maxima calculated on the basis of floor area of a development to the use of site area. This is the true measure of traffic generation relative to urban form and should be adopted in future standards. This would rationalise and encourage the provision of adequate accessibility by other means.
The use of accessibility planning should be the first step in any development transport assessment. If access by walking, cycling or public transport is weak, the question then becomes how to serve a new development, or redevelopment, by sustainable means, rather than a reason to allow more parking.

6. Adjusting the DfT Scenario forecasts

6.1 Key assumptions

Without describing the whole forecasting process in detail, the DfT's traffic forecasts are driven by certain key assumptions. The most detailed of these are for car travel and are as follows:

- Total population
- The average income per capita
- The average number of car trips made per person
- The average length of car trips
- The average cost of driving per mile (usually taken as fuel).

These are varied slightly to produce different scenarios – a change which was widely welcomed during the DfT consultation on the outputs of the 2015 forecasts.

Table 6.1: Key assumptions: DfT National Forecasts 2015

2010 to 2040 assumptions	
Population growth	19%
Income growth Scenarios 1,2,3	60%
Income growth Scenario 4	30%
Income growth Scenario 5	88%
Net change cost per mile	
Car	-26%
LGV	-15%
HGV	10%

These balance increases in efficiency with a rise in fuel costs:

Fuel price increase		Efficiency improvement	
Pump price petrol	26%	Car	40%
Pump price diesel	30%	LGV	34%
		HGV	14%

In all scenarios except for 3, it was assumed that rising income per head would cause a rise in traffic, although this would decline over time. In 3 it was assumed that the link between rising income and rising car use has already been broken.

The other variation was in the number of trips and trip length, two options were assumed: one using the historic average for trip rates extended into the future; the other using a slowly falling trip rate in line with recent trends. The first, (historic) was used for all scenarios except for 3, which used the trend values.

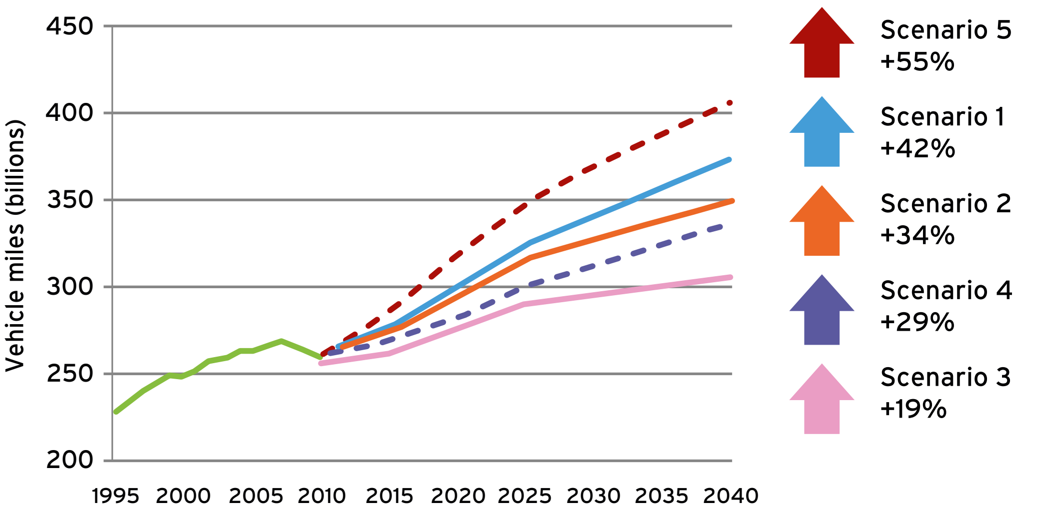
A summary of the scenario inputs tested by the DfT is shown below.

Table 6.2: Summary of variations between forecast scenarios

	Trip rates	Income relationship	Macroeconomic
Scenario 1	Historic average	Positive and declining	Central
Scenario 2	Historic average	Zero	Central
Scenario 3	Extrapolated trend	Positive and declining	Central
Scenario 4	Historic average	Positive and declining	High oil, low GDP
Scenario 5	Historic average	Positive and declining	Low oil, high GDP

These produced a range of forecasts which are set out below. The important point in producing the scenarios is that it the forecast is no longer based on inputs which are fixed and beyond the control of policy makers. While this is still true for population, income growth and oil price, it is clear that the number and length of car trips per person and the way in which extra income automatically creates new car trips are both changeable by policy means. This fundamental move in the forecast has not yet been fully understood or reflected in the decision making process.

Figure 6.1: Traffic growth by scenario (billion miles, all vehicles)



In addition, it is possible to extend the table of scenarios, using the standard inputs, to produce even lower forecasts. The obvious example is that Scenario 3 still assumes income growth linked to traffic growth (not assumed in Scenario 2). While we have not run the National Traffic Model it is possible to derive factors from the scenarios which approximate the income effect and to then remove it from Scenario 3. This results in traffic growth between 2010 and 2040 of only 6 per cent.

The approach in this study has been to produce further forecasts which also impact upon van (LGV) and HGV traffic which are produced more simply and mainly driven by economic growth. Here we have estimated impacts from other game changers, most notably:

- More efficient use of HGV capacity for trunk hauls
- A modest switch to rail for trunk hauls
- A rationalisation of distribution and deliveries, including a small impact from 3D printing.

This produces a range of forecasts some of which show modest short-term growth followed by stabilisation and, potentially, a return to present day levels of traffic. An example is shown in Figure 6.2 as Scenario 3b and 3c. In this timescale the benefits of CAV operation, particularly on the Strategic Road Network, should come into effect. Providing that user charging is in place (and something will have to be done to replace fuel tax revenue) this will mean that there is a real prospect of improved reliability, journey quality and safety for motorists.

Scenarios 3b and 3c were produced by combining elements of the DfT car forecasts based on their Scenario 3 and using different factors for LGVs, rigid HGVs and articulated HGVs. Further details are given in the Annex.

In addition to this, it is possible to adjust the traffic forecast by assuming an impact from CAV use. To do this we have used the delay reduction in the DfT study. A 50 per cent proportion of CAVs is assumed by 2035, and 75 per cent by 2040. To put this in perspective, such vehicles are likely to be on the market by 2025, and if all cars from 2030 onwards were CAVs the assumed targets would be exceeded.

However, these figures do not reflect the level of demand on the network. Some vehicles, in particular HGVs, require a more space than a car. To reflect this, the value of two passenger car units (pcus) has been applied to rigid HGVs and public service vehicles, and four pcus to articulated HGVs.

The results are shown in Figure 6.3, which illustrates the importance of articulated HGVs in congestion forecasting and the impact of CAVs. It also includes Scenario 6b, which makes an adjustment to lower the pcu value of CAVs. This is explored in more detail in the analysis section.

Figure 6.2: Traffic forecasts under different scenarios in vehicle miles

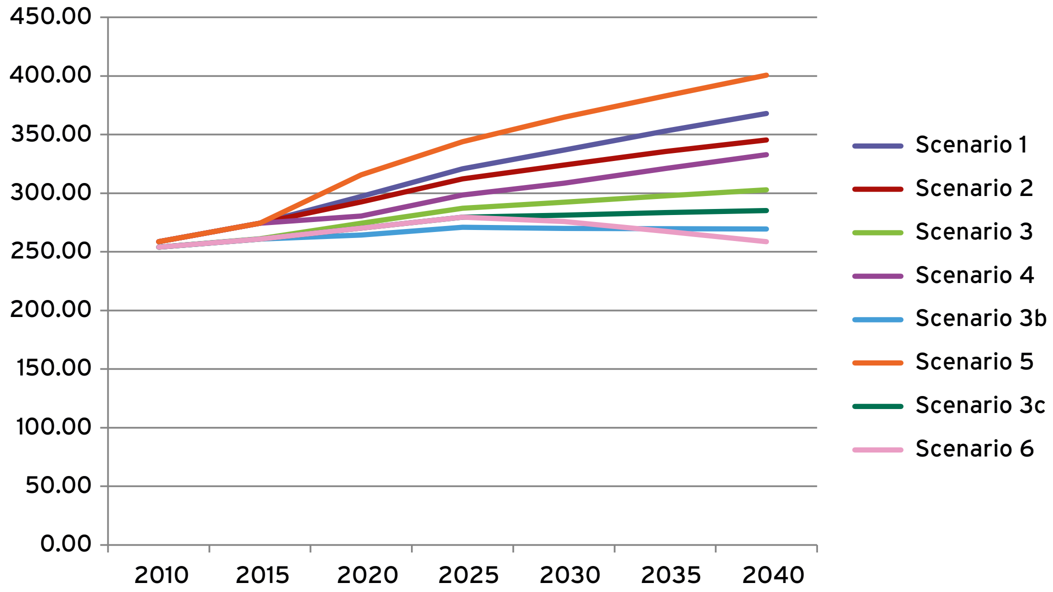
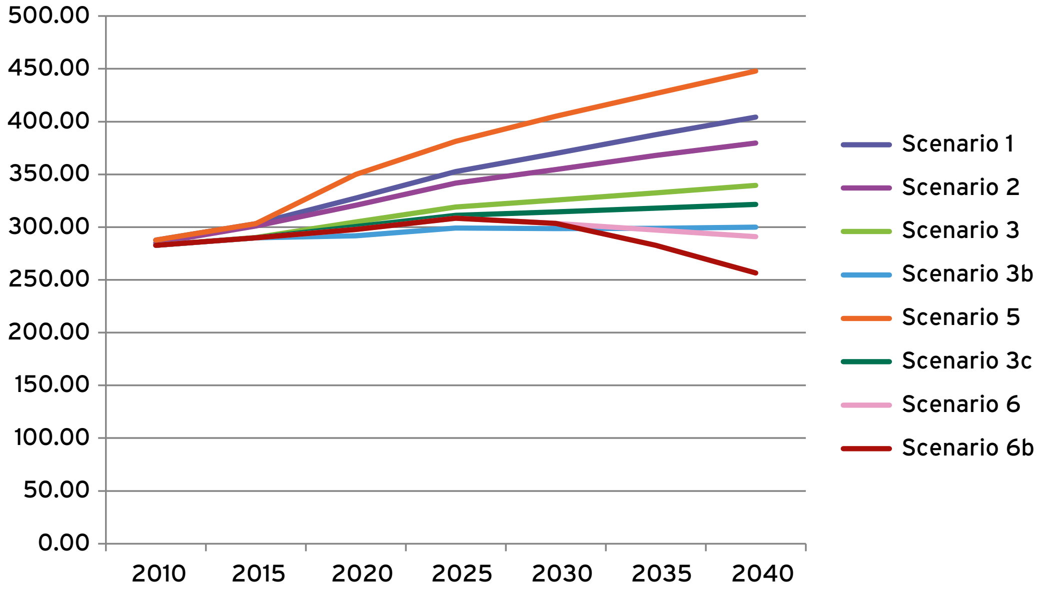


Figure 6.3: Traffic forecasts under different scenarios in pcu miles



6.2 Analysis of the forecasting results

The forecasts in Section 6.1 should enable a carbon emission forecast for each scenario and be capable of broad brush analysis of air quality. However, the DfT forecasts produce traffic by road type and area type so it should also be possible to produce forecasts which are better suited to local air pollution impacts.

Overall the conclusion is that policies which would support the trend in falling car trips per head of population and uncouple economic growth from car traffic growth (Scenarios 3b and 3c) would have a major stabilising effect. Combining this with transfer of freight from articulated HGVs to rail produces Scenario 6. Allowing for the impact of CAVs produces 6b, which effectively reduces the pcu value of cars to .93 in 2035 and .83 in 2030. It could continue downwards to .6 by 2045/50.

The implications for Government policy are clear. First, their encouragement of new technologies is fully justified and should accelerate. Second, their investment programmes and policy framework and charging frameworks should be reviewed. The next part of this report suggests key areas where changes in all three could set the guidelines for change which maximises environmental and economic benefits. However, even without such a review, the use of unrealistic medium term time savings, or of any beyond about 2030, are so uncertain as to be unsuitable for inclusion in cost benefit appraisal.

6.3 Policy making and sustainable outcomes

Policy packages and strategies for transport have been produced by local and central Government over many decades, both for regions and nations in the UK. It is arguable that there is no current national transport strategy for England, although there are for Scotland[22] and Wales.[23] While regional transport strategies were developed in the late 1990s and beyond, these have faded away since regional government structures were abolished in 2010. The UK Government does however produce National Policy Statements (NPSs) of which three are transport related: Ports, National Networks and Airports. In this context, some projects will be brought forward through a special approval process as Nationally Significant Infrastructure Projects (NSIPs).

It is immediately clear from what has been produced by Government so far that there is no particular co-ordination between the NPSs and there are already problems with the published versions. The Ports NPS (2012) is largely private sector led with little public benefit appraisal or consideration of the merits of different locations on grounds of surface access or environmental impact. The National Networks NPS (2014) does not include HS2 and again considers transport networks for road and rail in isolation from one another. The Airports NPS (consultation ended May 2017) devotes most of its content to promoting Heathrow expansion rather than starting with an analysis of what international gateways the UK needs, the national networks needed to support them, and the regional development and environmental impacts of different policies. Given the controversy over Heathrow, this very particular use of the NPS may well be tested in the courts.

Despite the removal of English regional transport strategies, city region and other regional-like transport strategies are in place or being developed as part of ongoing reforms to local government, most recently the combined authority approach and the introduction of more mayoral elections.

Thus a Mayor's transport strategy for London was put in place in 2002 and is now being reviewed, and the Northern Powerhouse, Midlands Connect and Transport for Greater Manchester (TfGM) have all produced or are producing comprehensive strategy documents very recently.[24] These all take as their starting point similar high level objectives related to the economy, social inclusion, environmental impact and health and safety. They then go on to set out subsidiary (sometimes called operational) objectives leading to delivery plans and funding requirements, usually involving central Government as a major contributor. The TfGM strategy is a very good exemplar, with a clearly structured approach related to land use planning and a major public engagement exercise. The Transport for the North Freight and Logistics report[25] and its Appendices provide a powerful indication of what such a strategy could achieve in support of environmental and economic objectives. The next section of this report considers how it would be possible to use policies to achieve the lower levels of traffic in some of the DfT scenarios.

7. Reducing passenger road traffic: a locational based approach

7.1 Introduction

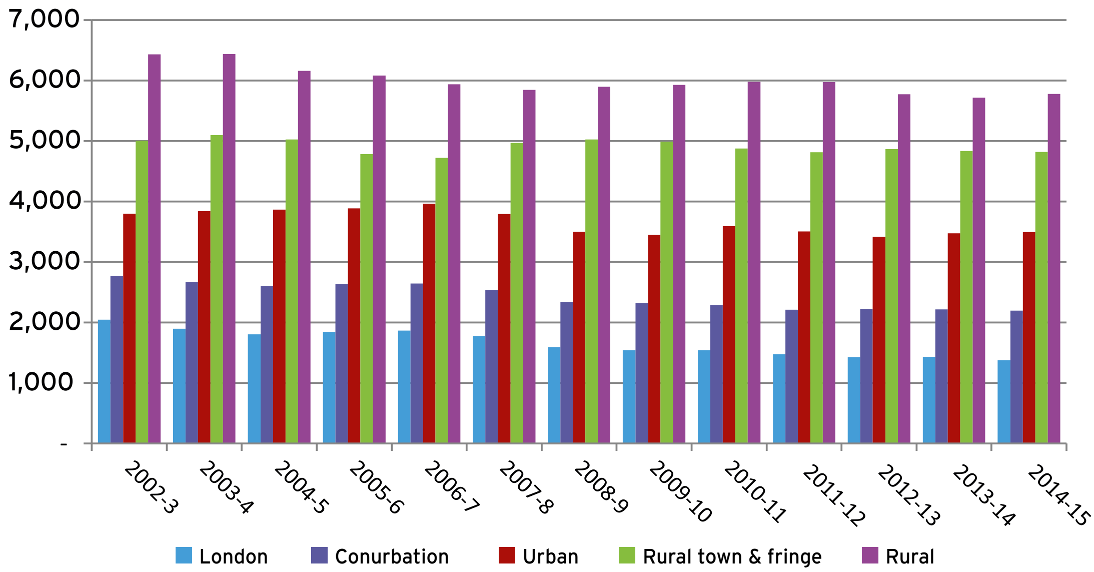
This study takes the approach of focussing on the key operational objective of slowing down road traffic growth, and possibly reducing some elements within it. However, the importance of policy packages, in which individual elements support and enhance each other, should not be underestimated. Within traffic growth there are two basic sources: passenger and freight. Within both of these there are key differences in terms of length of journey, and in journey purpose. For example there is a clear division in freight between large concentrated flows between depots or major industrial sites and local deliveries. These are undertaken in very differently sized vehicles and the various separate policies will affect them very differently. For personal car use there is a clear distinction between, for example, commuting or shopping, and again different policies may affect them. However there are very strong locational factors at work and some policies, especially those involving parking or charging have an impact across all purposes.

We set out some key policies in the following section for passengers, and in a later section for freight. Some of this uses a traditional analysis of journey length and journey purpose. Before doing so we address a further issue in relation to car traffic forecasts – rather than where or why the traffic is on the road network, it is important to understand who the people are who do the driving, and most importantly where they live.

7.2 Where do the drivers come from?

The first step is use data from the National Travel Survey (NTS) to understand the average distances driven by car by drivers living in different areas. This is not available from the DfT estimates for the different road types which are mostly based on roadside counts. Figure 7.1 shows the NTS data for 2002/3 to 2014/15.

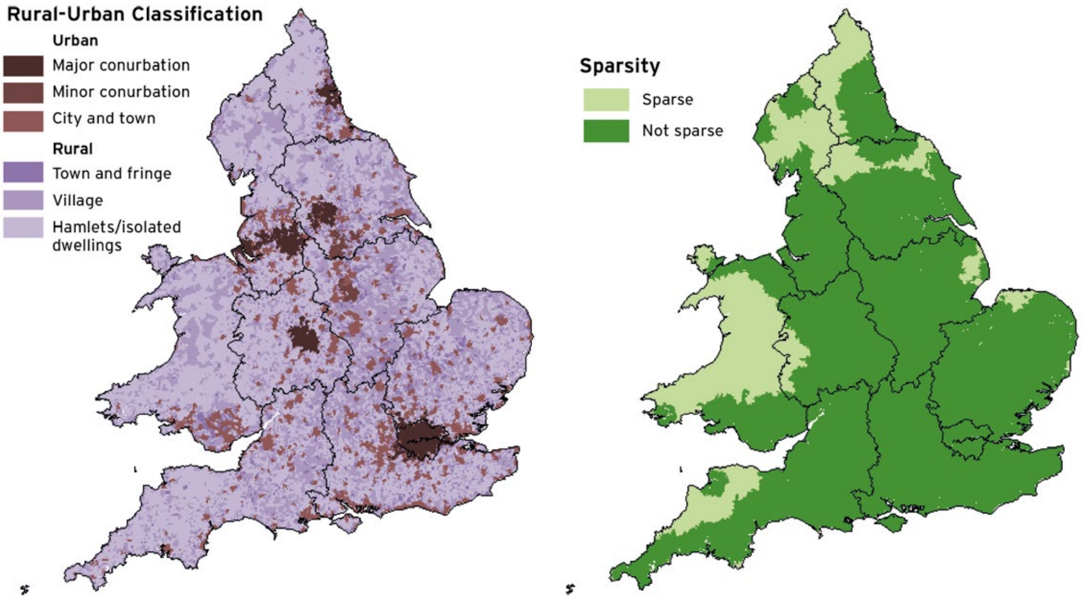
Figure 7.1: Average car driver miles per year by area of residence



Source: data extracted from NTS Table 9904

It should be noted that the conurbation category includes London which reduces the overall average for that category. As would be expected, it is clear that there is a strong relationship between car travel and the type of area. The next step is to translate these averages into total traffic, and to this the population in each type of area must be extracted. These areas have been chosen to be the same as those used for the National Census. A map showing the different categories is reproduced below.[26]

Map 1: Rural-urban classification and sparsity England and Wales, output areas, 2011



Source: Office for National Statistics

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The NTS used the following groupings based on the 2011 Census. The figures in the first column of Table 7.1 are absolute numbers for 2011, the percentages in the second column are the proportion of total population of England and Wales.

Table 7.1: Census classifications

Urban Conurbation (20.69 million)	Major and minor conurbations (33.5% and 3.4%) including London (14.6%)
Urban City and Town (25.04 million)	City and town in both sparse (0.3%) and non-sparse (44.4%) areas
Rural Town and Fringe (5.14 million)	Both spares (0.5%) and non-sparse (8.6%)
Rural Village, Hamlet and Isolated Dwelling (5.21 million)	Village 5.8% plus hamlets and isolated 3.5%. Sparse 0.9% and non-sparse 8.3%.

A further calculation has had to be made to separate out the average mileage for conurbations outside London which the NTS also includes in the conurbation category and has a significant lowering effect on the average – it represented 39.6 per cent of the Urban Conurbation category in 2011. Table 7.2 shows the data on which the chart is based but with the addition of London.

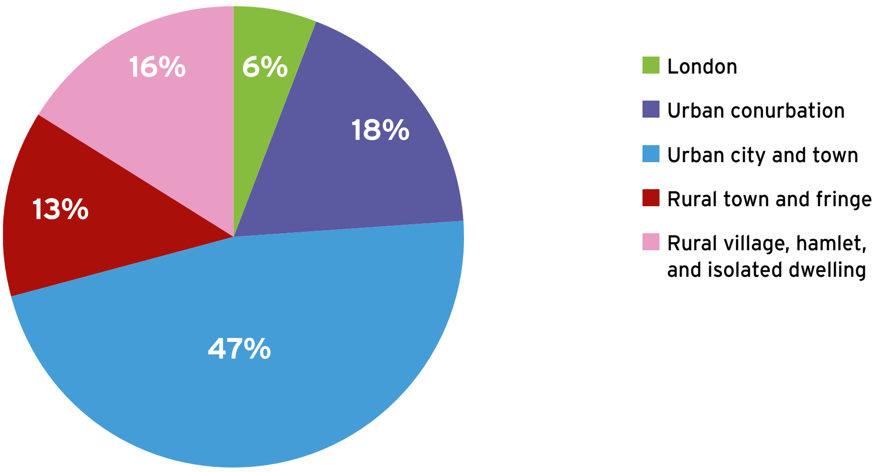
Table 7.2: Average miles driven per head of population by area of residence

	2011-12	2012-13	2013-14	2014-15
London	1,473	1,430	1,433	1,377
Urban Conurbation (without London)	2,670	2,719	2,707	2,708
Urban City and Town	3,505	3,418	3,477	3,497
Rural Town and Fringe	4,813	4,863	4,837	4,819
Rural Village, Hamlet and Isolated Dwelling	5,971	5,772	5,715	5,775
All areas	3,344	3,271	3,256	3,272

7.3 Producing total traffic flows associated with where the drivers live

To produce a total traffic estimate the proportion of the population in each area can then be multiplied by the average mileage for that area. This produces a forecast, not by road type but by place of residence, which enables a more direct estimate of the impact of policies in different local areas, which is where they tend to be applied. Only policies such as road user charging are applied on a network basis. This has in fact led to an underestimate of the potential for locally applied policies to influence overall traffic flows. Figure 7.2 shows the results of these calculations.

Figure 7.2: NTS based % of total traffic by area of residence



Source: 2011 Census, NTS Table 9904, MTRU calculations

There is one point to be made about the total traffic produced by this method. Because the NTS only surveys residents it does not pick up longer distance journeys driven by people outside England and Wales and thus would be expected to produce a lower estimate for total road traffic. The total estimate from the NTS method, for example, produces about 190 billion car miles in 2014, about 13 per cent lower than the National Traffic Forecast estimate.* Clearly the main value in both the counts and the NTS is for comparisons over time within their respective parameters.

*This is itself produced by multiplying the count data by road lengths and by sampling the minor roads

To summarise, Figure 7.2 allows for two factors:

- Higher than average distances driven by people in rural and less densely populated areas
- Lower levels of population in rural and less densely populated areas.

7.4 Policies applied where drivers live

Having worked towards a position where the impact of policies can be considered at an area type level, it is possible to estimate the national impacts of such policies. This means that a more realistic assessment can be made of different policy impacts, particularly those which operate more locally such as travel behaviour change. This will also coincide to a greater extent with the areas of governance which are emerging. Such policy impacts can of course be combined with network based policies, such as road pricing or longer distance travel policies (for example increasing rail capacity parallel to congested roads). Destination based policies are also relevant but given that many of the urban areas are based on travel to work areas, these should be included in the package for these areas.

The next section of the report considers some major initiatives which should be considered as one package. However, they broadly cover three key areas:

- Urban sustainability (An integrated transport and land use approach) for both:
  - Urban conurbation (the major cities)
  - Urban City and Town (smaller cities and large towns)
- Total travel (MaaS + Smarter Choices)
- Charging for transport which would address:
  - The need to replace fuel duty with a more acceptable alternative
  - The need to change behaviour on health or safety or environmental grounds (including Clean Air Zones)
  - To raise funds for local transport.

All these are of course closely connected, for example access to travel through MaaS has to include a common payment method which covers public transport, parking and, when required, road use. This must be integrated with addressing the other road user charging objectives and the land use policies.

7.5 Urban sustainability: a step change in urban transport and land use planning in major cities

The first part of a package would address the extent to which transport and land use planning, and the pattern of investment, in the major conurbations outside London could move towards the level of sustainable transport use already observed in the capital. This could include:

- Land use planning to ensure density and Transit Oriented Development (TOD)
- Unified and simplified payment structures including fares
- Incentives to use non-car modes through information infrastructure and MaaS
- Rolling five year plans for public transport infrastructure and sustainable travel
- Limiting parking places in new developments on a site area basis* (to ensure that employers support sustainable travel)
- Workplace parking levies
- Charging the most polluting vehicles

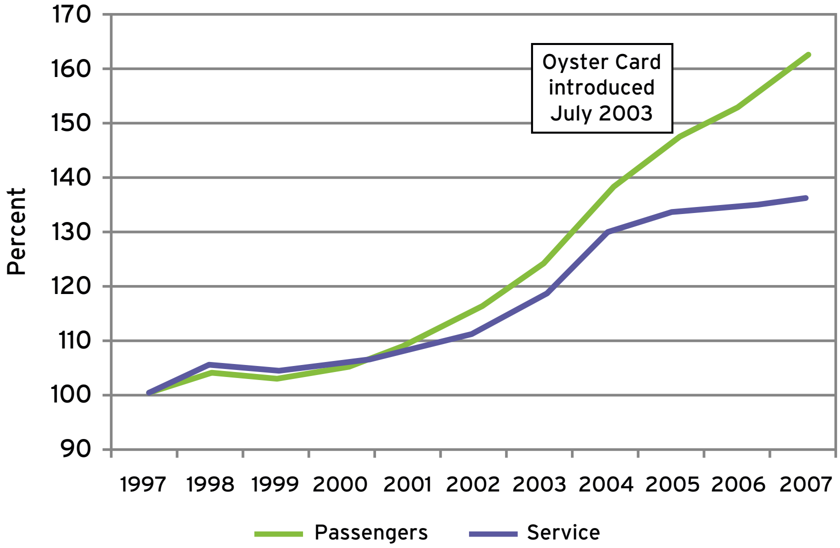
*Currently this usually calculated on a floorspace basis

It is important that the right governance is in place, with travel areas to work covered in a unified way, both for land use and for transport system integration. Some examples of how these policies can work are given:

Fares unification and simplification

London has shown the value of simplification, first of fares and then of payment – Figure 7.3 shows the impact of the 2000 simplification (2000-2003) and the introduction of Oyster.[27] Growth has recently plateaued, probably due to falling bus speeds and some switch to cycling. Tube use continues to grow (by a third over the last decade). All this has led to car use continuing to fall (see Table 7.2 on page 35).

Figure 7.3: London bus service level and passenger use



Land use and parking

London has clear limits on parking allowed in new developments and has had them longer than any other city. No parking spaces are allowed in new developments in central London, for example. Even limits in outer London are tighter than in other cities. The cost of land has been a strong encouragement to dense development, and new stations have been related to development as a matter of policy for several decades, most recently in the case of the Jubilee line and light railway expansion.

Charging for road use

London remains the only UK city with a large scale congestion charging scheme. This is now being amended to address pollution issues as well, particularly in light of the need to improve air quality.

Overall, cities outside London would benefit from new national guidance and support, including:

- Site based parking maxima for new development, applied nationally
- Development related to sustainable transport accessibility, again on a national basis
- Minimum density for new development and redevelopment
- A duty to implement either comprehensive parking space levies or road user charging on environmental and congestion grounds
- Legislation and funding to ensure simple and unified public transport ticketing and information
- Provision of ongoing support for Smarter Choice and MaaS initiatives – not time limited bids for one off projects

The emergence of new governance has been led in these areas, TfGM's new strategy and other cities have already been highlighted, and there should be reasonable confidence that these can continue to move towards London levels of sustainable transport. It is not expected that they would match this level, but even a closing of the gap would have major benefits and be completely in line with the stated aims of these major cities. Even a target of reducing the difference in the sustainability of these cities compared to London (measured as car use per head) would make a major contribution to a continuing fall in car trips (and distance). This would be in line with current trends and help deliver the DfT traffic forecast (Scenario 3) based on such a fall.

The cost of such change can only be estimated, and significant income would accrue from parking space levies or user charging, plus the growth from fares reforms. However, the income from people travelling unsustainably may fall as they switch to non-car modes. As at present, developer contributions would be another source of income, but this tends to be for capital expenditure.

To make such contributions a practical proposition, as well as any levies or charges, steps need to be taken to avoid competing authorities undermining any initiatives by offering developers a cheaper but unsustainable, alternative. This is why national parking maxima and development related to sustainable transport accessibility on a national basis is required.

Transitional funding is important but a continuing level of support remains likely to support the growth in these major city regions. Additional revenue funding of about £50 per head per year would imply a total cost of about £300 million across all the cities.

7.6 Urban sustainability: Spreading good practice to all other cities and large urban areas

The second part of this policy considers the extent to which conditions outside these conurbations, in what are medium sized cities and large towns, can also catch up with the highest levels of sustainable (and healthy) travel. They are the largest single category producing car traffic. It is important to note there are some places which should probably be in the major city category but we have followed the NTS classification. Their average car use is higher than the small number of major cities (by 29 per cent in 2014/15).

Earlier in this report the idea of promoting sustainable travel choices across a wide range of urban areas was put forward as a way of maintaining a fall in car trip making per person. In this case it would be achieved by several policies:

- Making public transport attractive through unified and simplified fares
- Completing the public transport information revolution, with instant real time access
- Unified planning and transport decisions, more development allowed where sustainable transport is already available, or funding sufficient to make it so*
- Income from development to supplement increased levels of support for bus services in urban areas outside London

*Existing accessibility mapping such as PTALs and Accession (now replaced by TRACC) has been capable of producing the data required to implement this for over a decade

- Network planning of all modes to provide a comprehensive non-car offer (supporting MaaS)
- On street priority measures for road based public transport
- Development of lower cost rapid transit with a similar sense of permanence to trams (including ULR and BRT)
- Creation of a local public transport national brand in terms of common standards for ease of access to information, payment system and quality.

This is clearly not a straightforward task, given the privatisation and fragmentation of the bus industry in particular. However, the London model is helpful is showing that it is practical to maintain private sector competition behind a common public face including fares and information. Since April 2017 there are new legal powers available for advanced ticketing schemes which include information. However, these are permissive and are likely to have set up costs and meet resistance from private operators who do not want to share data. There should be new legal responsibilities, alongside the new powers, placed on local authorities to ensure the common user interface for information and fares across all public services in their area. This would have to be matched with new responsibilities on the operators to co-operate in the implementation of the scheme.

There are 20 areas defined as having with more than 300,000 population in this City and Town category, listed in order of size: South Hampshire, Nottingham, Sheffield, Bristol, Leicester, Brighton, Bournemouth, Teesside, Stoke on Trent, Coventry, Sunderland, Norwich, Cardiff, Preston, Newport, Swansea, Birkenhead, Reading, Hull. There are 11 in the 200,000 to 300,000 category, again in order of size these are: Southend area, Derby, Plymouth, Luton, Farnborough/Aldershot, Medway, Blackpool, Milton Keynes, Barnsley/Dearne Valley, Northampton and Norwich. Familiar small cities and larger towns in the 150,000 to 200,000 category are: Swindon, Crawley, Ipswich, Wigan, Mansfield, Oxford, Warrington, Slough, Peterborough, Cambridge, Doncaster, York and Gloucester.

Within this group there are already examples of moving towards lower levels of car use, but for a variety of reasons. Brighton and Nottingham respectively have the highest bus use per head outside London, and Nottingham has both its workplace parking levy and expanding tram network.* Brighton has 60 per cent of the bus use per head of London. Outside bus use, Cambridge has some of the highest cycle use in the UK (see Table 7.4) plus a Bus Rapid Transit scheme, while other cities outside of Table 7.3 for bus use, such as Sheffield, (as well as some cities inside) already have their own tram system. By contrast some large urban areas are without a rapid transit system with its own dedicated track.

*Before the tram network opened bus use in Nottingham was even higher as shown in Table 7.3

There are huge disparities within this urban group, and this can be seen in Table 7.3. For example a few rural counties (such as Devon) outperform some of these urban areas, and the lowest in the 'City and Town' group achieve about a fifth of the use of the best (mid 30s in terms of bus use per head per year). The top ten for bus use per head are shown below. This also illustrates the changes which have taken place in a relatively short space of time to entries outside the top three. The three areas with absolute increases are highlighted in red.

Table 7.3: Top 10 areas for bus use per head of population per year

2015/16		2009/10	
London	264.3	London	281.8
Brighton and Hove	159.5	Nottingham	162.8
Nottingham	149.2	Brighton and Hove	154.0
Reading	126.2	Tyne and Wear ITA	118.7
Tyne and Wear ITA	104.1	West Midlands ITA	116.8
West Midlands ITA	94.5	Reading	108.3
Bournemouth	91.6	Leicester	106.0
City of Kingston upon Hull	88.7	Kingston upon Hull, City of	101.9
Merseyside ITA	87.5	Merseyside ITA	98.5
York	81.7	Blackpool	89.6

Source: DfT Statistics Table BUS0110a

The next table shows the top 20 areas for cycling in the UK. While special factors such as geography may influence some figures the variation even within this group is clearly very high.

Table 7.4: Proportion of adults cycling at least three times a week, England 2014/15

	Top 20 local authorities				
1	Cambridge	39.0%	11	South Cambridgeshire	11.4%
2	Isles of Scilly*	19.0%	12	Portsmouth	10.9%
3	Oxford	18.8%	13	Brighton and Hove	9.9%
4	Wandsworth	15.0%	14	City of London*	9.4%
5	Norwich	14.9%	15	Bristol, City of	9.2%
6	York	14.8%	16	Exeter	9.0%
7	Cambridgeshire	13.5%	17	Oxfordshire	8.9%
8	Gosport	13.4%	18	Newark and Sherwood	8.9%
9	Hackney	12.3%	19	Peterborough	8.6%
10	Islington	11.5%	20	Woking	8.5%
	AVERAGE FOR ENGLAND = 4.4%				
	*Sample sizes for these authorities are very small, and caution is needed in interpreting these results				

Such data points to the way in which moving the average for these cities towards the best could make a significant impact on road traffic. While a detailed area by area calculation has not been undertaken, bringing the average up to the best could easily achieve a 50 per cent improvement in the overall bus trip rate, enhanced where rapid transit systems could be introduced. If trips were switched from car, this alone would support a reduction in car trips of about 10 per cent.

Overall the same initiatives that we propose for the major cities should be pursued for this group. It is harder to estimate a cost but at a similar per head amount support of around £1.2 billion per year could be required but with a longer build up period. Again only a minority would necessarily come from central government.

As regards land use planning, the estimates produced when planning guidance was being prepared in the early 1990s suggested reductions of around 15 per cent were possible. Having had the experience of two decades of albeit imperfect implementation, could it be that the identified fall in car trips is at least partly due to such policies? In this case their removal is counterproductive. Again this supports the national guidance proposed as part of the policy package.

7.7 Total travel, MaaS and area based policies

What do we know about the impact of MaaS?

A key question for this report is what is needed to achieve a level of implementation of this group of different policies that will have an impact on the three objectives and what will that impact be. The three objectives were:

1. To reduce the number of car trips per person in line with recent trends
2. To support national economic growth without directly increasing road transport
3. To ensure income per head can rise without directly increasing road transport.

There is considerable speculation as to how MaaS will revolutionise travel behaviour but it is hard to find evidence of such a disruptive technology sufficient, for example, to produce forecasts of its impact on traffic. However there are already clear indicators of what is possible. These can in part be derived from the work done in relation to transport interventions such as travel planning, travel information, Smarter Choices, public transport fare and service changes and car clubs.

The use of smartphones to provide real time information on availability and cost (time and fare) across and within modes, including parking, is already here and behaviour is changing as a result. Some further clues to the potential can be found in the work undertaken in relation to smarter travel planning which began in 1995 and grew rapidly, most recently being funded through the Local Sustainable Transport Fund (LSTF). The hall mark of these schemes was that they were innovative, but funded on a competitive short-term basis. For road and rail infrastructure there has been a move towards longer term planning through the programme of five year plans such as the Road Investment Strategies (RIS). These are set out well in advance, for example we are in RIS1, RIS2 is being planned in some detail now, and projects are being developed for RIS3. One obvious recommendation is that planning for sustainable travel must be given the same consistency of long-term approach. The true costs of preparing, bidding, building up and winding down short-term projects can be as great as the project itself. The constant bidding, reinvention and short-term extensions have become a waste of human resources as well as money.

There is also some data on changing attitudes to car ownership, for example in younger age groups[28] where licence holding is falling, or those living in urban areas with dense public transport networks.

Much of this work was related to changing behaviour, through financial 'sticks and carrots', improvement to physical infrastructure and services, and/or simply providing better information on what was already available. This could be done at destinations, for example through workplace travel plans, or at origins, through home based travel information provision (often in person rather than via mass media).

The most effective schemes used a combination of elements from the travel planning tool kit:

- New facilities (such as cycle storage and changing rooms or an externally organised and moderated car share scheme)
- New or improved services (designed using information from staff travel surveys)
- New infrastructure such as bus and cycle lanes and safe and secure walking routes
- Highly targeted financial incentives and disincentives (such as travel discounts, car park charges or subsidised bike servicing and purchase)

- Information (for example outside London awareness of available public transport can be very low)
- Creation of a sense of common organisational purpose (for example biker breakfasts with senior management taking part, poster campaigns and promotional gifts).

The importance of combining elements to create the effect is reflected in the recent DfT report showing a simple mass mailing of a public transport offer had a very weak response. Combined approaches with staff involvement to develop a clear travel plan and specific measures can be highly successful, BAA's extensive travel plan work including doubling staff bus use at Heathrow, similar scale of change in bike use at Hewlett Packard and Sky are well documented examples. The original Airport Travelcard was ground breaking outside the London system and survived the break up of BAA, although now less comprehensive and higher in cost.

There is considerable material on the effectiveness of Smarter Choices but schemes have always been localised – a national approach has not really been tried. This possibly reflects a reluctance to make policy at the national level other than setting up a short-term (usually no more than three years) and highly competitive funding stream.

Added to this mix has been the establishment of car clubs and bike hire, and the rise of smartphone based operations such as Uber or Lyft, and e-hail for conventional taxis. Car clubs provide data on how people behave when they retain access to cars but without owning them.[29] In broad terms people will continue to use cars if they give one up, and will start to use cars if they did not own one before. However, the pattern of travel reveals far greater choice of modes and overall an increase in cycle and bus use, about double for bus and a fourfold increase for cycling (but with a smaller absolute number of cyclists). The bus result is in line with how households without a car choose to travel. This has as yet unexplored implications for the bus industry and how a package of measures in which bus services became easier to use and pay for, and car clubs were implemented in those areas, could achieve far greater impact than isolated implementation of the policies. Obviously this also raises the issue of a common means of payment which would make travel choice more open and more diverse.

Other examples are provided by the earlier pilots of demand responsive (DRT) schemes such as the rural challenge fund, launched in 1999. These would have been able to reduce costs dramatically with the technology which has now become available. Within its operating area, DRT varies its route according to demand, but the fact that DRT bus bookings were made through a call centre (even when a mobile phone was used) placed an overhead on the operations which was as much as running the bus itself. The lack of real time interaction also meant that early bookings by an individual could remove the flexibility of the DRT service and lose some of the efficiency savings.

With the advent of instantly available information on travel options and cost (time and fare) the idea of widening travel choice becomes much easier than when travel planning ideas such as those above were first implemented – this reflects the extraordinary rate of change. For example one drawback for car sharing and some public transport options for commuting was that the time of leaving work was more variable than the time of arriving. Providing a taxi guarantee for the ride home if work demanded it was, even a few years ago, not straightforward outside central urban areas. Uber has changed that completely. The idea of getting out bus timetables and reading through them to calculate when or even whether a journey was possible has been rendered unnecessary by Google Maps (and many other apps are available). This vastly increases confidence in being able to access and use public transport systems, time previously spent waiting or worrying at a stop can be better used at origin or destination.

In Nottingham, where travel planning was pioneered in the UK, Smarter Choices have been combined with a workplace parking levy and the funding of a new tram network. This was also accompanied by the local bus operation benefitting from continuity from the original municipal operator, and a consistent long-term approach on sustainability and urban quality. This has resulted in a strong local economy, high public transport use and a sense of leadership.

While a common method of payment and simplified fare structures can make a major contribution to a divergence of choice in travel mode away from the car, this total change in the way people perceive and use different modes offers a range of new opportunities. Among these are the idea of active pricing. In previous ideas for road user charging, one was that cars would be fitted with a black box which would start charging their driver if the journey became congested. Understandably this provoked opposition on the grounds that people would not know how much their journey would cost before they started.

The range of recommended policies in relation to MaaS are:

- Policies for MaaS and Smarter Choices should be combined and mainstreamed, all transport authorities should have clear policies and continuity of funding should be provided
- Common means of payment across bus operators and across modes
- Unified information platforms – apps may compete but must be comprehensive
- Simplification of fare structures combined with the above
- Provision of access to car use without ownership – car clubs are a start but CAVs will play an increasing role
- Exploration of DRT options through new development funding and upgrading of existing services
- Use of data collected on travel use to define new opportunities for public transport
- Active pricing – cost of travel could be varied according to real time external costs or to encourage changes in behaviour (for example car use of congested networks). Uber already do this in part to regulate demand, as do train companies.

Expected outcomes

- Trend to lower car ownership will continue, especially among younger people living in conurbations
- This cohort is unlikely to turn to car ownership due to factors such as:
  - Lifestyle changes, such as having children and moving into lower density housing occurring later
  - Availability of viable alternatives such as car clubs, and an increase in both low and high demand public transport solutions.
- Income is a key driver of car ownership which in turn is a key driver of car use so car trips per head should fall in line with the DfT low trip forecast (Scenario 3) as well as lower income related growth (Scenario 2)
- The advent of MaaS will allow for an enhanced impact of existing and new Smarter Choices schemes and lead to a diversity of choice within which car use could fall.

Uncertainty and risk

While more conventional improvements to public transport have a track record of success in urban areas, there is far greater uncertainty as to the impact of MaaS. The use of CAVs may remove the barrier to car use of learning to drive, although in urban areas the speed at which they will be able to negotiate shared spaces are unlikely to be faster than walking. While their role for interurban travel may be far greater, there will also be greater choice (including rail and new forms of car share) when the capital cost of car use is almost zero but the marginal cost of car use is higher than today.

7.8 Charging for travel

The third element in the policy package relates to both urban sustainability and MaaS and is related to charging for transport and ought to address:

- The need to replace fuel duty with a more acceptable alternative
- The need to change behaviour on health or safety or environmental grounds (including CAZs)
- Raising of funds for local transport.

The use of smartphones to create a wider range of travel choice, better information, clarity of cost and potential for marketing has been discussed earlier. Alongside this must come some overall approaches, in particular the replacement of fuel duty by a use charge to reflect long-term costs of using the road network including external impacts such as congestion, pollution and carbon emissions. It is not clear what impact this will have, or exactly how the DfT treated this in its forecasts, although car use is predicted to fall in cost in all the scenarios.

The issue of local sources of funding has also been explored earlier, so in this section we use an illustration of how various policy objectives could be addressed in relation to a combined costing approach across modes to reduce pollution in urban areas. This may well be necessary quite quickly if minimum air quality standards are to be met. It is also clear how such policies can work to achieve several targets at once.

7.9 Charging for pollution

Pollution from diesel cars is a major focus of concern, but using price to reduce their use in problem areas has been criticised because people bought them ‘in good faith’. One idea is to pay people to scrap the vehicles, this has two main problems: high cost and ineffectiveness (no switch to sustainable/healthy travel). Instead we suggest a package of charging for polluting vehicles (or banning) together with an alternative total travel offer which reduce both pollution and congestion. The main focus here is on high frequency users of polluting vehicles in problem areas, which is where the schemes would operate. However, infrequent users could also access the scheme.

The mechanisms being explored for this report could be used to provide a number of carrots to go with any option for a financial penalty for using diesels, or indeed a ban. Some of these are adaptations of policies developed and tested during the travel planning (Smarter Choices) programmes of recent years including LSTF. Putting such items together is in line with the new total travel approach.

An obvious contender would be the extension of car clubs combined with car sharing and a discount season ticket. These could be offered as alternative packages or as a single travel concession scheme in which the user chooses the most suitable option on the day.

Car Club and Car Share schemes

The government would offer to part purchase electric vehicles (for example up to 50 per cent) which are to be used by new or expanding car clubs in areas where a restriction on diesel cars is to be introduced. When they are sold the same proportion would flow back to the government. This is not dissimilar to some of the car lease/purchase schemes already in widespread use.

In return the car club would offer free membership to those who own the diesel cars which are subject to a ban or a charge. Proof of purchase prior to the Government's announcement of action to tackle pollution would be required (easily accessible via Driver and Vehicle Licensing Agency). In addition a number of trips per year, say 50, would be offered at a heavily discounted rate. A car sharing scheme would be included and promoted as part of car club membership. The individual user would not have enough credit to use the car club vehicle for an everyday commute, but three or four people could. This is similar to the mechanism sometimes used in travel planning to promote car sharing. This has the important effect of multiplying the impact of the new clean vehicles on replacing the polluting ones. In the case of less frequent users, the new vehicles would avoid the high risk of a very significant deadweight subsidy from a simple scrappage scheme.

Turnover of cars is likely to be higher than average, also ensuring an increased supply of cleaner second hand vehicles from year three onwards. This supports the carbon reduction target which is not currently on track for transport. Other collateral benefits could accrue from more walking and cycling which usually results from car club membership and the resulting wider choice of travel mode. This form of membership would be novel so these are less certain but could be an add on to the clean travel package. The idea of a common method of payment/charging for this package would allow for other travel offers to be made on cycling and walking. These range from discounts on cycle purchase and maintenance, to a new use of fitness type apps to provide extra benefits if walking or cycling is undertaken as part of active travel. Some gyms already operate similar incentive systems and various attractive marketing initiatives for staff have been used to launch and to support commuter travel plans, for everything from free biker breakfasts to various non-transport prizes to encourage sustainable travel.

Public transport discounts

Travel planners have long used fare reductions to encourage people to try or to use public transport on a regular basis. A well-known and successful example mentioned previously is the Airports Travelcard, introduced at Heathrow in 1997, then rolled out to Gatwick and Stansted. Heathrow was already investing in non-London Transport bus services such that between 1992 and 1999 (the two major employee surveys) bus mode share went from 6 per cent to 11.7 per cent (pretty much doubled while nationally bus use fell by about 25 per cent). The point here was that a substantial discount (70-80 per cent) was negotiated with the bus operators together with minor service improvements funded by BAA. The scheme has had to change when BAA broke up but is still operating at the same level of discount at individual airports.[30]

In this case the discount would be negotiated and possibly topped up so that either a carnet or monthly season would be offered to regular users of diesels.

Common payment/rewards

One new aspect to this approach is the idea of a common payment system, probably smartphone based (although a personal contactless card is another possibility). This would be needed to make payment easy but also to ensure that benefits accrue mainly to the target diesel owners. Alternatively, the scheme could be broadened out and untargeted in terms of users, while targeted in terms of only operating in the areas suffering the worst pollution. This would coincide with many of the areas which are key targets for the urban policy proposals in this report. It is suggested that the means of payment for any pollution charge uses the same platform to reduce cost but also to ensure full user perception of the alternative costs. The charge would need to be sufficient to be both a deterrent and make driving the polluting vehicle very uncompetitive in terms of cost.

Cost and impact

The level of impact depends on the level of support but we suggest the main cost would be the electric vehicle subsidy. At £5k per car with a support level of £20 million a year rising to £50 million would cost £190 million over five years and potentially remove about 130,000 car trips a day from problem areas after allowing for the impact of multiple use and car sharing.* Congestion and carbon would also be reduced. Paying individuals who own diesels to buy an electric car with the same subsidy would remove 38,000 cars, but not at all guarantee they would be removed from problem areas, although there might be lesser benefits elsewhere. However, this would impact purchasers very differently – some would not be willing or able to scrap their cars since the government would only be paying the electric ‘premium’ rather than the whole scrappage cost. Increasing the scrappage subsidy would mean rapidly escalating costs or achieving only marginal change.

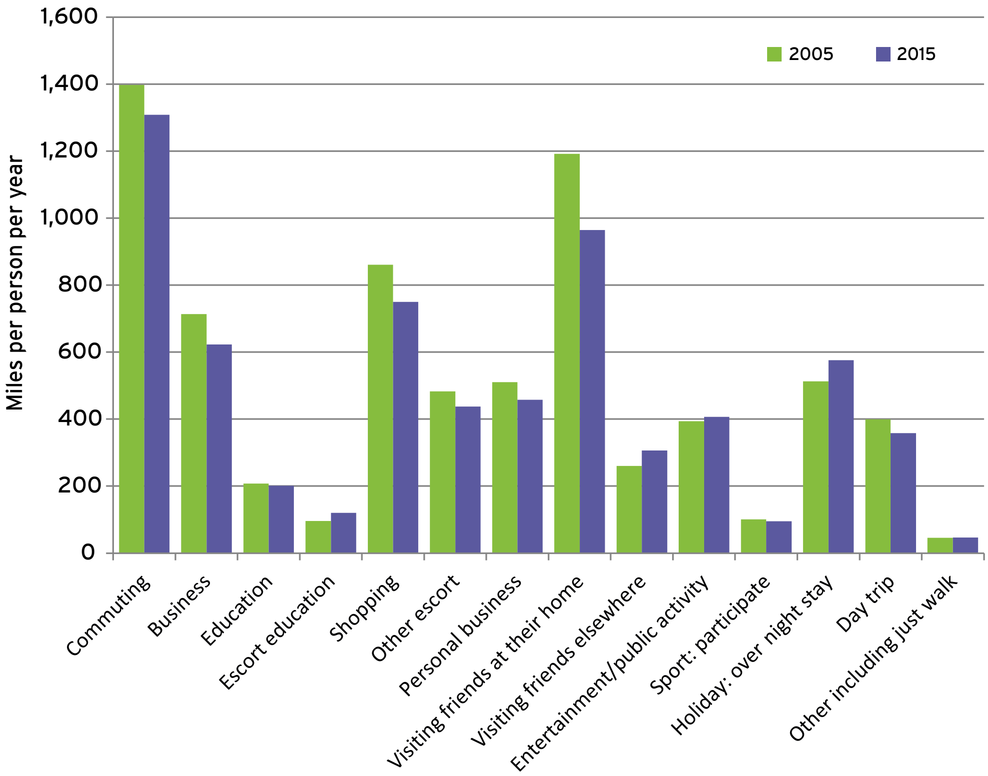
*A multiplier of 3.5 is assumed in car occupancy

Overall the idea of a sustainable travel bonus combined with CAZ charging seems both cost effective and a better strategic fit with government policy and international agreements. It illustrates the potential for a MaaS approach to create new opportunities to change travel behaviour and achieve personal benefits as well as social gain.

8. Relating area based policies to journey purpose

While the area based approach provides new insight into how traffic growth and thus emissions can be addressed, an analysis can be undertaken to cross check the policies against the travel by journey purpose. To put this in context, Figure 8.1 (the latest data from the National Travel Survey) shows the distribution of travel by purpose. It also shows the changes in importance of different categories.

Figure 8.1: Distance travelled by journey purpose, England 2005-15



Sources: MTRU calculations from TRA 3105, ENV0104

As can be seen, the fall in distance travelled reflects the lower number of trips which underlie the different DfT scenario forecasts.

The table shows how sustainable travel initiatives can be constructed. Thus commuting will benefit from work based travel planning. Business travel will benefit from that too, but also from improvements to technology to enable 'telepresence' to better substitute for physical meetings. The continuing rise of internet based shopping may already be affecting the figures and is likely to continue. This could be reinforced by policies on local centres, parking limits in large retail developments and planning conditions. Home delivery is likely to increase and thereby reduce car shopping trips. However there will be a rise in delivery vehicle traffic. Working away from traditional centres of employment suggest further falls in the amount of personal travel will occur.

The analysis suggests that linking policies within the MaaS category to the travel planning toolkit which has been developed over a decade or more will guide the impacts of MaaS towards supporting sustainable travel. The urban travel initiatives support the idea of dense city life with economic activity requiring less physical transport. Other technologies will support thriving local areas with good mass transit links for those journeys to larger centres or in a different part of the conurbation. This would link back to the visiting friends and entertainment categories in the table. Both are significant, visiting friends at home is the second largest category of trip making.

It must also be remembered that these figures are not only road transport. Some mode shift is also likely, particularly in major conurbations, as MaaS reduces individual car ownership and wider travel choices are made. Therefore people's travel will have a mix of car use and other modes, with car use extended to people who do not use cars at present and who will have, in the long run, access to autonomous vehicles. The patterns of use from car clubs show that where people give up owning a car, they use cars significantly less and choose a far greater range of modes. This should, providing the car travel is not underpriced, produce a net traffic reduction. However, the use of AVs by non-licence holders is a long way off and there are a number of challenges that would have to be overcome. In the meantime the urban and rural initiatives proposed will benefit non-licence holders now, as well as providing a context for AV development.

The key to this report remains its analysis using the parameters which are used for the national forecasts:

- Whether trip rates stay the same or continue to fall
- Whether driving costs per mile rise or fall
- Whether economic growth continues to cause more car travel
- How fast the UK's economy and the population grows.

9. Carbon emissions from HGVs

9.1 Classifying emissions

Emissions from HGVs constitute at least 16 per cent of carbon emissions from transport. A key source for data on HGV emissions is Table ENV0201 (TSGB0306), Greenhouse gas emissions by transport mode, United Kingdom: 2004-2014.[31] This does not contain estimates for different categories of HGV so the overall amount was replicated for this report using the fuel consumption figures for different types of HGV from the Continuing Survey of Road Goods Transport (CSRGT) and data for traffic flow from DfT counts. As ever there are slight differences caused by definitions such as Great Britain versus the United Kingdom, and there are important differences between CSRGT and DfT counts for their estimate of vehicle miles, as well as normal statistical variation. However, the approach of applying CSRGT fuel consumption to DfT count data reproduces the carbon dioxide amount in ENV0201 within 2 per cent. The results are shown in Table 9.1.

Table 9.1: CO_2 emissions from HGVs by vehicle type

Vehicle type in gross weight	Average mpg	Billion vehicle miles	Billion gallons	% of total HGVs
Rigid				
3.5 to 17 tonnes	12.1	5.3	0.44	23%
17 to 25	9.2	1.2	0.13	7%
>25	6.5	1.2	0.18	10%
Sub total		**7.7**	**0.75**	**40%**
Articulated				
3.5 to 33 tonnes	8.8	0.7	0.08	4%
>33	7.9	8.3	1.05	56%
Total artic		9.0	1.13	60%
Overall total			**1.88**	

Sources: MTRU calculations from TRA 3105, ENV0104

The total can be converted to kilograms of carbon dioxide using 10.1 kilograms per gallon: 19 million tonnes.

The total from ENV0201 is 18.6 million tonnes carbon dioxide.

While there remain uncertainties over absolute values, the percentage shares are considered robust.

9.2 Trends in HGV emissions

There is little evidence of major improvements in average fuel consumption from CSRGT, which tends to vary from year to year, although there may have been a small improvement (1-2 per cent) between 2012 and 2015, the years for which comparable data is available.[32] This is shown in Table 9.2 on page 50, extracted from DfT Table TSGB0304.

The introduction of Euro V standards in 2008 and Euro VI standards in 2013/14 in fact saw a very slight increase in carbon dioxide emissions per kilometre due to engine modifications to improve air quality.[33] The replacement of older vehicles with the latest Euro VI HGVs is therefore unlikely to reduce fuel use by a significant amount.

Table 9.2: Average heavy goods vehicle fuel consumption: Great Britain, 2012-2015

	Net weight (tonnes)	2012	2013	2014	2015
Rigid vehicles	Over 3.5t to 7.5t	13.2	13.4	13.6	13.8
	Over 7.5t to 14t	11.9	11.5	11.3	11.9
	Over 14t to 17t	9.5	10.4	9.8	10.5
	Over 17t to 25t	9.4	9.4	9.4	9.2
	Over 25t	6.3	6.2	6.5	6.5
	All rigid vehicles	**9.0**	**8.9**	**8.9**	**9.1**
Articulated vehicles	Over 3.5t to 33t	8.9	9.0	9.0	8.8
	Over 33t	7.7	7.7	7.8	7.9
	All articulated vehicles	**7.8**	**7.8**	**7.9**	**8.0**

Source:
Table TSGB0304
(ENV0104), DfT

9.3 Technologies to reduce carbon

While progress is being made in diesel buses which operate in urban and suburban areas, through hybrid engines and regenerative braking, articulated HGVs do most of their travel on motorways (58.8 per cent) and trunk roads (a further 22.7 per cent) and in these conditions such technology does not offer carbon savings over diesel. There appears to be scope for improvement in smaller HGVs, for example 21.3 per cent of travel by two axle HGVs is in urban areas, compared to 5.9 per cent for articulated HGVs.[34] There is likely to be a split in purchasing choices between those who use such vehicles for deliveries or local distribution, and those who have operations involving longer distance movement.

There are a range of other measures which would improve fuel consumption such as driver training, aerodynamic changes to tractors and trailers, changes to tyres and improved refrigeration units, but these will not deliver a scale of change comparable to cars.

9.4 Efficiency and demand management

There is a strong argument to look at other measures which actually reduce HGV vehicle kilometres, in particular those from articulated HGVs. The key reasons are:

1. They will continue to use current engine technology well into the next decade[35]
2. There are lower carbon alternatives to long distance road freight
3. There is scope for making road freight more efficient, i.e. fewer vehicle kilometres to transport the same amount of goods
4. There is scope for supply chain reform to reflect greater priority for energy efficiency rather than competitiveness or instead of substituting 'just in time' delivery for stockholding.

Recent reports have considered the heaviest articulated vehicles and the potential for transfer to rail for longer distance hauls.[36] Both of these suggest potential for reducing HGV kilometres by 19-20 per cent by 2030.

There is currently a charge imposed on HGVs which use UK roads both UK based and from other countries.* This is not related to distance travelled, is at a low level, and was to be subject to EU challenge. It is currently under review by the DfT. Given that other HGV taxes have been reduced or frozen it has little impact on overall demand or efficiency.

*The UK HGV Levy introduced in 2014, raising about £50 million a year

The introduction of a Lorry Road User Charging (LRUC) based on a weight distance tax, such as established schemes in Switzerland, Germany and Austria, would both support mode transfer and encourage internal efficiencies such as a reduction in empty running and an improvement in average load.[37] Empty running remains consistently high at around 28 per cent.[38]

It is unlikely that increasing size or weight limits would lead to a long-term improvement in efficiency without careful pricing strategy. Previous increases have led to early adopters making best use of the increases, but as the vehicles become a standard throughout the industry these benefits fall away and inefficiencies return. The fact that goods have such different densities means that while some commodities have a preferred weight limit, others have a preferred volume limit. One will always less than perfect for the other and thus there is always pressure for change. Pricing should lead to a better matching of vehicle type to load and strong motivation to consolidate loads and to find loads for the return trip to base.

9.5 Scope for reductions 2015 – 2030

Rail transfer alone could produce savings of 19-20 per cent but would require investment, particularly in new capacity not just on the network but in distribution and consolidation centres. Many of the latter are already being proposed or built through the private sector, but with some support from sustainable facilities grants.

The addition of LRUC would support this approach, as well as reflecting the real third party costs of HGV transport. Its implementation should, post Brexit, continue to follow guidelines which make it compatible with the systems used across Europe. However, it could possibly be made easier since the UK would be able to abolish fixed annual duty at the same time without transgressing EU rules.

This report assumes a stabilisation of articulated vehicle traffic at 2010 levels by 2030, equivalent to about 20 per cent less than the 'business as usual' DfT forecast. This would save about 2.5 million tonnes of carbon dioxide equivalent. This is considered realistic – the DfT report considered that a reduction of 4.6 million tonnes was feasible from rail transfer alone. However they used a higher total for goods carbon than this report. Again the percentages are more robust than the absolute figures.

10. Conclusions

While the precise nature of future transport demand is unknown, and the fact that it may be more fluid than in previous decades adds further uncertainty, the direction of travel of new technologies can be influenced by the policies implemented now. Some of these have been explored in this report and are listed in the Summary.

Above all, government needs to make an overall commitment to achieving the lower end of its demand forecasts for road traffic. This should then be incorporated as an overarching principle in its current guidance (such as the NPPF) and any future guidance on transport or planning, including shipping and aviation.

The final goal is to achieve environmentally sustainable development, which will need clear and decisive action in the face of a rapidly changing social, economic and technological context.

Summary of policies and possible outcomes

Policy inputs for carbon/congestion

M is first 10 years, L is 10 to 25

Bulk freight

M LRUC leading to better utilisation on trunk hauls

M Creation of new GB freight network with longer trains and consistent gauge

M Motorway connected depots (Strategic Road Freight Interchanges)

M Use of SRFI/SRdFI/Gateways to transfer freight to zero emission HGVs

L Larger HGVs + platoons motorways only (contingent on LRUC)

Retail distribution

M Increasing use of electric vehicles

M Short haul electric HGVs from road/rail depots

M/L 3D printing (all levels)

Local delivery

M Specific new electric fleet for areas other than highly rural

M 3D printing (mid to low levels of complexity)

M/L Home 3D printing*

M Drones (mainly on-road working from vans)

Car tech

M Connected autonomous cruise control on motorways*

L Connected semi-autonomous vehicles majority all roads*

L Autonomous and connected vehicles majority*

M Increase in hybrid vehicles*†

L All electric vehicles dominant in the fleet*†‡

Road tech

M Use of data to control routeing – extend smart motorways tech and coverage

M/L Extend active signal control across all urban areas

M/L Develop comprehensive system for parking space booking/management

Land use

M/L Encourage densification (planning, rates, use of site area to determine parking places)

M/L Localisation (rates, planning)

M/L Closer links between housing and public transport (Smart Growth etc)

M 5G and broadband expansion

Notes:
*Opportunity for tax incentives/ disincentives, but potential distributional issues

†Power connectivity issues in urban areas

‡Peak power supply issues

Direct demand management: national

M Revisions to first year VED to encourage low emission choices

M/L Road user charging (integrated into AVs from the start)*

M National multi-modal e-fares

M Parking space charge above minimal levels

M Move in expenditure from road capacity to technology infrastructure and road maintenance

Direct demand management: local

M/L Active Travel (health benefits from non-motorised modes)

M/L New governance for transport in the conurbations combined with per capita funding increases for public transport and for developing mass transit

M/L MaaS extension to urban areas outside major cities (includes car share, Uber, PT info, via smartphones)*

M/L Development of new rural transport packages using new technologies in different ways, for example a wider spectrum of shared transport services and a MaaS rural approach

M/L Local workplace parking levies linked to mass transit funding (as Nottingham)

Measuring carbon emissions

M Realistic assessment of loss of tax revenue versus emission reductions

L Carbon content charge to include international transport

Overall outcomes

1) Less congestion and overall more predictable and plannable car journeys

2) All the benefits from lower emission vehicles captured and not eroded by traffic growth

3) Freight system makes significantly higher reductions in carbon emissions than is possible under 'business as usual'

4) Car use extended while personal ownership falls

5) Road transport becomes safer

6) Road travel time may become more usable

7) Improved facilities for, and increases in, walking and cycling and use of mass public transport in urban areas

8) New rural travel opportunities without owning a car

9) National short term growth in traffic followed by stabilisation in about 2030 and then modest reduction to a level around that of today (2015) by 2040. Rigid HGVs may show a small increase within this picture

10) Loss of fuel tax revenue compensated by user charges for CAVs and LRUC.

Areas for concern

1 Electricity distribution network issues in areas of potential high and peaked demand

2 Distributional issues – both from user charging and high cost of new vehicles.

Annex for 2030

Forecasts for 2030

This annex sets out more detail on how the carbon emission forecasts were calculated. The first comment must be that the level of uncertainty for future emissions forecasts increases rapidly as the time period increases. For example, the time for replacement of the current car fleet is about 15 years (average age 7.8). Thus in 2025 a large number of vehicles operating will be those purchased from now to 2020. Given the state of the current market and model availability, current trends will continue but not transform the market. While less certain, it is very likely that between 2020 and 2025 a wider range of very low emission vehicles, improvements to electric car charging infrastructure, and some policy measures, could lead to a dramatic uplift in very low emission vehicle sales. This still takes time to work through the total UK car fleet (the 'parc'). The model used for this report for total fleet emissions (unadjusted for traffic increases) runs until 2025. It distinguishes four types of car: petrol, diesel, plug in hybrids and electric only. The petrol and diesel categories include the growing number of non-plug in hybrids. This is how the emissions in these categories fall significantly.

For 2025 to 2030 the uncertainty increases, for example the market choice of the distance a plug in can drive without support from its diesel or petrol engine is an important factor in its total emissions. To produce a reasonable estimate the 2025 improvements have been extrapolated from 2025 but accelerated by assuming that the rate of reduction in emissions per vehicle of the total car fleet between 2025 and 2030 is double what it was from 2015 to 2025. This produces a plausible new vehicle scenario as follows:

Annex Table: 2030 emissions and market share by type of vehicle, MTRU estimate

	Average emissions	Market share
New vehicles	52.5 gms/km (116.5 mpg)	1,430
Electric only	0	20%
Plug in hybrid	50	30%
Hybrid and conventional	75	50%

It should also be noted that there are now figures for 2016 which show that the rate of progress in terms of new car emissions has in fact slowed down significantly. The average new car emissions in 2016 fell from 121.4 gms/km to 120.1 gms/km. To meet EU target of 95 gms/km for new cars by 2020, on average the fall should be about 4.75 gms/km per year. As set out earlier in the report, such failure to reduce fast enough, early enough creates a deficit which needs to be compensated for. Again the reliance on vehicle efficiency alone means that the required level of reduction over the whole period is less likely to be met.

The figures also assume that the plug in hybrids have a rating of 50 gms/km, 131 mpg. The best so far measured from the Which tests is 85 mpg (up to 25 miles on battery – this seems to be the industry's consensus). This is therefore also challenging.
The average for new cars today (2016) is 120.1 gms/km – 55 mpg.

The 50 per cent share from electric vehicles and plug in hybrid electric vehicles in the above calculation is somewhat lower than the CCC estimate of 66 per cent but there must be considerable uncertainty over the balance between plug in and non-plug in hybrids. Most of the conventional category will have to be non-plug in hybrids and the Government has set the limit for the sale of conventional cars at 2040.[39] The relevance of this target must be called into question but more important will be the policy framework put in place before then, in particular in the next five years. Either the CCC or the more cautious estimate for this report are very challenging in the light of the current state of the market and the caveats in this report. These are repeated below.

There are at least two serious issues. The first is that the extra economy will traded up to larger cars (there is evidence of this already from the Society of Motor Manufacturers and Traders 2017 report).[10] The second and related aspect is that larger cars travel longer distances. If the consensus plug in hybrid range on battery only is 25 miles, for distances over this level the advantages of a plug in hybrid are eroded as the internal combustion engine is used to provide most of the power.

Finally these calculations all exclude the carbon emission from power generation. While this has been a convention for some time, a significant increase in demand will inevitably mean the retention of less sustainable generating plants for longer, and have the knock on effect of making the power generation targets harder to reach. This report has not studied the requirements or the implications in detail but at least this should be treated as an important risk factor.

Overall this suggests that the policy framework should work to avoid legacy issues, such as a large number of more powerful internal combustion engine hybrid and plug in hybrid cars, by encouraging change as soon as possible. This will have to be accompanied by measures to reduce the amount of travel.

Again the uncertainty involved in achieving such a huge technological change need to be stressed. It is unlikely that all the measures proposed will succeed completely – this argues for a comprehensive and diverse series of actions drawing on both demand management and vehicle efficiency. In this sense it is no different from other areas such as energy or water, where such a combined approach is already the basis for progress to be made.

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37 MTRU LRUC report, 2011

38 FTA Logistics Report 2016

39 UK plan for tackling roadside nitrogen dioxide concentrations An overview DEFRA and DfT, July 2017

Tracks

Tracks is a dynamic Thought Leadership programme that reacts to contemporary issues in the transport sector. The annual programme comprises four themes, linked to current and evolving challenges. 'Environmental quality, climate change and transport innovation' is one theme within the 2017-18 programme.

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