The economic effect of road investment

The necessity & value of upgrading the UK's road infrastructure

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Independent Report Commissioned by the FairFuelUK Campaign

Cebr

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Executive Summary

This report considers the economic and environmental importance of road investment in the UK. Given the concentration of funding towards rail infrastructure in recent years, we evaluate the argument for committing to further expansion and upgrades to the road network. Benefits range from saving commuters valuable work hours and reducing costs for the freight industry to cutting pollution. Having explored the direct and indirect effects of road transport in the UK, the key findings of the research are:

- **Roads are the most important element of the UK's transport system -** in 2015, 89% of all distance travelled was made on roads, 83% of which was by car.
- **Long-term trends show road use has risen considerably over time -** total miles travelled by road increased almost ninefold from 1950 to 2015. Yet, road length grew just 33% over this time.
- **While fuel price rises and recessions have slowed car usage in the short-term, road use is on the up -** total traffic volume on UK roads will increase 12% between 2015 and 2025.
- **Rail investment is almost nine times that of road investment per mile –** £186,000 was spent on rail infrastructure for every million miles of passenger travel, compared to £21,000 for road spending.
- **The average delay on the UK's Strategic Road Network,** responsible for around two-thirds of all haulage, was 9 seconds per mile in 2016, or 4.9 days lost per person in the UK.
- **Congestion is extremely costly to the UK economy –** delays costs drivers lost wasted time and petrol, as well as pushing up the cost of doing business. We estimate the total cost of road congestion to be £307 billion from 2013 to 2030 in the UK.
- **Road congestion in cities holds back local growth –** in the UK's top ten most congested cities, at least 30% of time is added to the average journey by car through delays.
- **Road investment is better value for money –** Road investments return average benefits of £4.50 in per pound spent, compared to £2.83 for rail.
- **Well targeted road investment reduces congestion –** Technology such as Active Traffic Management systems can help reduce delays cost-effectively.
- **Had the same investment of HS2 been spent on road**, based on historic averages for road investment, there would be benefits of £251 billion. For the cost of HS2, it would be possible to widen over 1,900 miles of motorway, every motorway in England.
- **A smart Active Traffic Management system could be applied to every UK motorway,** yielding benefits of £117 billion, for just over a third of the cost of HS2.
- **Low-emission vehicle use is on the rise –** In 2017, alternatively-fuelled vehicles made up over 4% of new car sales. By 2040, the government aims for every new car bought to be a low-emissions vehicle.

Introduction

By some distance, roads are the most important element of Britain's transport network. Carrying almost nine-tenths of all travel, roads play an indispensable role in economic growth. Whether connecting industries to key supply chains, or bringing new job opportunities to workers, roads are integral to national connectivity and productivity.

The use of Britain's roads has grown significantly over time, along with economic growth and greater household access to private vehicles. From 1950 to 2015, total traffic on Britain's highways and local roads rose by almost ten times. Although other forms of transport have grown in prominence, roads remain the foundation of transport in UK.

Yet, on recent evidence, investment into the UK's roads is taking a backseat. Eye-catching rail projects have caught the imagination over the past decade, but they have also consumed the bulk of the budget. The disparity between rail and road investment is now wider than ever - in 2016, the amount spent on railways per mile travelled was nearly nine times that spent on roads.

It is little wonder then that the UK's highways lag behind European counterparts. Having built a total of just 46 miles of new motorway between from 2000 to 2009, the UK's road infrastructure is now ranked 27th in the world, 11 places behind Germany and 21 behind France.

With the economic importance roads play in keeping Britain connected, the cost of congestion is high. By delaying drivers, polluting cities, and pushing up the cost of doing business, traffic puts the stoppers on the British economy. We estimate the cost of congestion will amount to £307 billion between 2013 and 2030.

The UK's highways are especially important for the freight industry, which requires roads for around 70% of all haulage. Road freight contributes over £11 billion to the UK economy annually, reliant upon the UK's Strategic Road Network, which was built from the 1930s to the 1960s but now carries vehicles over 87 billion miles a year.

Some have claimed that car use has peaked, and that use of Britain's roads is on the decline. A deeper look into trends shows that road usage in again rising. Traffic on Britain's roads is set to increase in the coming decades, exerting further pressure on the UK's ageing road infrastructure and exacerbating the problems of congestion and pollution.

It this report, we discuss not only the necessity but the value of road investment. While other forms of transport offer unique advantages to the national transport system, numerous appraisals have highlighted the comparatively higher benefit to cost ratios of road investment. Well-targeted road investment can help alleviate the problems of congestion. Furthermore, technological advances can help streamline Britain's highways, and low-emissions vehicles are helping making road travel increasingly environmentally friendly.

This report considers a variety of systems which could be utilised through greater investment into the UK's road network. We find that road investment, bringing modernity and efficiency to the country's main transport system, is not only cost-effective but essential to promote economic growth.

This report is structured as follows:

- **Section 1** considers established and emerging trends in the UK's transport network, and analyses investment into roads and railways.
- **Section 2** examines the cost of congestion to the UK economy.
- **Section 3** compares the value for money of road and rail investment, by analysing different benefit-to-cost ratios for such projects.
- **Section 4** examines the environmental impacts of transport and analyses the potential of low-emission vehicles.
- **Section 5** draws conclusions from the preceding analysis.

1 Trends, investment & forecasts: road and rail

Although roads carry nearly nine-tenths of all passenger travel and car use is on the up, railways receive nine-times the amount of spending per mile travelled than roads.

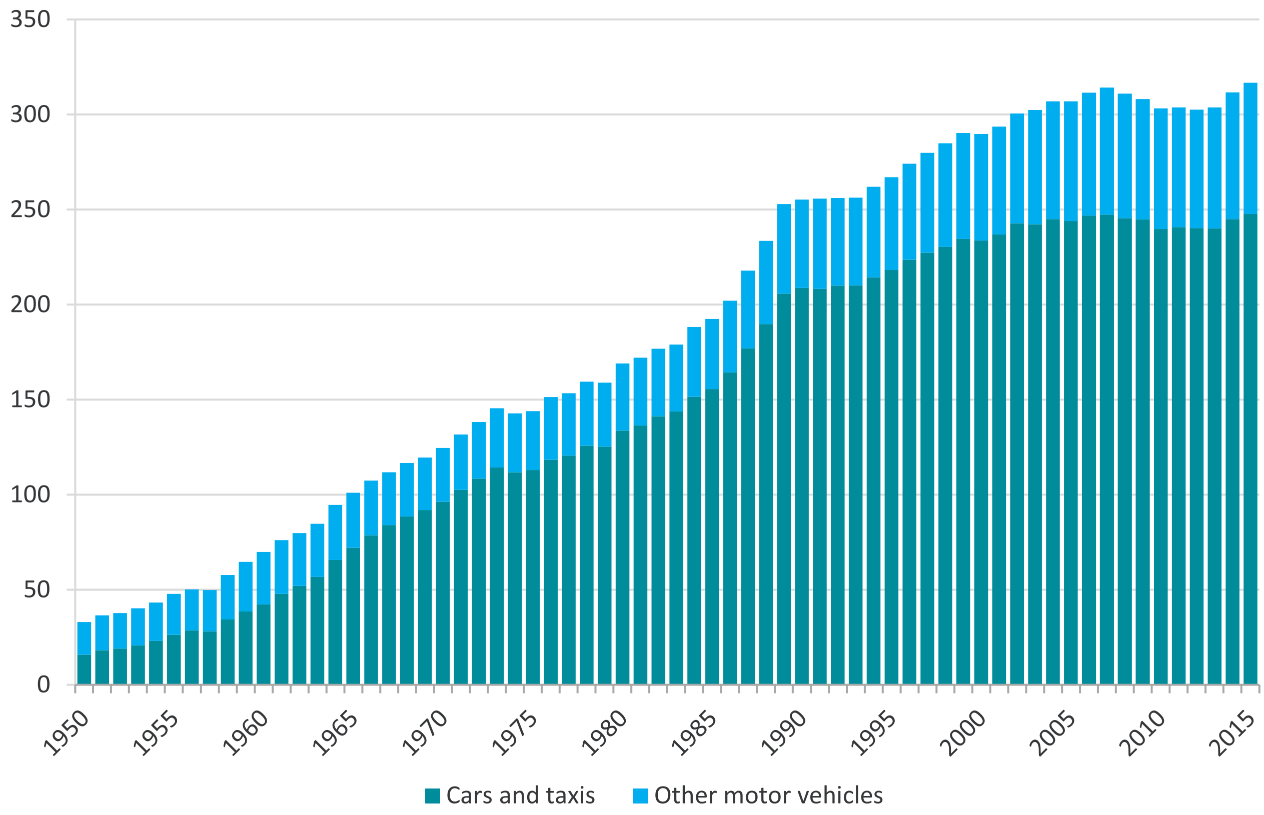
The UK's roads are the most important part of the national transport system. Whereas 10% of all travelled distance in 2015 was made by rail, 89% was covered on roads (the remaining 1% was made by air). Of the 493 billion total miles of UK travel made in 2015, 83% of this was travelled in cars, vans and taxis.

There are a number of emerging and established trends in the transport sector, affected by changes in demographics, attitudes and technology. Analysing these trends can help inform current policy as well as build projections for the future, to help highlight areas which require investment.

1.1 Historic and recent transport trends in the UK

Over the long-term, use of Britain's roads has grown massively. This is due mainly to a greater number of cars on the roads, as household access to private vehicles has improved, and also down to increases in average journey length. In terms of distance travelled by motor vehicles, total traffic on Britain's roads rose over 860% from 33 billion miles in 1950 to 317 billion miles in 2015. Of total vehicle distances travelled in 2015, 248 billion miles were made by car.

Figure 1: Road traffic (billion miles travelled) by vehicle type, 1950 to 2015



Source: Department for Transport (2016)

At the same time, whilst car passenger distances have seen more than an 11-fold increase, total road length has risen by only 33% from 1950 to 2015. From 2000 to 2009, just 46 miles of new motorway were opened across the UK. In this time, the Netherlands opened 225 miles of motorway, France opened 850 miles, and Germany 680 miles[1]. In 2015, there were 246,000 miles of road in the UK, less than a 0.1% increase from the previous year.

1.2 Is road use falling?

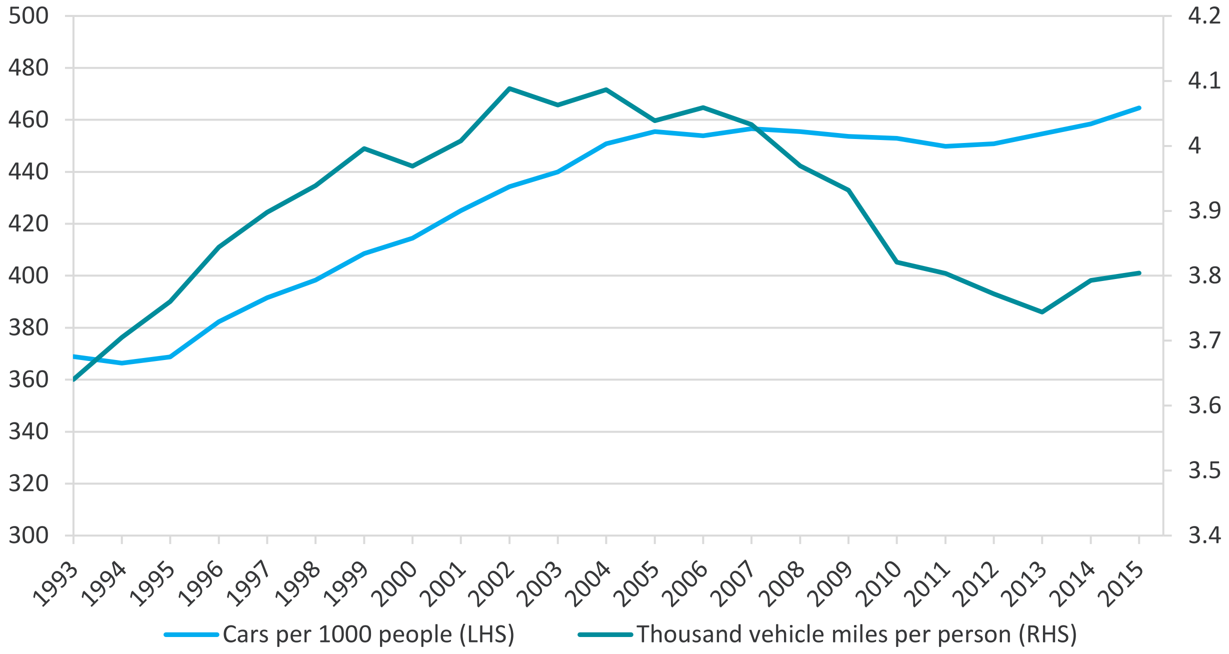
Over the past 20 years, travel by rail has increased considerably – from 1995 to 2015, total annual distance travelled by rail increased from 23 billion passenger miles to 48 billion. Travel by car, van and taxi has also increased over this timeframe, but by a smaller amount, and has fallen by bus.

While the share of total distance travelled by car has remained high, growth in road use has slowed over the past two decades. In particular, in the mid-2000s, car usage began to decline in consecutive years. In 2007, for every thousand Brits, there were 457 cars; this figure was to fall in the three subsequent years.

With distance travelled by car per person falling, and car ownership seemingly on the decline, 'peak car' theory began to emerge. The theory states that distances travelled by motor vehicles have passed their peak in Western developed economies. This idea began to gain traction as road passenger miles fell in the UK and US around this time.

The idea that car usage in UK will either remain static or decline may have influenced transport investment. Around this time, a higher share of transport investment began to be directed towards rail infrastructure. Yet, a deeper look into 'peak car' theory shows that short-term trends of slowing car usage may not imply a longer-term trend, especially when wider historical factors are considered.

Figure 2: Cars owned per thousand people (left); thousand miles travelled by car per person (right), 1993-2015



1 Department for Transport (2013) Action for Roads – A network for the 21st century

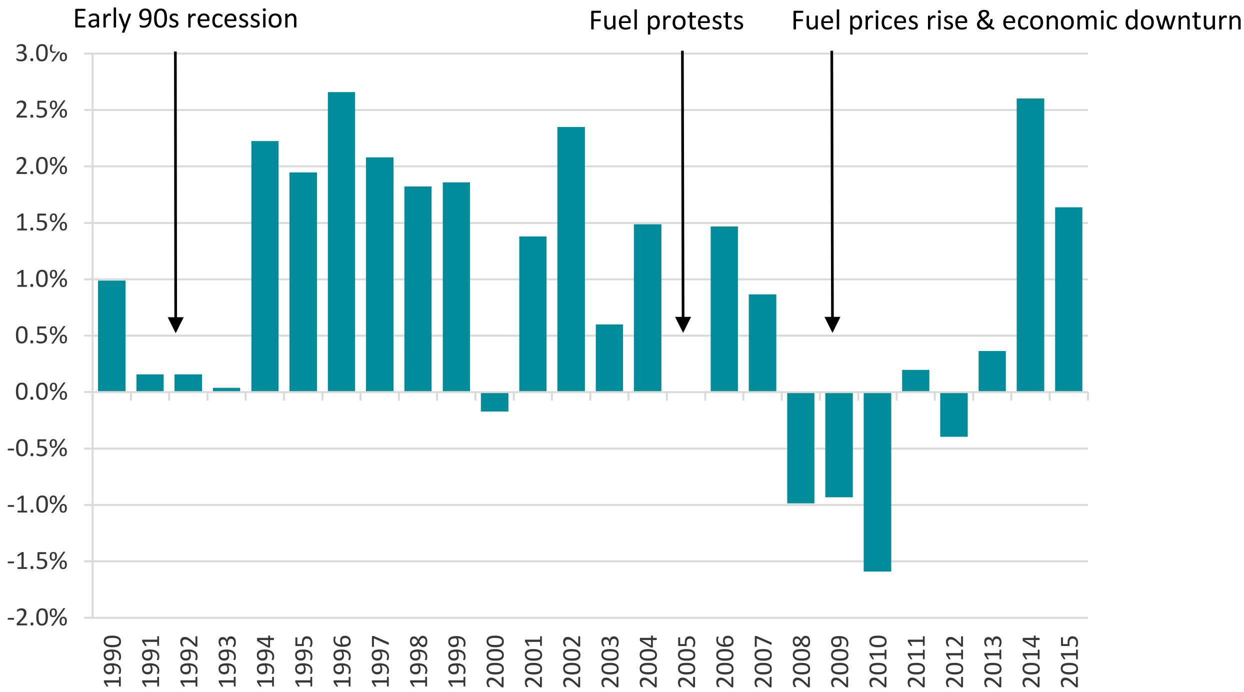
Source: Department for Transport (2016)

Typically, popularity of roads and private cars are considered to follow economic growth and greater financial access to vehicles (or lower costs of running them). In recent decades, it has been claimed that the relationship between vehicle ownership and economic fundamentals has been broken due to social and demographic shifts.

Factors include the falling number of firms offering company cars, the changing societal status of cars, and young people staying in the family home for longer – indeed, there have been major decreases in car ownership among the young[2]. These trends, it is argued, are embedded and will lead to declining, or flatlining, car use over time. If road use is falling, other forms of transport are likely to take the place of road, thus encouraging higher investment into other transport networks, such as railways.

However, a wider look into the theory against historic trends reveals that economic fundamentals may still be the leading factors behind road use. Over the past 20 years, the three significant falls in annual road usage have followed or coincided with economic recessions or fuel price hikes. As figure 3 illustrates, both recessions of the past 20 years have been followed by falling or slower growth in road use. Notably, the sharpest fall was seen after the far deeper, recent recession of 2008-2009. With unemployment rising as high as over 8% after this recession, it is understandable that private car usage would fall (as is shown in Figure 2). Furthermore, higher oil prices at this time were also likely to have deterred consumers from road travel.

Figure 3: Year-on-year growth in road vehicle traffic, 1990 to 2015



Source: Department for Transport (2016), Cebr analysis

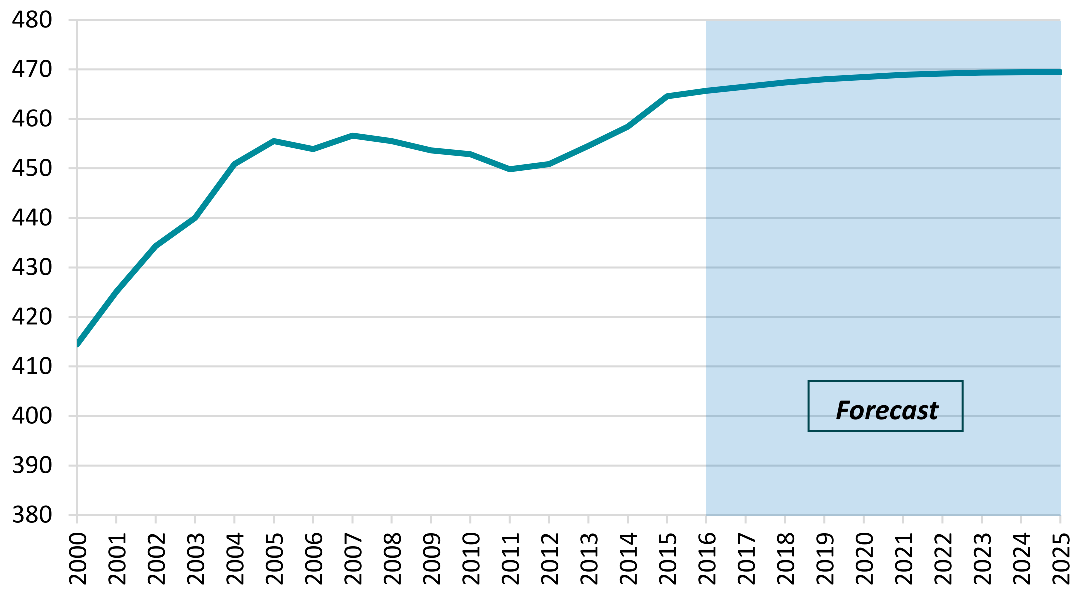
2 Houses of Parliament (2015) Trends in Transport

If wider economic downturn is a leading factor behind declining road travel, then it would be expected that road usage would recover in times of economic growth. This corroborates with the evidence, with road traffic rising in times of higher, consistent economic growth. In recent years, as UK GDP growth has recovered, use of roads and car ownership has grown again. Cars per thousand people rose to 466 in 2015, well above levels before the 2008 recession, and further growth is forecast.

The latest data from SMMT shows that new car registrations hit 174,564 in January 2017, the highest levels since 2005, representing a 2.9% year-on-year rise in total car sales[3]. This seems hard to reconcile with 'peak car' theory, but makes much more sense within a traditional understanding of road usage.

Going forward, the Department for Transport predict between 2015 and 2025, total traffic volume on Britain's roads will rise 12%, and privately owned cars per 1,000 people are set to increase too, as shown in Figure 4.

Figure 4: UK cars per 1,000 people, 2000-2025



Source: Department for Transport, Eurostat, ONS Population Projections, Cebr analysis

1.3 Investment into road and rail

In light of rising road traffic in recent years, and with more growth forecast in the future, in 2015 the government laid out an investment plan for Britain's roads worth approximately £15 billion by 2021.[4]

The plan focuses on the UK's Strategic Road Network, or SRN, which carries around a third of all road traffic despite comprising only 2% of the country's roads by length. The investment, which aims to modernise the SRN, shorten journey times and improve safety, is much needed. Across the 1990s, annual spending on trunk roads fell to £0.4 billion per year[5]. This underinvestment has extended into

3 SMMT (2017) https://www.smmt.co.uk/2017/02/uk-new-car-market-kick-starts-2017-with-milestone-for-alternatively-fuelled-vehicles/

4 Department for Transport (2015) Road Investment Strategy for the 2015/2016 – 2019/2020 Road Period

5 5 Department for Transport (2013) Action for Roads – A network for the 21st century

recent years – in 2010, per capita spending on roads was 40% higher in Germany and 75% in France than in the UK[6].

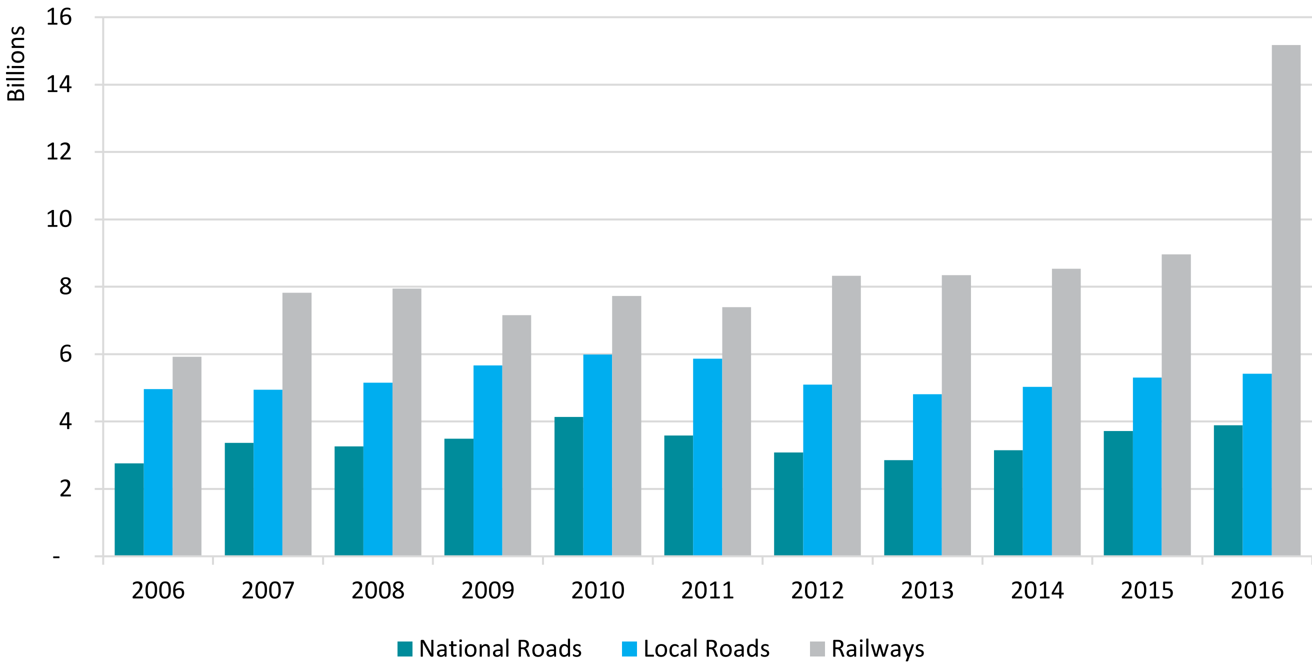
As a result, the UK's road network lags behind that of European counterparts. In 2017, the World Economic Forum's placed Britain's road infrastructure 27th in the world, its lowest ranking of nine infrastructure indicators; Germany came 16th, France came 6th.[7]

The Government has recognised the progress the UK's roads must make. On top of the National Roads Fund announced at the Summer Budget of 2015, in his 2016 Autumn Statement 2016, Chancellor Phillip Hammond assured an additional spending of £1.1 billion from the National Productivity Fund to 'relieve congestion and deliver much-needed upgrades on local roads'.

However, although government rhetoric has consistently restated the importance of Britain's roads and recognised the need for investment, actual commitment has been less easy to discern. Road building fell between 2011 and 2013[8], and other much-needed road projects have been delayed repeatedly.

Instead, the majority of transport spending in recent years has been devoted to rail travel. As Figure 5 highlights, this trend is becoming more pronounced, and higher spending on rail is leaving less for the UK's roads. In 2006, total public spending into railways was just over twice the amount invested into national roads. In 2016, the total spent on was £15.2 billion, almost four times the £3.9 billion on national roads.

Figure 5: UK public expenditure on transport by function



Source: Department for Transport

6 Department for Transport (2015) Road Investment Strategy: for the 2015/16 – 2019/20 Road Period

7 WEF Global Competitiveness Report 2016-2017

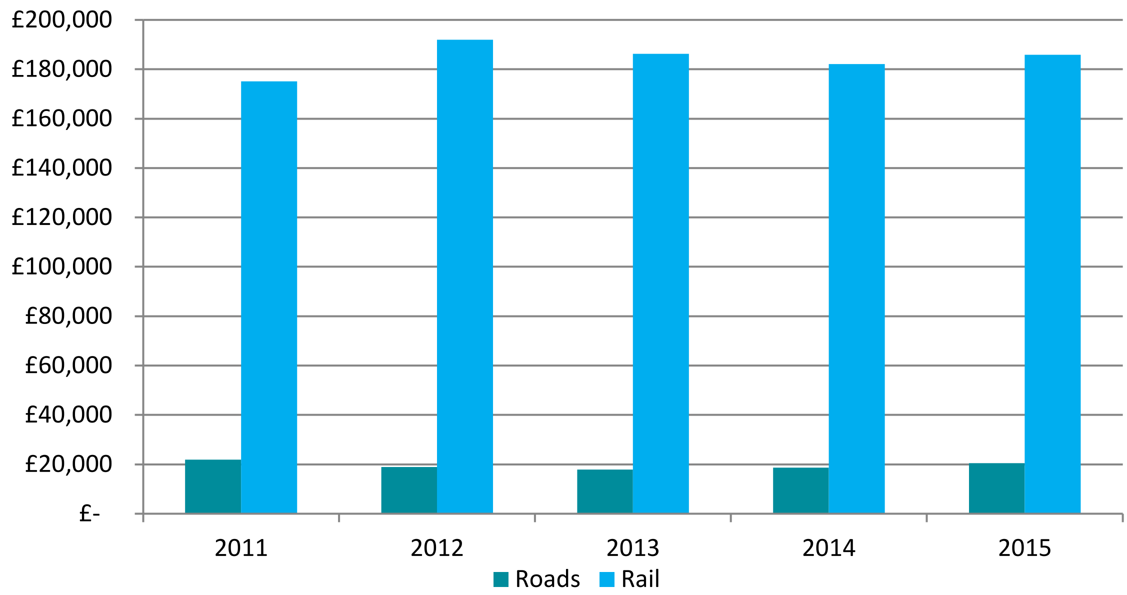
8 Financial Times (2014) https://www.ft.com/content/a50158ee-52de-11e4-a236-00144feab7de

Investment into the UK's roads has remained relatively stable over the past decade. By contrast, spending on rail projects has been steadily rising. This is due to recent large-scale rail projects, such as London's Crossrail and High Speed 2 (or HS2).The total cost of Crossrail – Europe's largest construction project – is estimated to be £14.8 billion and the long-term cost of HS2 is £55.7 billion. As will be discussed in Chapter 3, the returns for these projects are significantly lower than the typical benefits relative to cost for road projects.

Furthermore, the high level of spending into rail projects does not align with their share of usage in the national transport system. Figure 6 illustrates the disparity between investment in road and rail per million miles of travel. In 2016, £186,000 was spent for every million miles of British passenger rail travel, almost nine times the £21,000 spent for every million miles of road travel.

In the next two chapters, we analyse whether this represents a reasonable return, given the economic and environmental cost of congestion to Britain's highways and roads, and the benefit-to-cost ratios of different projects.

Figure 6: Public investment into road and rail per million miles of passenger travel, 2011-2015



Source: Department for Transport, Cebr analysis

It is true that spending on rail infrastructure has also coincided with increased usage. Over the last 20 years, the annual number of rail journeys has doubled. The fastest growth in rail travel has been seen in commuter travel, but freight movement by train is also increasing, at around 2.5% per year for the last 20 years. Rail travel currently accounts for around 9% of all freight movement; road accounts for 76%.

However, whilst travel by rail is playing an increasing role within the national transport system, it is still dwarfed by the share of transport on Britain's roads. Despite this, train infrastructure is apportioned a far larger share of the national transport infrastructure budget. In the following sections, we assess whether investment into railways is cost-effective in terms of the benefits to the UK's transport system and economy, and whether the necessity and value is higher for spending on Britain's roads.

2 The cost of congestion

Congestion on Britain's motorways wastes almost five days per person every year. Traffic delays cost people valuable time, extra consumption of petrol, and increased cost of doing business. Between 2013 and 2030, congestion will cost the economy a total of £307 billion.

Gridlock is detrimental to any economy. In particular, within Britain, where roads are the lifeblood of national travel and freight, the cost of congestion to the domestic economy is extremely high.

The direct costs of congestion equal the value of the wasted time spent sitting in traffic, as well as the fuel wasted due to delays. Indirect cost include the increased cost of doing business due to traffic; for example, it is more costly to transport goods in heavily congested cities and more time-consuming to attend business meetings if delays are likely. As well, unreliability of roads increases 'planning time', as road users take account of the possibility of traffic (particularly during peak times), adding time onto journeys. These costs are passed onto consumers through higher prices for final goods and services.

We also consider the environmental cost caused by stationary, idling vehicles. The fuel consumed in traffic results in higher greenhouse gas emissions, pollutants and poorer air quality, especially in urban areas. The cost of this to national health is considerable, and will be discussed further in section four.

2.1 Time cost of road congestion on the SRN

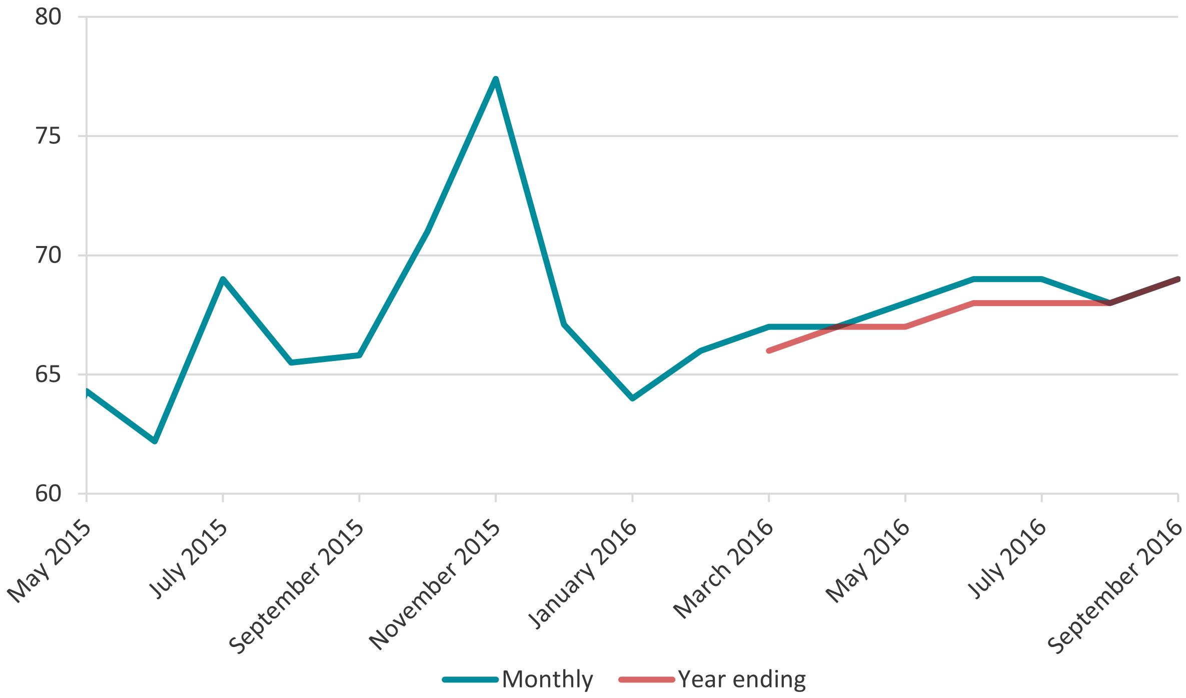
The UK's Strategic Road Network (SRN) comprises over 4,300 miles of motorways and major 'trunk' A-roads. Although making up just 2% of the UK's total roads, the SRN carries two-thirds of the UK's freight. The SRN is vitally important to the UK's haulage industry, and heavy goods vehicles (HGVs) travel more miles on SRN roads than on locally managed roads. Use of the SRN has also grown considerably in recent years, with a 45% increase in light goods vehicle usage of the network since 2000.

In the year to September 2016, the average delay on Britain's Strategy Road Network was 9 seconds per mile. Assuming road traffic growth of 1.2% from 2015 to 2016 (in line with the Department for Transport's projections), there will be a total of 413 billion passenger miles covered on the UK's roads in 2016. Therefore, such delays will amount to 4.9 days lost from traffic delays per person in the UK in 2016.

Including the Planning Time Index – which calculates time added to journeys through expected delays - an additional 69% of time was also added to drivers' journey times[9] in the year to September 2016. As Figure 7 illustrates, the additional time factored in by drivers, due to possibility and expectation of delays, is on an upward trajectory. In five of the six months for which there is comparable 2015 data, additional time on the SRN had risen year-on-year in 2016.

9 Department for Transport, November 2016 - Travel time measures for the Strategic Road Network, England: October 2015 to September 2016

Figure 7: Reliability of travel times time on the UK's Strategic Road Network, % additional time, May 2015 –September 2016



Source: Department for Transport

2.2 Congestion in UK cities

While there is a considerable cost to traffic delays on the UK's highways, the most concentrated effects of congestion are to be found in the UK's cities. The TomTom 2016 Traffic Index showed that, in each of the top 10 most congested UK cities (see Figure 8) road traffic leads to at least 30% of average added travel time, compared to a free-flow traffic environment.[10]

The most congested city in the UK, according to the 2016 TomTom Index is Belfast. Congestion causes an additional 40% of travel time on the city's roads, rising to highs of 86% time added during peak congestion hours. As a result, drivers in Belfast waste an average of 195 hours a year in traffic - an extra 51 minutes every day being spent waiting behind the wheel, on top of their journey time without traffic.

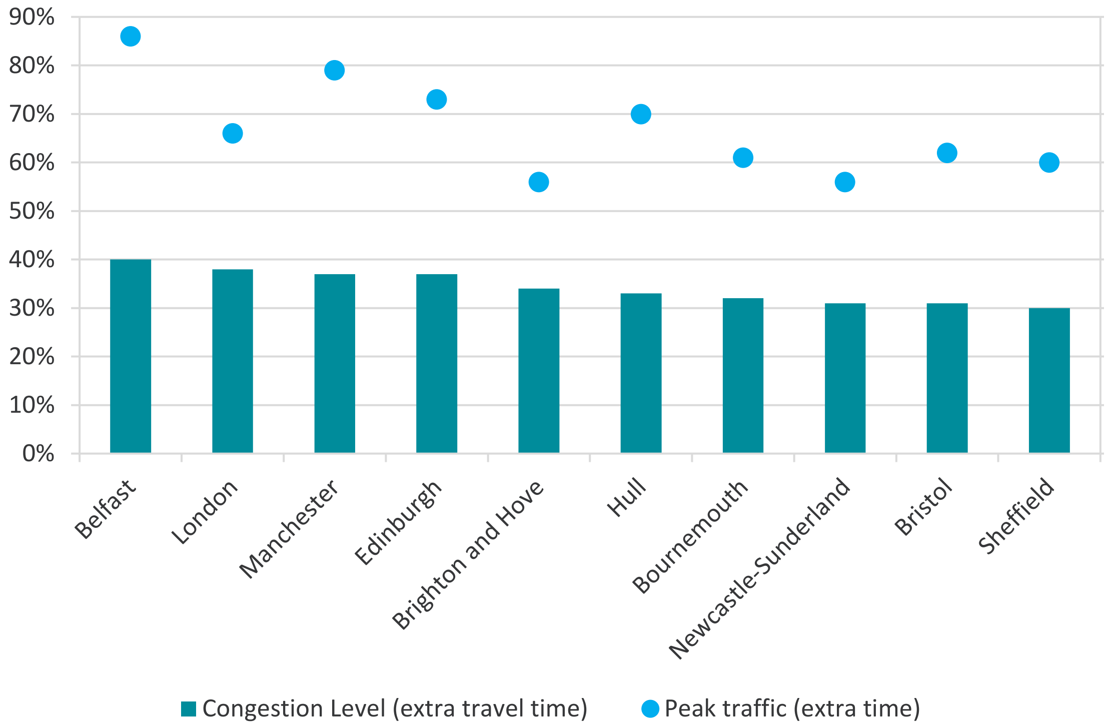
Congestion is causing significant harm to the economies of UK cities. Congestion in the capital has been exacerbated by construction work, population growth, the rise in private hire vehicles and delivery vans, and long-term declines in road space. The total annual vehicle delay on London's roads between 2014 and 2015 was 13,135 million minutes. In 2016, road traffic added 38% on the average journey on London's roads, which increases to 66% in the evening peak, according to TomTom. According to INRIX, the total cost of congestion in London was more than £6 billion in 2016.[11]

10 TomTom Traffic Index, 2016 - http://www.tomtom.com/en_gb/trafficindex/

11 INRIX (2017) http://inrix.com/press-releases/traffic-congestion-cost-uk-motorists-more-than-30-billion-in-2016/

Manchester is the third most congested city in the UK. Drivers spend an additional 37% of time on journeys due to road traffic, amounting to 169 hours per driver over the course of 2016, making it the 25th most congested large city of 174 on TomTom's Traffic Index worldwide.[12]

Figure 8: Top 10 most congested UK cities, 2016



Source: TomTom Traffic Index (2016)

In a 2016 study of over 20,000 traffic hotspots across the UK, INRIX calculated the 'Impact Factor' of traffic pinchpoints, by analysing typical duration, distance and frequency of recurrent traffic jams. The total direct cost to drivers at these traffic hotspots, based upon the Department for Transport's 'value of time' assumptions, will amount to £61.8 billion by 2025 if congestion levels are not reduced.[13] According to INRIX, drivers waste the UK is the 4th most congested developed country in the world.

A large share of these traffic hotspots were located in London, but almost 900 were located in Birmingham, over 700 in both Manchester and Leeds, and over 500 in Bristol and Bradford. INRIX found that the implementation of technology, such as Smart Motorway traffic signalling was effective in significantly lowering congestion around such points.

While public transport, such as trains, can be a highly effective method of transport for inner-cities, helping direct workers from suburbs into areas of high employment and business density, in greater city areas, car travel is usually a far more effective method of travel. Public transport is less effective for routes from non-central areas to other suburban areas or outskirts, or orbital transport around cities.

12 Rank of cities with a population of 800,000 or more, based on congestion level, in extra travel time - TomTom Traffic Index, 2016

13 INRIX Road Analytics, 2016 - http://inrix.com/press-releases/inrix-reveals-congestion-at-the-uks-worst-traffic-hotspots-to-cost-drivers-62-billion-over-the-next-decade/

2.3 The economic cost of congestion

Whereas other studies estimate the cost of congestion by examining the direct cost in terms of purely lost time for drivers, Cebr has calculated the total cost of congestion by looking at both the direct costs to drivers and the indirect costs. In a 2014 study on the impact of traffic congestion to households, we considered three sources of **direct cost**:

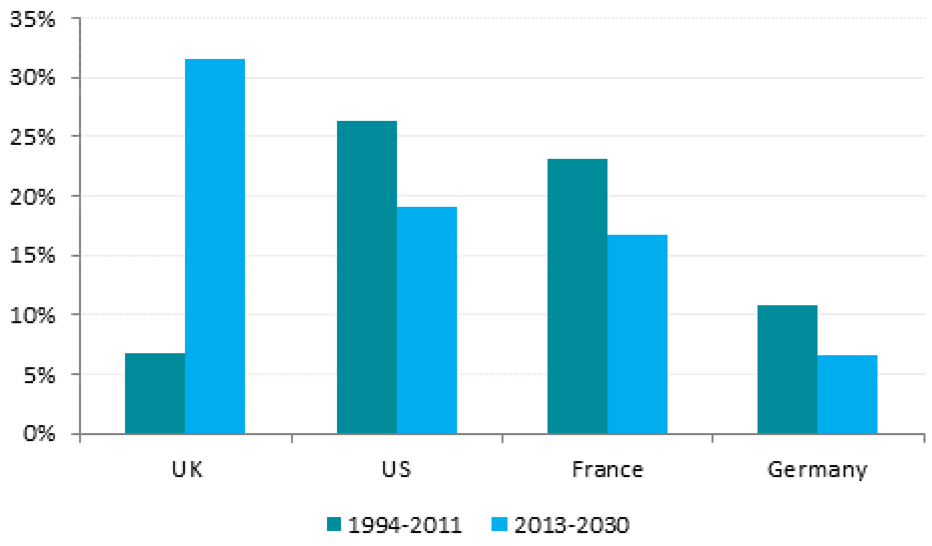
1. The opportunity cost of the time wasted due to delays through road congestion (which includes ‘planning time’ for the possibility of traffic delays);
2. The cost of the wasted fuel whilst vehicles are sat idle in traffic;
3. The impact of traffic congestion on the environment, and social costs involved.

The largest factor of the three is the first – the cost of wasted time in delays, which could have been better spent on another task (the opportunity cost); we restrict this to the direct context of commuters travelling by car.

The study also included **indirect costs** to households. Although the root cause of the indirect costs are the same three as identified above, the subjects of indirect costs are those travelling for business purposes and those transporting freight. Congestion affects these activities, imposing a higher cost of doing business, which is passed through to households through higher prices for consumer goods and services. The higher the congestion level, the greater both the direct and indirect costs will be.

Our 2014 study uses road demand forecasts based upon long and short-term trends and factors of population growth, GDP expansion, fuel and motoring costs and car ownership rates. The change in passenger vehicle-miles in four countries was projected in four countries – the UK, Germany, US and France. As illustrated in Figure 9, the UK is forecast to see higher vehicle growth rates than other markets.

Figure 9: Growth in car passenger vehicle-miles, historic 1994-2011 and forecast 2013-30



Source: Department for Transport, US EIA, OECD International Transport Forum, Cebr analysis

The slower growth in vehicle miles from 1994 to 2011 in the UK is due to the effect of two recessions, a series of fuel price hikes, and heavy investment into rail. However, going forward, population growth and other economic fundamentals are expected to drive growth in demand for road vehicle usage, with UK road traffic set to increase by over 31% from 2013 to 2030.

We calculate the total cumulative cost of congestion in the UK to be £307 billion from 2013 to 2030. Of this, total direct costs are £191 billion, and indirect costs equal £115 billion. By 2030, we estimate the total cost of congestion per household will be £2,057. From 2013 to 2030, the annual cost of road congestion will have risen 63%.[14]

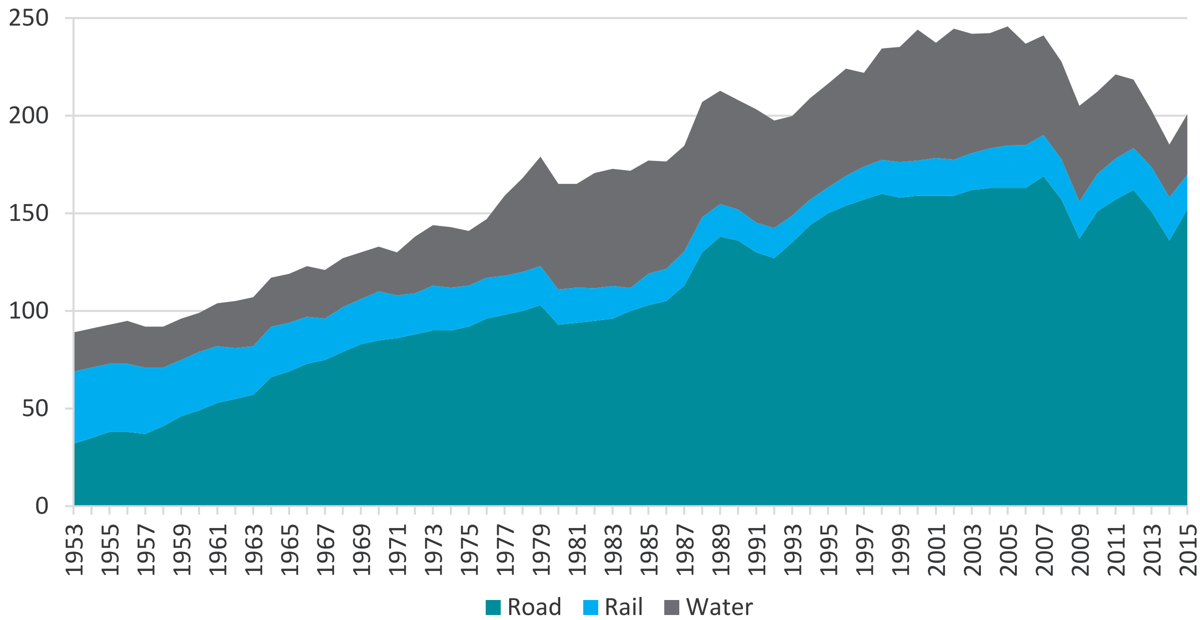
2.4 The impact on haulage & freight

In particular, road congestion has a considerable impact upon the haulage industry, as roads are the main method of transporting freight across the UK. In 2015, 152 billion tonne-kilometres of freight were carried by road. This made up more than three-quarters (76%) of all freight in 2015. By contrast, 9% was carried by rail and 15% by water.

Freight is a highly valuable industry worth over £11 billion to the British economy and employing over 220,000 people. Furthermore, freight businesses have experienced strong growth in recent years: there was a 15% year-on-year increase in road freight enterprises from 2013 to 2014, an increase of more than 36,500 firms.

Therefore, given the central importance of road travel to the haulage industry, the efficiency of the UK's roads are vital to the movement of goods. For this reason, the indirect costs of congestion are very significant. In Cebr 2014's study, indirect costs of road congestion made up 38% of total costs, due mainly to the increased cost of haulage due to congestion, particularly on the UK's SRN.

Figure 10: Goods moved (billion tonne-kilometres) by mode, 1953-2015



Source: Department for Transport (2016)

14 Cebr, 2014 – The future economic and environmental costs of gridlock in 2030

3 Value for money? Cost-benefit analysis of investment

Road investment is typically better value for money than spending on rail, returning far greater economic benefits for every pound spent.

As seen, the lion's share of public investment into transport in recent years has been directed into railways. Prominently, there has been a preference for large-scale rail projects, coming at a high cost – the agreed funding for HS2 is £55.7 billion[15]. But do such projects represent good value for money? In this section, we compare the typical returns of rail and road investment, and examine recent investment into road technology, to analyse further potential benefits.

3.1 Benefit-to-cost ratios

To make efficient use of public funds, the Department for Transport conducts Value for Money assessments on infrastructural projects. The economic case for projects is obtained through the department's guidelines, which take into account wider economic benefits, social and environmental considerations, and the impacts on other transport methods.

Projects are attributed a Value for Money rating based their benefit-to-cost-ratio, or BCR. A project's Value for Money is judged to be:

- Poor if the BCR is less than 1.0
- Low if the BCR is between 1.0 and 1.5
- Medium if the BCR is between 1.5 and 2.0
- High if the BCR is between 2.0 and 4.0
- Very high if the BCR is greater than 4.0[16]

Projects are also assessed against criteria of necessity, commercial viability, financial feasibility and how achievable they are in terms of management and delivery.

In a wide ranging study of over 180 projects, including 93 highway agency schemes, 48 local road schemes, and 11 rail or light-rail schemes, Eddington found that on average road infrastructural projects yield a far greater return relative to their cost than rail investments.

According to the study, the average BCR for rail schemes is 2.83. This compares to an average BCR of 4.66 for investment into Highway Agency roads, and 4.23 into local roads (including widening, road improvement and new road laid)[17].

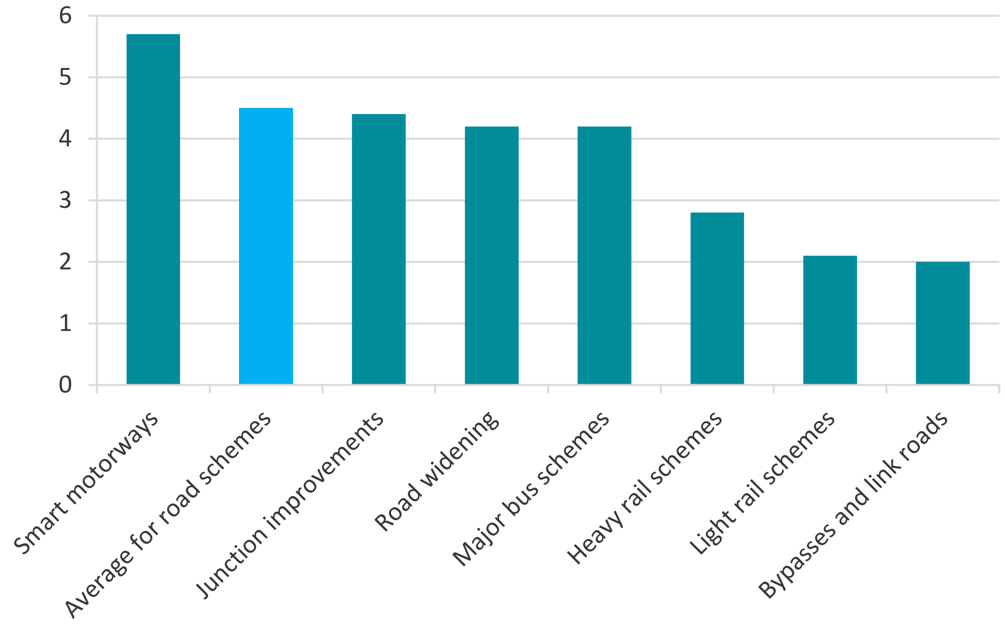
15 Department for Transport (2015)

16 Department for Transport (2016) - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/255126/value-for-money-external.pdf

17 From Dodgson (2009) RAQ Foundation - Rates of Return on Public Spending on Transport (Table 2: Summary of BCR Results from the Eddington Report, by Sector) - a summary of the study can be seen in the Appendix.

The BCRs for road projects were as high as 20.5, in the case of upgrades to the A1 between Peterborough and Blyth. In total, 58 of the 93 road projects in the study gained a BCR of 3 or above, with 40 scoring 4 or above. Therefore, 43% of road projects gained a 'very high' value for money score. By contrast, just 18% of the heavy rail schemes gained a BCR of score of 3 or above.

Figure 11: Average BCRs for rail projects (Eddington), road schemes of different types (DfT, 2015), and major bus schemes



Source: DfT (2015), DfT (2016), Eddington (2006)

Numerous other reports have similarly shown that road projects yield high BCRs. For example, in a summary of road investment proposals conducted by the Department for Transport in 2015, the combined benefit-to-cost ratio of 25 road schemes was 4.5, representing very high value for money under departmental guidelines. In particular, the 15 Smart motorway schemes yielded benefits of £16.3 billion for a cost of £2.8 billion, presenting the highest BCR (5.7) of the four types of schemes – Smart motorways; junction improvements; bypasses and link road; and road widening[18]. Furthermore, a 2016 report from the Department for Transport calculated the average BCR for major bus schemes at 4.2. £4.20 for every pound spends is also considered very high value for money.[19]

With the government aiming to maximise return on transport investment, the comparative difference between road and rail investment is significant. This disparity is especially important given the large proportion of transport public spending which is directed into railways, in particular through large-scale, high-cost rail projects.

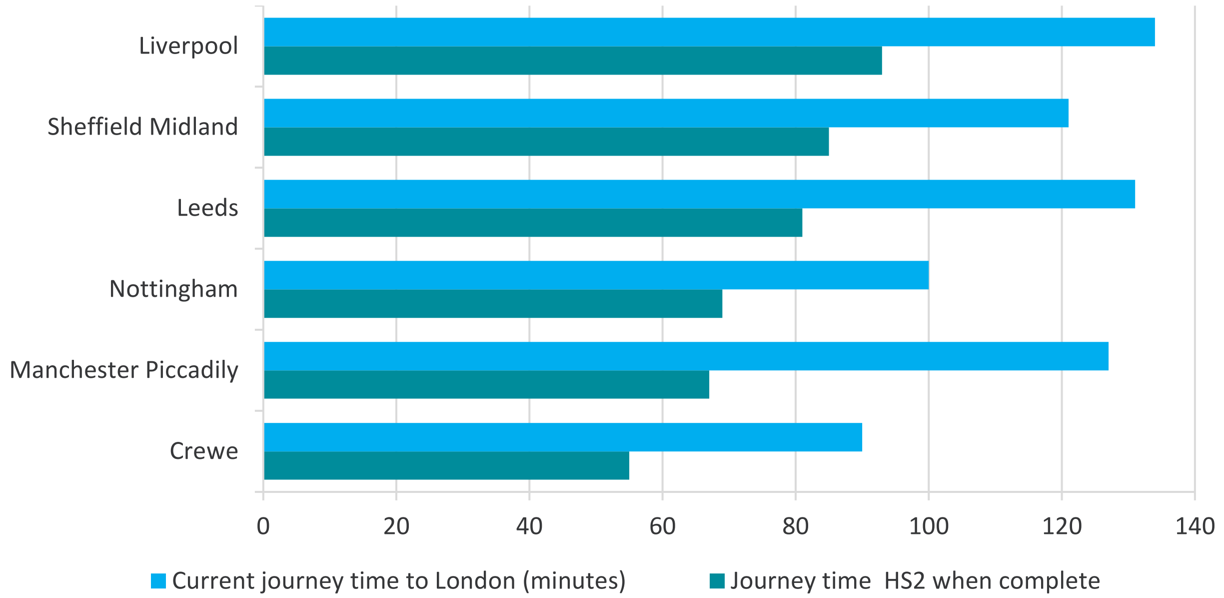
With an agreed funding of £55.7 billion, HS2 will be the largest engineering and construction project ever undertaken in the United Kingdom. The Government's objectives for High Speed 2 are to enable economic growth, address existing and future rail passenger demand, and improve connectivity between

18 DfT (2015) - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/411417/ris-economic-analysis.pdf

19 DfT (2016) - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/503824/Value_for_Money_Assessment_for_Major_Bus-Related_Schemes.pdf

UK towns and cities. Yet, the total economic benefits for the project are comparatively low by transport investment standards.

Figure 12: Time savings from HS2 from selected cities to London



Source: Department for Transport (November 2016)

The estimated benefit-to-cost ratio (BCR) for HS2 varies from around 1.8 to 2.5 for the full Y-network, including wider economic benefits. Phase one of the line, which will run from London to Birmingham, will yield a BCR of between 1.4 and 1.7. This gives phase one of HS2 a value for money rating of between low and medium, rising to between medium and high upon completion of the whole line, due to be opened between 2030 and 2033.

Figure 12 shows the time savings enabled when HS2 is complete. Whilst some of these time savings are significant, these timings do not take into account the journey that customers must take to reach the train stations, which is usually made on roads. This also undermines one of the environmental arguments for HS2, namely that it will reduce congestion as more travellers will use rail over road, overlooking the intra-city congestion arising from passengers travelling to the station to use the railway. Although HS2, upon completion, may bring time savings between cities, it is not clear whether it will help to reduce congestion, or in fact lead to further road congestion in order for people to utilise the network.

We calculate that, using average benefit-cost ratios for road projects, had the same investment currently budgeted for HS2 been directed into road, there would be benefits of £250.7 billion. This is more than four times the expected net benefits of the entire HS2 network.

For the same cost as HS2, it would be possible to widen over 1,900 miles of motorway, enough to widen every motorway in England. For just over a third of the cost of HS2 (around £20bn), a smart Active Traffic Management system could be applied to every motorway in the UK, yielding benefits of almost £117 billion.[20] The expected net benefit of HS2 is estimated to be £72 billion upon completion of the full line[21].

20 Motorway widening costs £18m per km, Active Traffic Management system £5.6m per km - Institute of Engineering and Technology (2011)

3.2 Case studies, technological innovations, and methods of road investment

As discussed in section 3.1, road projects have been seen to offer superior value for money compared to investments into rail. In this section, we examine some of the different types of road upgrade, and assess their value in terms of cutting congestion and minimising time wasted for drivers.

Smart Motorways

Smart motorways utilise a variety of technologies to monitor and respond to traffic flows. These stretches of road use a form of traffic management technology, such as an 'Active Traffic Management' (ATM) system, to moderate flow and lower congestion. Smart motorways were first introduced in 2006 on the M42, as discussed in the case study below. Such technology has since been extended to a number of carriageways in the UK.[22]

The use of the hard shoulder as an extra lane in times of high traffic has been especially effective in smoothing traffic jams.[23] An evaluation by Highways England of the Smart motorway 'All Lane Running' programme running along 16 miles of the M25 found that the project reduced hours of delay by 50%[24]. This reduction was achieved despite a 10% increase in traffic volumes. Overall, the scheme saved drivers around 6,000 hours every day. Over the course of a year, this amounts to a time saving over £30 million, assuming the DfT's 2016 value of travel time of £11.44 an hour.

Given such success stories, Smart motorways have been put forward as a solution to improving traffic flows and decreasing delays without the need to extend motorway length or add lanes. As Smart motorways offer similar benefits to more traditional road widening strategies, but at lower costs, such schemes can be a cost-effective way to deliver results, and yield high BCRs. The Department for Transport found that Smart motorways offered the highest average BCR of any type of road investment, of 5.7.

Case Study: Active Traffic Management A42

Active Traffic Management was utilised on the M42 carriageway in the East Midlands in 2006. The system was able to increase the peak capacity of the highway and smooth traffic flows by monitoring road conditions. The system enabled several responsive techniques, such as using overhead signals to allow vehicles to use the hard shoulder, and adjusting the maximum speed limit. The system also allows rapid response to accidents and other incidents.

The scheme led to a significant reduction in congestion, lowering average journey times on the northbound carriageway by more than a quarter. This created gains for motorists and the environment – overall fuel consumption was reduced by 4%, emissions were cut by 10%, journey reliability improved by 22% and serious accidents were reduced by more than half.

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21 DfT (2013) The Economic Case for HS2 – 'Using the standard approach, the point-estimate BCR of the whole network (including Wider Economic Impacts) is estimated at 2.3'

22 Highways England (2016)

23 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/515796/POPE_of_Major_Schemes_M62_J25-30_SM_OYA_Executive_Summary.pdf

24 Highways England (2016) http://assets.highways.gov.uk/specialist-information/knowledge-compendium/2014-2015/M25+J23-27+SM+ALR+Monitoring+12+Month+Evaluation+Report_v2.0_Final.pdf

Overall, the scheme cost £9 million per mile, less than a third of the cost of motorway widening, and yielded a Benefit-Cost Ratio of 7.6.[25] Such technology is an effective way of integrating modern technology with current road infrastructure, to deliver policy objectives such as cutting emissions and reducing congestion at a reduced cost. The EU Commission has estimated that the cost of traffic congestion can be reduced by 10% through the use of intelligent traffic systems.[26]

Case Study: South Heywood Proposed Link Road

While building entirely new road can be more costly than integrated schemes and maintenance, in some cases, laying new roads can be an effective solution to divert traffic around heavily congested areas.

One example is the South Heywood Link Road. A major project to upgrade existing stretches of the M62 and M60 near Manchester is already underway to convert the hard shoulder into an extra lane between key junctions. The project is aimed at tackling heavy congestion outside Manchester. However, the necessity for a further extension to the current strategy has been underlined in a 2016 report by Transport for Greater Manchester[27], which evaluates the building of a new link road between South Heywood and the M62. This link road would divert traffic away from busy pinchpoints on the M62.

Modelling from the report calculates that the present value cost of the scheme would be £8.3 million. By contrast, the present value of scheme's benefits were calculated to be £182.0 million, giving the project a benefit cost ratio of 21.9 and a net present value of £171.7 million.

The bulk of the benefits, according to the investigation, are derived from time savings due to better access to the M62 from Heywood, and more direct routes for 'heavy vehicles to existing distribution centres'. This report highlights the efficacy of new road building, which in certain cases offers the most effective solution. Redirecting traffic can be extremely cost-effective, when other integrated solutions may not be an option.

This is especially prevalent in the UK. As seen in Table 1, the UK has a far lower motorway density than European counterparts France and Germany. The traffic density on Britain's roads is more than twice that of both of these countries – there are 113 million vehicle miles for every mile of motorway in the UK, whereas there are 39 in France and 47 in Germany. Road building has also been exceptionally low in Britain over the past decades, even with the high BCRs that new road-building can offer.

Table 1: Motorway networks in Europe

	Motorway network (miles)	Density of network (UK=100)	Motorways built (miles):		Traffic density on motorways (million vehicle miles/mile)
			Since 1990	Since 2000	
France	6950	115	2700	850	39
Germany	7950	237	1200	680	47
UK	2300	100	300	46	113

Source: Department for Transport (2015)

25 Institute of Engineering and Technology (2011) More for Less

26 The EU Commission has estimated that the cost of traffic congestion can be reduced by 10% through the use of intelligent traffic systems.

27 Transport for Greater Manchester (2016) - http://www.tfgm.com/ltp3/Documents/South-Heywood-Executive-Summary.pdf

While upgrading Britain's roads through adopting responsive technology systems can be an effective method to reduce congestion, extension of the current highway network to avoid and redirect traffic in key traffic hotspots can also be a useful solution.

Local Road Maintenance

With the recent government affinity for eye-catching major transport projects – nine major transport schemes identified in the 2011 National Infrastructure Plan represent £75 billion in investment – there is a risk of overlooking the finer details.

It is also these details which mean the most to Britain's drivers: research carried out by the RAC Foundation in 2015 found that 53% believe road and pavement conditions should be the number one concern for ministers[28]. Furthermore, the need for such maintenance is mounting – last year, every single English region reported a fall in the proportion of their road network which is in good condition[29].

The benefits of good road upkeep are clear, as poor quality roads pose dangers to drivers, cyclists and pedestrians. In 2015, £21.6 million was paid out in insurance from local authorities for pothole-related incidents. In some cases, poorly maintained roads can lead to serious injury or death for cyclists, costing the National Health Service as a result.

The Campaign for Better Transport recommends a Road Repair and Renewals Fund to address the £12 billion backlog of local authority road potholes; other organisations that back a similar fund include the RAC, the British Chamber of Commerce, the Federation of Small Businesses and Cycling UK.[30]

As seen in this section, there are many effective methods for upgrading the UK's transport network. Many of these methods deliver a higher value for money than investing in rail schemes. The necessity for such investment has also been outlined – Britain's roads lag behind European counterparts, congestion is highly detrimental to cities and the national economy, and drivers waste days in traffic every year. Furthermore, there are many ways to address these problems, from greater investment in road upkeep, to new road building and integration of traffic technology. In the next section, we look at the environmental impacts of road transport and different policies.

28 RAC Foundation Transport issues survey, by COMRES (2015)

29 Asphalt Industry Alliance (2016) Annual Local Authority Road Maintenance Survey

30 Campaign for Better Transport (2016) Fix It First

4 Environmental effects

Technological advances and changing attitudes mean road vehicles are getting progressively greener. Commitment to modern roads and low-emission vehicles could remove emissions from road travel, but meaningful investment is needed to prime Britain's roads for clean, emission-free transport.

Heavily-used transport networks can come at a high environmental cost. Road travel currently causes the bulk of emissions and air pollution, leading to numerous economic and health problems.

However, funnelling investment into rail, in an effort to alleviate the environmental toll of road travel is short-sighted. Overlooking and underinvesting in roads exacerbates the problems of congestion, which intensify pollution. Furthermore, changing trends amongst British buyers offer new, cleaner solutions to limit the environmental impact of transport. Road investment and innovative policies can help unlock Britain's potential to be a leader in low-emissions transport.

4.1 The cost of emissions

Transport is a major source of air pollution in the UK, and it therefore has a pivotal role to play in solving these problems. In 2014, road transport contributed 21% to the UK's total greenhouse gas emissions.

The highest emission levels from road transport, and their greatest impact, occur in urban areas. As we have seen, congestion is centralised in cities and towns, concentrating the effects of air pollution in places with the highest populations. Of the 600 local Air Quality Management Areas (AQMAs) declared in the UK – areas which breach UK national air quality objectives –95% are a result of transport activity[31].

In cities, exposure to fine particulate matter (PM 2.5) poses a high health risk, along with nitrogen dioxide. Across Europe an estimated 20–30% of the urban population are exposed to PM2.5 levels which exceed EU reference values, and 91–96% are exposed to levels above the more stringent World Health Organization (WHO) guidelines.[32] Another European cross-country study estimated the total economic cost of air pollution to be at least €330 billion a year across the EU.[33]

In terms of public health, air pollution is a considerable concern. The Royal College of Physicians estimates that outdoor air pollution causes around 40,000 premature deaths every year in the UK, at a cost of over £20 billion to the country's health service and businesses annually.[34] Two-thirds of Britain's 5.4 million asthma sufferer claim air pollution makes their condition worse.[35]

4.2 Can roads be greener?

For many years, the environmental impact of road vehicles has been a significant drawback. Road travel is the largest source of greenhouse emissions – cars alone contributed 13% of the UK's total greenhouse gas emissions in 2014. Whereas cars were responsible for 68.5 million tonnes of greenhouse gas emissions in 2014, rail travel resulted in 2.0 million tonnes.

31 Defra (2013a). Air Quality Management Areas

32 Guerreiro, C., de Leeuw, F. & Foltescu, V. (2013) Air Quality in Europe: 2013 report. EEA report No. 9/2013. Luxembourg: Publications Office.

33 Defra (2010) Valuing the Overall Impacts of Air Pollution

34 Royal College of Physicians (2016) The impact of air pollution

35 The Times (2017) - http://www.thetimes.co.uk/edition/news/commuters-warned-of-new-air-pollution-risk-n53q82c09

The level of emissions from vehicles must be a central consideration in any transport policy. However, simply diverting investment from roads to other forms of transport is unlikely to solve the environmental issues in the transport sector. In fact, it is likely to exacerbate them.

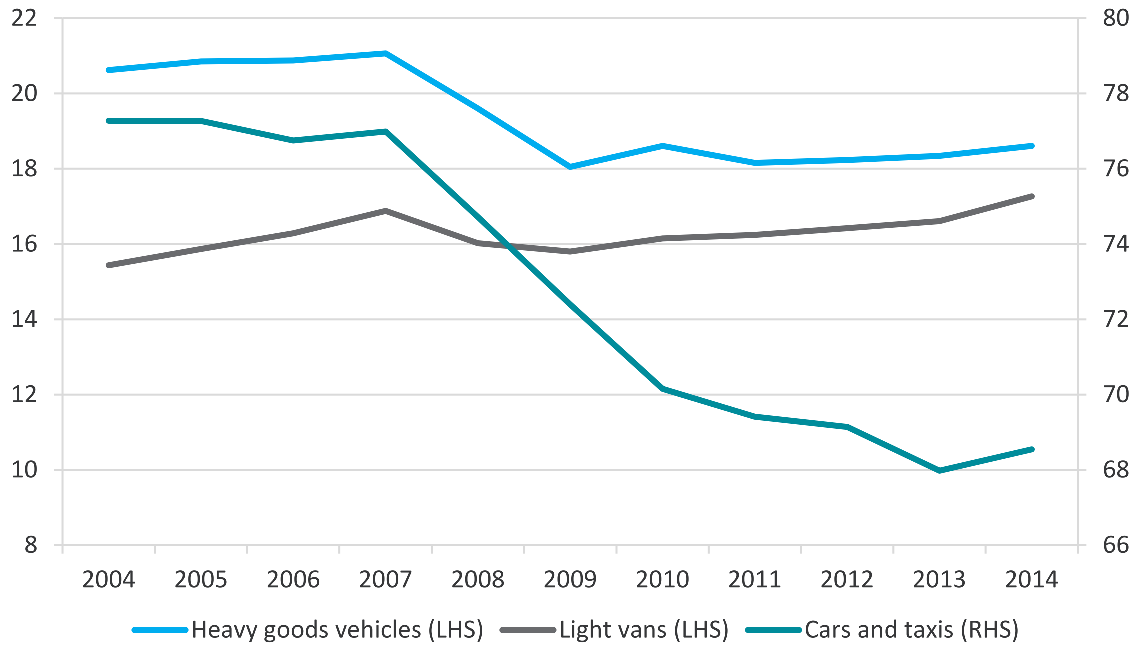
Given road use has increased in recent years, even with limited investment in road infrastructure, negligible road building, and high congestion. Therefore, the growth in road use will continue even if spending on roads does not. This is because cars are often the only method of connecting people to their workplace, and with 68% of people driving to work, cars are therefore a necessity.

As we have seen, car and road usage is generally a result of macroeconomic factors, such as availability of cars to households and fuel costs. Road use is likely to rise in the coming years – with the Department for Transport forecasting a 12% increase in the total traffic volumes on Britain's roads between 2015 and 2025. Poor road infrastructure does not appear to deter drivers, but merely exacerbates the problems of congestion and pollution. As the RAC notes, cars 'will remain the main form of personal mobility in 2050', but the challenge will be to 'minimise adverse effects of traffic growth and congestion'.[36]

Therefore, a transport policy which wishes to limit damaging emissions should aim towards two policy goals – **minimising congestion**, and **lowering vehicle emissions**.

As discussed, cutting congestion requires planning and investment into the UK's transport network, but would be highly effective in cutting road pollution. Vehicle emissions per kilometre on motorways increase three to four times in congested areas, and a vehicle travelling at 60km per hour emits 40% less CO_2 than if travelling in stop-start conditions at 20km per hour[37]. Therefore, smoothing traffic flows and cutting congestion drastically reduces the environmental impact of driving.

Figure 13: Million-tonnes of greenhouse gases, by source, 2004-2014



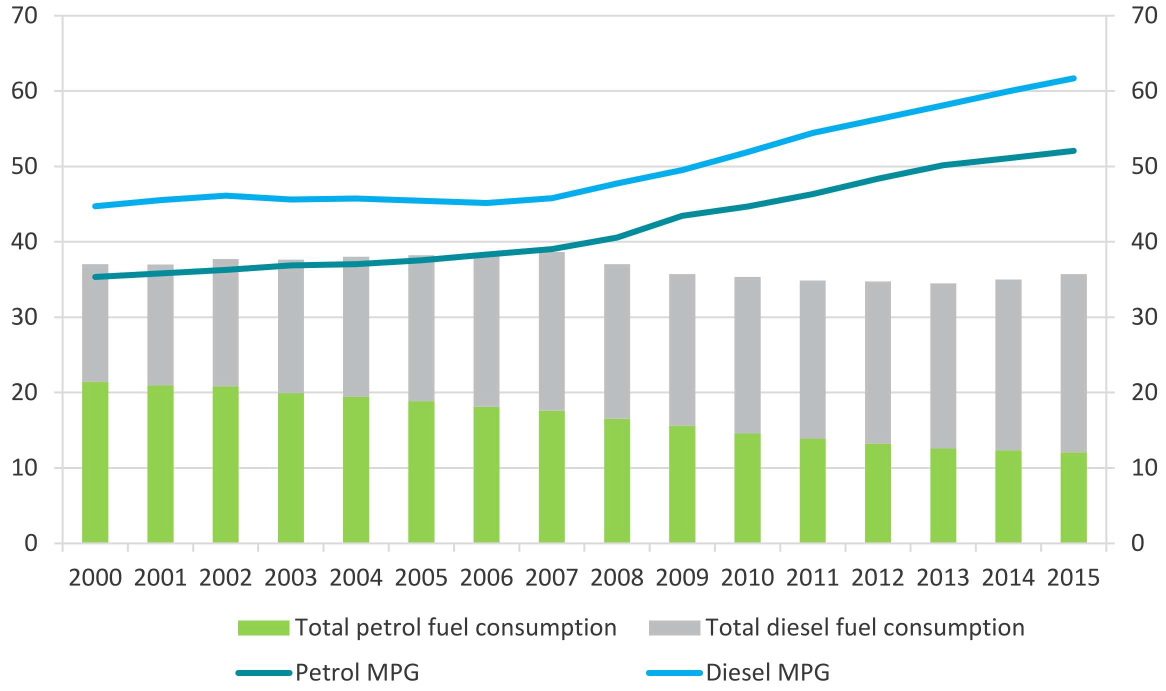
Source: Department for Transport (2016)

36 RAC (2002) Motoring Towards 2050

37 Institute of Engineering and Technology (2011) – research cited to Margaret Bell, Newcastle University

Promisingly, the second objective – to cut emissions per vehicle – appears to be on the right track. Figure 13 shows that total greenhouse gas emissions from cars and taxis has fallen significantly in recent years. This has been driven by improved fuel efficiency in new vehicles, with miles per gallon (MPG) rising in new petrol cars. In 2000, new petrol vehicles had an average MPG of just over 35; this had increased 47% to over 52 MPG by 2015. Fuel efficiency also improved 38% in diesel cars in this time.

Figure 14: Miles per gallon of new petrol and diesel cars; total petroleum consumption (million tonnes) of petrol and diesel cars, 2000-2015



Source: Department for Transport (2016)

The trends for petrol cars are particularly promising. Figure 14 shows that petrol cars are becoming increasingly fuel-efficient, reducing the greenhouse gas emissions per vehicle. Continuation of these trends will help lower the environmental impact of road usage.

However, emissions from diesel vehicles remain a significant concern. Although fuel-efficiency of diesel vehicles has improved, total fuel consumption from such vehicles has not declined over the past 15 years. Diesel exhaust gases include harmful compounds which pose significant health risks, including benzene, formaldehyde and polycyclic aromatic hydrocarbons. However, as reports claimed they emit less carbon dioxide than petrol cars, tax breaks for diesel vehicles were introduced in 2001, leading to a rise in licensed cars and light goods vehicles running on diesel.

A reduction in older diesel-powered vehicles would be instrumental in lowering the footprint of road usage. Several strategies have been proposed to lower the share of diesel cars on UK roads. These include a scrappage scheme to encourage drivers to switch to less-polluting cars, or localised measures such as congestion charges for diesel vehicles, such as London's £10 'toxicity charge' on pre-2005 diesel cars.

Promisingly, recent purchasing trends point to a shift away from diesel motors and towards more eco-friendly vehicles. Amid negative publicity about the health concerns of diesel vehicles, and news that manufacturers have distorted emissions data, sales of diesel cars have been falling for several months.[38]

In January 2017, sales of diesel vehicles were 4.3% lower than they were in the same month a year earlier. With petrol cars outselling diesel in January 2017, this may signify a key turning point in vehicle preferences, as consumers are turning away from diesel motors.

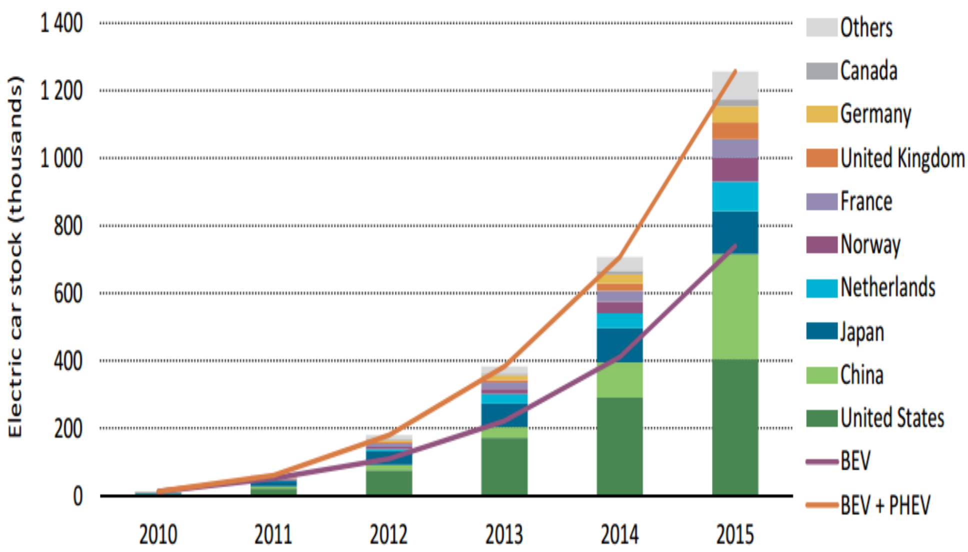
Whilst diesel motors in private cars may be on the decline, they are still common amongst light vans, heavy goods vehicles and buses, which cause high emissions. Diesel buses expose passengers to more pollution due to open doors and windows.[39] Yet, growing electric public transport in cities will help counter this, and London will soon have the largest all-electric bus fleet in Europe[40].

4.3 Low-emissions vehicles and the future of road transport

In January 2017, another major low-emissions milestone was hit, with the market share of alternatively fuelled vehicle above 4% for the first time[41]. Purchases for alternatively-fuelled vehicles were up a fifth annually, with the highest growth in pure electric vehicles. In the year to January 2017, over 1,000 pure electric plug-in cars were bought, a 73% annual rise; there are now 85,000 plug-in electric cars in the UK.

This highlights the growing potential of low-emissions vehicles, spurred by government incentives and consumer awareness of the environmental footprint of cars. International comparisons show that electric and low-emissions vehicles (LEVs) can become a leading part of national transport in a matter of years, but investment is needed to harness this potential.

Figure 15: Evolution of the global electric car stock, 2010-2015



Source: Global EV Outlook Report 2016 – International Energy Agency (2016)

38 BBC (2017) http://www.bbc.co.uk/news/business-38880019

39 The Times (2017) http://www.thetimes.co.uk/edition/news/commuters-warned-of-new-air-pollution-risk-n53q82c09

40 TFL (2016) https://consultations.tfl.gov.uk/environment/air-quality-consultation-phase-2/?cid=airquality-consultation

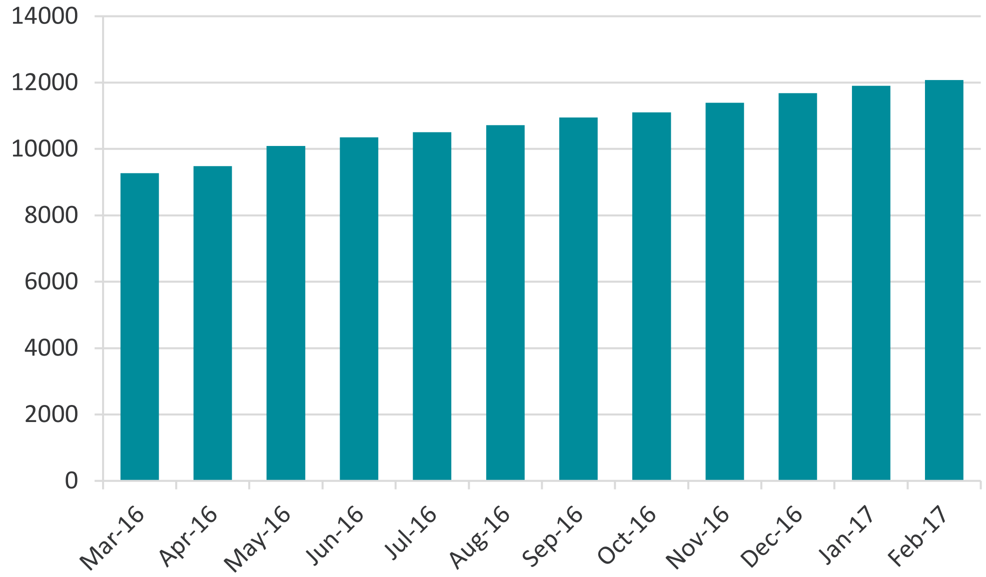
41 Alternatively fuelled vehicles are pure electric, other electric, petrol-electric hybrids and diesel-electric hybrids – SMMT (2017)

The remarkable growth in electric car uptake in recent years is possibly the greatest source of optimism and potential in the future of low-emissions road travel. As the International Energy Agency point out, in '2005, electric cars were still measured in hundreds'. Figure 15 illustrates how quickly this has changed, with the rapid uptake of electric vehicles in recent years enabled by charging infrastructure and cheaper, more efficient batteries.

The UK is well placed to become a world leader in low-emissions and electric vehicles, and the government has bold aspirations, aiming for every new car in 2040 being an ultra-low emission vehicle (or ULEV)[42], a major step towards zero-emissions travel. This aim may seem a far stretch, but given the substantial progress made in just the last few years, this target may be achieved even sooner. In quarter one of 2015, ULEVs made up over 1% of total new car sales for the first time. One year later, there were a further 10,500 ULEVs on Britain's roads, a 22% year-on-year increase.

The government aims to facilitate these targets through financial incentives for EV purchases, such as the successful Plug-In Car and Van Grant, and investment into a national charge point network. Provision of charge points will be a pivotal factor in the uptake of such vehicles. Figure 16 shows the steady increase in total charge points in the UK over recent months.

Figure 16: Number of charging points in the UK, March 2016 – February 2017



Source: ZapMap Charging Point Statistics (2017)

Countries which have most heavily committed to installing charge points over a short space of time have seen consumers respond with EVs fast becoming the norm on their national road networks. For example, Norway spent heavily in creating a comprehensive charging network, also incentivising private chargers with subsidies, and now has the highest EV market share of any country. In 2016, Japan showed its commitment to low-emissions cars, having installed more charge points nationwide than petrol stations[43].

42 Office for Low Emissions Vehicles (2015) - A ultra -low emission vehicle is any vehicle that uses low carbon technologies, emitting less than 75g of CO2/km from the tailpipe and is capable of operating in zero tailpipe emission mode for a range of at least ten miles – SMMT

43 Guardian (2016) https://www.theguardian.com/world/2016/may/10/japan-electric-car-charge-points-petrol-stations

Having laid the foundations for electric car use, consumers are more likely to turn towards electric cars. Before a full charging network is in place, drivers may be wary of buying electric vehicles, but once comprehensive coverage is achieved, the benefits of buying EVs become greater and uptake may begin to increase substantially.

This has certainly been the case in Norway, where charging infrastructure, financial benefits, and preferential rights for LEVs have led to an explosion in EV uptake – the use of nuanced non-financial incentives for low-emissions vehicles has also boosted the attraction of buying a low-emissions vehicle.

In his Autumn Statement, the Chancellor laid out investment plans to drive the UK's low emission transport goals forward. Investments include £390 million worth of funding by 2021 to support ULEVS and renewable fuels, including £80 million in charging infrastructure[44]. Delivering on this investment will be vital to helping build momentum with British uptake of LEVs. Financial incentives for purchases are strong, including up to £4,500 towards the buying an ultra-low emissions car, and up to £8,000 for a van[45], but such incentives must be matched with infrastructural commitments on Britain's roads.

Low-emissions transport investment will be especially concentrated in four British cities – London, Nottingham, Bristol and Milton Keynes – winners of the Go Ultra Low scheme. The project, which will share £40 million of added investment between these cities, aims to boost ULEV usage through innovative pilot schemes[46]. Projects include car-charging street lighting in London and the creation of a Low Emissions Zone in Harrow, wider fast EV charging networks and free parking for low-emissions vehicles in Bristol, and trials for Low Emissions Lanes in Milton Keynes. These projects hold potential for greener roads in the UK's cities, but comprehensive investment is needed for widespread effects. Further rollout of charge points will be crucial in providing the platform for further EV uptake, and the government must take an active role in providing this.

Case Study: Norway

Norway, the current leader in low-emissions road transport, is a reminder of the potential speed of electric-vehicle uptake. In just under a decade, electric vehicles (EVs) have gone from obscurities to a leading feature on Norway's roads. With innovative transport policies, and forward-thinking investment to prime the country's roads, electric vehicle uptake has been remarkable.

Today, Norway has the highest share of all-electric cars per person in the world: more than 100,000 in a country of 5.2 million people. Last year, EVs made up nearly 40% of the nation's newly registered cars, by far the highest share in the world.

This has been achieved through comprehensive investment and incentives to help make electric vehicles as desirable as possible. In 2008, in a bid to lower emissions, the Norwegian capital of Oslo paved the way for EVs by installing hundreds of electric charge points to the city and subsidising private chargers. There are now over 1,000 chargers across Oslo. Buyers of electric vehicles also enjoy tax and toll

44 HM Treasury - Autumn Statement (2016)

45 http://www.racfoundation.org/assets/rac_foundation/content/downloadables/RACF_plug-in_grant_factsheet_June_2016.pdf

46 https://www.goultralow.com/go-ultra-low-cities-winners-announced/

exemptions, use of bus lanes, and free parking in city centres. With residents quick to buy-in to such advantages, the change on Norway's roads has been rapid.[47]

Norway's success has been achieved through a series of well-targeted commitments and investments with a clear end-goal in sight: to cut emissions on roads as much as possible. Norway may be used as a model for other countries wishing to emulate these goals.

The UK is similarly poised for an explosion in the LEV usage. Yet, further infrastructural investment, and more nuanced non-financial incentives for low emissions travel can help drive this potential. The growth of alternatively fuelled vehicles in Norway is an important reminder that the future of low-emissions road travel is closer than many may think.

47 Guardian (2017) https://www.theguardian.com/environment/2017/feb/07/power-to-the-ev-norway-spearheads-europes-electric-vehicle-surge

5 Conclusions

The quality of a country's transport system is fundamental to growth. Greater connectivity means efficiency and lower costs for businesses, bringing opportunity as well as valuable time to people. Well-functioning, modern transport networks facilitate employment, investment, and growth, and directly impact productivity. However, an overstretched transport system is more than inconvenient; it is hugely costly, in economic and environmental terms.

This report has highlighted the vital role roads play in keeping the country moving and growing, and with this there is a responsibility for policy makers to make sure these networks are well-funded, technologically modern, and fit-for purpose. Yet, as shown, in recent years, funding into roads has lagged behind spending in other forms of transport.

Road use is set to rise considerably in coming years, and in order to keep up with this demand, meaningful investment is needed to ensure problems of congestion are addressed. At current levels, congestion is set to cost the UK economy £307 billion between 2013 and 2030. A coherent transport policy must look to solve these problems, bringing the greatest benefits from investment.

This report has underlined the benefits, as well as urgent necessity, of road investment. Numerous strategies for modernising Britain's roads have been considered, offering greater value for money than most of the government's recent large-scale transport projects. The UK's roads have scarcely grown over the past two decades, meaning the country's strategic road network now faces traffic volumes around ten times the levels carried than when built. By 2040, traffic on the UK's SRN is forecast to increase by up to 60% from current levels.

By comparative European standards, Britain's roads are far off the pace, and the country's road infrastructure ranks amongst the lowest in major developed economies. The cost of this, in lost time and unreliability, is huge. Congestion is also extremely costly environmentally, putting considerable strain on health services. A coherent national transport strategy must take account of these facts.

Forward-facing transport policies can also promote uptake of low-emissions vehicles, which hold great potential for the future of greener urban transport. The government has made its bold ambitions clear, to place Britain at the forefront of low-emissions transport; now it must commit the investment to match.

6 Appendix

Appendix Table 1: Summary of BCR Results from the Eddington Report, by project type:

Sector	Number of projects	Average BCR	Relationship between BCR and VFM categories			
			No VFM Value	BCR & VFM the same	VFM < BCR	VFM < BCR
Highways Agency Schemes	93	4.66	61	26	4	2
Local Road Schemes	48	4.23	5	39	2	2
Local Public Transport Schemes	25	1.71	9	11	5	0
Rail Schemes	11	2.83	11	0	0	0
Light Rail Schemes	5	2.14	2	2	1	0
Walking and Cycling	2	13.55	2	0	0	0
Total	184		90	78	12	4

Source: Dodson (2009) from Eddington (2006)

Appendix Table 2: Summary of BCR Results from the 2015 Department for Transport report, by project type:

Scheme type	Number of schemes	Total value benefits	Total Costs	Net Present value	Benefit-Cost Ratio
Smart motorways	15	£16.3bn	2.8bn	13.4bn	5.7
Junction improvements	6	£2.1bn	0.5bn	1.7bn	4.4
Bypasses and link roads	2	£2.4bn	1.2bn	1.2bn	2
Road widening and other online improvements	2	£0.8bn	0.2bn	0.6bn	4.2
Total	25	£21.7bn	4.8bn	16.9bn	4.5

Source: Department for Transport (2015)

Appendix Table 3: Investment scenarios, costs and benefits:

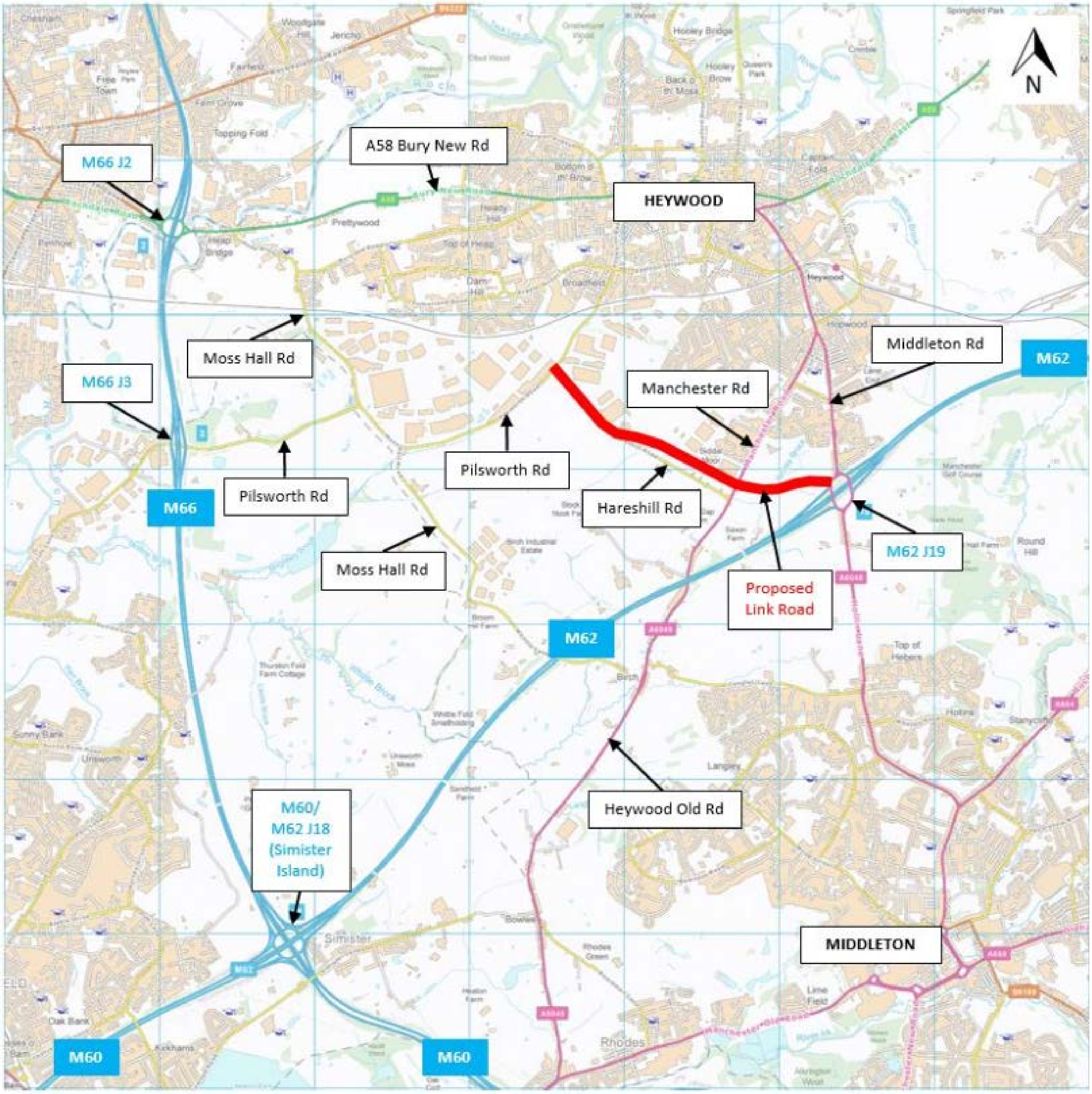
Scenario	Investment cost	Benefits	Net Benefits
HS2 investment without similar roads investment	£55.7 billion	£128.1 billion (including wider economic benefits, by 2033)[48]	£72.4 billion
Road spending equal to HS2 spending (but without HS2)	£55.7 billion	£250.7 billion	£195.0 billion
Smart motorway along whole network in the UK	£20.5 billion	£116.6 billion[49]	£96.2 billion

Source: Department for Transport (2013, 2015), Cebr Analysis

48 Based on the DfT BCR for HS2 (2013) the economic case for HS2 – 'Using the standard approach, the point-estimate BCR of the whole network (including Wider Economic Impacts) is estimated at 2.3'

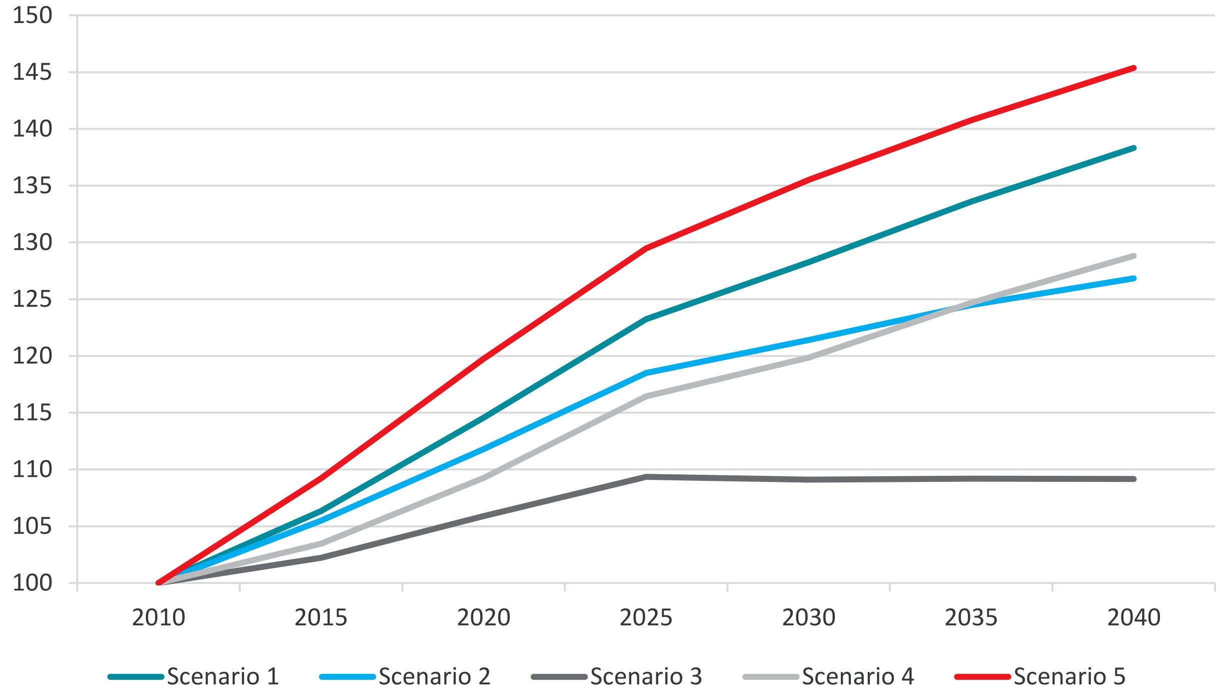
49 Based on DfT's 2015 average BCR of 5.7 for Smart motorways – DfT (March 2015)

South Heywood proposed link road (in red) – local area and strategic highway network map:



Source: Transport for Greater Manchester (2016)

Figure 17: Forecasts for UK road traffic until 2040, Department for Transport scenarios



Source: Department for Transport (2015)

Appendix Table 4: Summary of variations in the Department for Transport's projection 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

Source: Department for Transport (2015)