# Driving Down Emissions

## How to clean up road transport?

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# Executive Summary

## Context

Road transport plays a crucial role in society. It enables people and goods to move around the country, thereby sustaining economic growth and prosperity. The 38 million registered vehicles in the UK travelled 324 billion miles on our roads in 2016 - numbers that have increased substantially in recent decades and will continue to grow in the future. I**n order for this to be *environmentally* as well as economically sustainable, it is essential that we tackle the twin problems of greenhouse gas emissions and air pollution from road transport.**

Road transport is responsible for nearly one quarter of total UK greenhouse gas emissions. Unlike other parts of the economy, where significant progress has been made to reduce greenhouse gas emissions, road transport emissions have actually *increased* by 1% since 1990. Improvements in fuel efficiency mean that $CO_2$ emissions per mile are reducing over time, but this has been offset by an increase in vehicle mileage - with particularly strong growth in the distance travelled by light goods vehicles (e.g. due to the growth in home deliveries). **It is essential that progress is made to reduce greenhouse gas emissions from road transport if the UK is to meet its commitments under the Climate Change Act 2008.**

Transport is also a major source of local air pollution, which is harmful to human health. Our previous report, *Up in the Air*, found that nitrogen oxides ($NO_x$) and particulate matter (PM) pollution reduces life expectancy by around two years on average across the population of London.[1] This is primarily a diesel problem: road transport is responsible for 80% of the NOx concentrations at roadside locations, and the vast majority of this relates to diesel vehicles. Since the 1990s, successive governments have used a range of fiscal incentives to encourage the use of diesel vehicles on the basis of their superior fuel efficiency and lower greenhouse gas emissions. However, this approach has backfired from a local pollution point of view. Diesel vehicles have far greater $NO_x$ emissions than equivalent petrol vehicles – for example, an average Euro 5 standard diesel car (sold in the period 2010-14) emits almost 20 times as much $NO_x$ per mile as a Euro 5 petrol car. The European Commission has set ever tighter standards for $NO_x$ emissions, but diesel vehicles have systematically failed to meet these standards on the road, culminating in the 'diesel-gate' saga in 2015 concerning the illegal cheating of emissions tests by Volkswagen. **Going forward, the decarbonisation of transport must go hand in hand with reducing air pollution. The Government must not repeat the mistakes of the past, pursuing $CO_2$ objectives at the expense of air quality.**

## Options to clean up road transport

There are a wide range of technology options available to clean up road transport. This report includes a review of the main options, as summarised in the table below. Each has been evaluated in terms of how quickly they could

1 Howard, R. (2016) *Up in the Air: How to solve London's air quality crisis - Part 2*, Policy Exchange

be deployed, their effectiveness in terms of reducing carbon emissions and air pollution, the additional costs to consumers, and the infrastructure requirements for mass uptake.

**Table ES1: High level assessment of technology options for cleaning up road transport**

| | Time to deployment | Decarbonisation potential | Air quality potential | Consumer cost | Infrastructure requirements |
|---|---|---|---|---|---|
| **Conventional vehicles (inc. non plug in hybrids)** | Fast | Medium | Medium | Low | Low |
| **Battery electric vehicles & plug in hybrids** | Medium | High | High | Medium | High |
| **Hydrogen fuel cell electric vehicles** | Slow | High | High | High | High |
| **Biofuels** | Medium | Low | Low | Low | Low |
| **Gaseous fuels** | Fast | Low | High | Low | Low |
| **Modal shift** | Varies | Medium | High | Low | Varies |
| **Mobility as a service (e.g. car sharing)** | Fast | Medium | Medium | Low | Low |
| **Autonomous vehicles** | Slow | Uncertain | Uncertain | High | High |

The vast majority of vehicles on the road in the UK are **conventional vehicles** with an internal combustion engine (ICE) fuelled by petrol or diesel. Significant improvements in fuel efficiency and carbon emissions have already been made due to vehicle emission targets and financial incentives geared towards lower-$CO_2$ vehicles. Looking forward, the Committee on Climate Change estimates that new conventional cars sold in 2030 will have real-world $CO_2$ emissions 37% below those sold in 2010. In recent years, $NO_x$ emissions from diesel vehicles have been well above the required Euro standards, but there are signs that most auto manufacturers are now making improvements.

At present there are relatively few **battery electric vehicles (BEVs)** or **plug in hybrid electric vehicles (PHEVs)** on the road in the UK – around 96,000 as at the end of 2016. Battery technology has improved greatly in recent years, with a reduction in cost and increase in vehicle range. Costs are expected to decline to the point that electric cars and light vans will become cost competitive with conventional vehicles by the early 2020s (without direct subsidy). The major issue with battery electric vehicles is the associated infrastructure for charging. BEV owners typically plug their vehicle in to charge when they return home in the evening. If left unmanaged, this would mean that charging coincides with the daily peak in power demand, which would place additional strain on the power system, requiring investment in local power distribution networks and new generation capacity. However, these issues can be managed if charging is smart and controllable. Vehicles could even feed power back in to the grid in order to help

balance the system at times of high demand (although further research is needed into the impact of this on battery life).

**Fuel cell electric vehicles (FCEVs)** use electric motors for propulsion (like a BEV) but generate the electricity using hydrogen. At present FCEVs are considerably more expensive than conventional vehicles or BEVs, but the cost differential is expected to decrease substantially by 2030. The main advantage of hydrogen over electricity is its higher energy density, which means that FCEVs can travel farther on a single tank of hydrogen than a BEV can on a single charge. Fuel cell technology could potentially be applied to heavy duty vehicles (HGVs and buses) where it will be difficult to apply battery technology due to the weight of the batteries required. One company is developing a hydrogen-powered HGV with a range of 1,200 miles - far beyond the capability of a battery powered HGV. The major drawback lies in the difficulty of producing and transporting low carbon hydrogen. Hydrogen is currently produced primarily from steam reforming of natural gas, which releases significant amounts $CO_2$. In order for hydrogen vehicles to be 'low carbon', this $CO_2$ would need to be captured and stored permanently. Alternatively hydrogen could be produced through electrolysis (using a low carbon form of electricity) but at present this process is not cost-competitive.

**Biofuels** are already in use in the UK, albeit that they make up a relatively low proportion of total transport fuel (around 3%). Biofuels can be blended into conventional fuels or used on a standalone basis given the right engine-fuel combination. Biofuel uptake has been driven by the European Renewable Energy Directive, which mandates that 10% of total transport fuels should be renewable by 2020. The major issues with biofuels are finding enough sustainably-sourced material to create the fuel without displacing farmland for food crops or resulting in land use changes which undermine effective carbon savings.

Fuels derived from **natural gas**, such as **liquefied petroleum gas (LPG)** and **compressed natural gas (CNG)** could offer a fast and relatively low cost strategy to reduce $NO_x$ emissions, although the greenhouse gas emission savings from switching to these fuels is negligible. There are already around 200,000 LPG fuelled cars on British roads, with a network of 1,400 filling stations. CNG buses, meanwhile, are already commonplace in America and could be deployed in UK cities as a strategy to reduce urban air pollution.

Carbon emissions and air pollution can also be reduced through **'modal shift'** - switching from road vehicles to alternative forms of transport. For example, there is potential to shift freight from road to rail, and shift car users to public transport, or cycling/walking for short journeys. These options not only make the transport system cleaner, but also more efficient.

Finally, a range of new technologies may change the way we use road transport. In the short to medium term, we will see further steps towards the provision of **'mobility as a service'** – with a range of companies offering e-hailing of taxis, ride sharing, and car sharing / car clubs. There are already 193,500 car club members in London alone. It is estimated that car club membership reduces a Londoner's transport carbon footprint by 73%, in part due to the fact that car club vehicles tend to be much cleaner than the average car on the road.

In the medium to long term, we will also see a move towards fully **connected and autonomous vehicles (CAVs)**. Many new vehicles already have a degree of connectivity (e.g. navigation) or basic autonomous features (e.g. cruise control).

Car makers and technology firms are now testing fully autonomous cars, but still need to overcome a number of technical and regulatory hurdles before they become commonplace on our roads. Autonomous vehicles have the potential to completely change the way in which we move goods and people around the country – extending the 'mobility as a service' concept described above. Autonomous technology could make vehicles more efficient – through less aggressive driving behaviour and reducing aerodynamic drag by 'platooning'. However, there is a risk of a 'rebound effect' in which autonomous vehicles become so convenient that people use them instead of public transport, thus increasing road miles, congestion, and possibly emissions.

## A new strategy to clean up road transport

The Government clearly recognises the need to clean up road transport. However, to date the approach to tackling road transport emissions has been disjointed and insufficient. Despite efforts by successive governments, greenhouse gas emissions from road transport have increased by 1% since 1990. The latest data shows that London plus 74 other cities and local authorities across the UK still exceed the legal and healthy limit for $NO_2$ concentrations. Far more needs to be done if the new Government is to deliver on its **Manifesto pledges to uphold the Climate Change Act and to 'be the first generation to leave the environment in a better state than we inherited it.'**

**As it stands, there is no overarching Government strategy to deliver the required reductions in greenhouse gas emissions, and the latest plan to reduce $NO_x$ emissions is inadequate.** The closest thing the Government has to a strategy is the Committee on Climate Change's (CCC) Fifth Carbon Budget[2] - but this is more of a blueprint than a strategy, and the CCC is an advisory body. The CCC's analysis shows that greenhouse gas emissions from road transport could be reduced by 38% between 2010 and 2030, principally through further improvements in the efficiency of conventional vehicles, together with the adoption of ultra-low emission vehicles (ULEVs). However, the same document shows that this level of emissions reduction simply will not be delivered by current and planned policies. **Overall, it is clear that Government needs to develop a new strategy to clean up road transport in order to deliver the emissions reductions required under the fifth carbon budget, and to successfully address air pollution.** This could be developed as a standalone strategy, or as part of the Emissions Reduction Plan (or 'Clean Growth Plan') which the Government is due to release later this year.

Based on our analysis we suggest that the Government's approach should follow the following broad principles:

- **Make a clear commitment to clean up road transport:** The new strategy needs to set out a credible plan of actions to deliver the carbon targets set out in the Fifth Carbon Budget. At the same time, there needs to be closer integration between policies to reduce greenhouse gas emissions and policies to clean up air pollution. The policy to promote diesel vehicles from the 1990s onwards on the basis of lower $CO_2$ emissions has undermined efforts to improve air quality. The Government needs to learn from this mistake and ensure that policies concerning greenhouse gas emissions are more closely aligned.

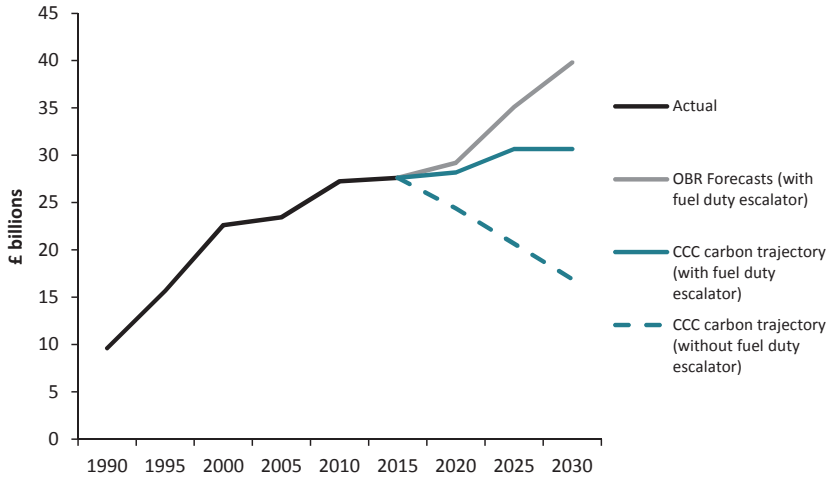
2 Committee on Climate Change (2015) *The Fifth Carbon Budget: The next step towards a low-carbon economy*

- **Provide leadership across Government:** Many different parts of Government have an interest in road transport – including No. 10, HM Treasury, DfT, BEIS, DCLG, Defra, OLEV, the Committee on Climate Change and National Infrastructure Commission, as well as the Devolved Administrations and local authorities. This complexity has led to an uncoordinated approach to reducing road transport emissions. A striking discovery in our analysis was that the Department for Transport and the Committee on Climate Change are working off completely different projections for the total greenhouse gas emissions from road use (with the DfT assuming much higher emissions). Greater coordination is needed to ensure that all parts of Government are working towards a common vision of the future of road transport. **We recommend that the Government establishes a cabinet-level committee focused on emissions reduction and clean growth – potentially as a sub-committee to the Economy and Industrial Strategy Committee.** There is also a need for greater focus and leadership on these issues at a local regional and city scale. **The new Metro Mayors should be a focal point for action to clean up road transport in major UK cities, drawing on experience from London to date.**
- **Put the consumer first:** Voters identify the cost of living as their number one policy issue, and energy costs as their number one concern in terms of household budgets. The Government needs to ensure that consumers remain at the heart of the new strategy to clean up road transport and avoid unduly penalising motorists. It would be morally unacceptable for the Government to heavily penalise diesel drivers who were actively encouraged to switch to diesel by successive Governments. Government should adopt a 'carrot and stick' approach, with a mix of penalties for the most polluting vehicles and incentives for cleaner vehicles. **To this end, we reiterate our call for a diesel scrappage scheme to take more polluting vehicles off the road, alongside measures such as Clean Air Zones which will restrict the most polluting vehicles from entering cities.**
- **Pursue a technology-neutral, least-cost approach:** We strongly believe that the most cost-effective way to clean up road transport will be to adopt a technology neutral approach. This means exploring all opportunities to reduce emissions on a fair and equal basis, and setting policies to achieve specific environmental outcomes rather than targets for any individual technology. **To this end, the Government should scrap the European target for 10% renewable transport fuels by 2020 and avoid setting targets for the number of ultra-low emission vehicles on the road.** The uptake of ultra-low emissions vehicles should be decided by market forces rather than government decree.
- **Tackle Infrastructure System Challenges:** Cleaning up road transport could have significant implications for infrastructure – including transport, energy and even communications systems. Whilst we can already identify and describe these system implications at high level, there is still significant uncertainty as to the precise nature, scale and timing of the impacts and infrastructure requirements. This raises questions in terms of how to plan network and system investments given the high level of uncertainty. **For this reason, we suggest that Ofgem should seriously consider shortening the length of the next set of price controls for energy networks (e.g. from 8 to 5 years) or building in more significant re-openers, to cater for uncertainties.**

**Finally, the Government needs to recognise the significant fiscal implications of cleaning up road transport.** Road use currently generates £34 billion in tax receipts through fuel duty and road tax alone.[3] Total fuel duty receipts increased rapidly to 2010, but have since stalled due to the decision to repeatedly cancel the fuel duty escalator. Actual fuel duty receipts in 2015/16 were £7 billion lower than the Office for Budgetary Responsibility (OBR) was projecting for the same year in 2010.

Fuel duty is effectively a tax on carbon emissions, whilst road tax is in part designed around $CO_2$ emission bands. This means that, all else being equal, tax receipts from road use will decline as road transport is decarbonised. The OBR's 2014 Fiscal Sustainability Report suggested that fuel duty receipts could reach £40 billion per year by 2030 (based on DfT projections for road use and carbon emissions). However, if instead we achieve the carbon trajectory suggested by the CCC, then total fuel duty receipts would be far lower – reaching £31 billion in 2030 with the fuel duty escalator, or £17 billion without.[4] **In other words, assuming we achieve the fifth carbon budget emissions trajectory, fuel duty receipts could be £9-23 billion lower in 2030 than the OBR is currently assuming.** On a cumulative basis, this represents a loss of £60-170 billion in tax receipts between now and 2030.

**Figure ES2: Scenarios for fuel duty receipts**




HM Treasury is already alive to this possibility, and has already made changes to road tax and Company Car Tax rates to reflect the trend towards lower $CO_2$ vehicles.

However, there are still some significant flaws in the system that gave rise to serious side effects. For example, the current system of fiscal incentives relies on official emissions estimates that are known to be inaccurate. Moreover, official emission estimates only include direct tailpipe emissions, and completely ignore indirect emissions associated with the generation of power used to charge the battery. For Plug-in Hybrid Electric Vehicles in particular, this means that official figures advertised by manufacturers give a highly misleading picture as to the true miles per gallon or $CO_2$ emissions per km on the road – yet PHEVs are still eligible for grants and reductions in road tax and company car tax. **Government**

3 Office for Budget Responsibility (2017) *Economic and fiscal outlook*

4 Note that our model assesses first order effects of changing parameters such as the fuel duty rate or total carbon emissions. It does not consider second order effects such as fuel switching.

**should develop a new system for rating vehicle emissions, that takes into account both direct and indirect emissions, and underpins tax incentives going forward.**

Our analysis suggests that the total tax take from road use could be equal to or less than the cost of maintaining the road network by the 2030s (in a scenario consistent with the Fifth Carbon Budget). **On this basis, the Government needs to seriously consider whether in the long term it will be necessary to move from the current system of taxing fossil fuels and carbon emissions to a system of road user charging (e.g. toll roads, charges per mile, or congestion charges in cities).**

## Technology specific recommendations

The report makes a number of detailed policy recommendations concerning individual technologies:

### Conventional vehicles

- **Clarify the UK's position regarding European vehicle standards and emissions targets following Brexit.**
- **Improve transparency on real-world $NO_x$ emissions,** by requiring all manufacturers and vehicle retailers to display this information at the point of sale.
- **Introduce Clean Air Zones in the most polluted cities,** where $NO_2$ levels are likely to exceed legal limits in the 2020s without further action. Vehicle charging should only be introduced where it is strictly necessary.
- **Ensure that all charging schemes and Clean Air Zones correctly target the most polluting vehicles.** As currently defined, the London 'Toxicity Charge' fundamentally fails to meet this requirement.
- **Introduce a targeted Vehicle Scrappage/Retrofit Scheme,** alongside the introduction of Clean Air Zones, to take the most polluting vehicles off the road.

### Ultra -low emission vehicles

- **Continually review the system of grants for ULEVs to ensure that they represent value for money.** The Government should signal a phase out of grants for BEVs and PHEVs (cars and light vans) by the early 2020s, by which time cost reductions will mean they will be cost-competitive with conventional vehicles without grants.
- **Government should continue to provide grants for FCEVs,** but cap the total grant funding available.
- **Continually review the system of grants for home, workplace, and on-street charging points** to ensure that Government is not over-subsidising their deployment. The Government should signal a phase out of subsidies for charging points by around 2020.
- **Put in place an appropriate regulatory framework to create a competitive market for battery electric vehicle charging and hydrogen refuelling.** Electric charging infrastructure and services are currently unregulated, creating

significant risk for investors and consumers, and should be brought within the remit of Ofgem (the energy regulator).

- **Conduct further research into the public perceptions of smart charging** to determine how consumers are likely to respond to time of use tariffs.
- **Ensure that all electric charging infrastructure is smart and controllable** in order to minimize the investment required into local power networks and additional electricity generation capacity.
- **Ensure that data is collected on the location and usage of all electric charging points in the UK** (public and private) and this data made available in an appropriate form to energy suppliers, network operators and Government.
- **Commission further research into how to reduce the cost of low carbon hydrogen production,** transport, storage, and refuelling infrastructure.
- **Focus hydrogen vehicle research initially on HGVs and buses** as these appear to be the vehicle segments where hydrogen has an advantage over BEVs.

### Biofuels

- **Abandon the arbitrary European target of 10% renewable transport fuel by 2020** (which it is unlikely to be achieved in any case) and re-examine policies concerning biofuels.
- **Continue to focus on biofuels derived from wastes rather than energy crops.**

### Natural gas (LPG and CNG)

- **Consider replacing older buses with new models running on natural gas,** as a short term measure to reduce $NO_x$ emissions.
- **Expand incentives offered to taxi operators under the Clean Vehicle Technology Fund to convert diesel taxis to run on LPG.**
- **Provide greater certainty for motorists about fuel duty on LPG and other gaseous fuels,** maintaining the current differential between fuel duty on LPG versus petrol/diesel for a period of 5-10 years.

### Modal shift and behaviour change

- **Work with the rail industry to increase the amount of freight shipped by rail,** by identifying spare capacity on the network and how it can be used, and resolving pinch points on the network.
- **Accelerate the electrification of the rail network, such that by 2030 the 'core network' can be operated by electric trains,** and make targeted investments to increase the use of electric locomotives for freight. Where electrification is unviable, Government and the rail industry should investigate the feasibility of electric/diesel hybrids and battery powered trains.
- **Explore the potential to convert existing train lines to light rail, train-tram and ultra-light rail,** which could then be factored into future rail franchises.
- **Allow all local authorities (not just those with an elected Mayor) to take a leading role in the tendering of bus services.**
- **Increase the proportion of the overall transport budget spent on cycling and walking, and adopt the 'London Cycling Design Standards' as a national standard.**

- **Integrate 'mobility as a service' solutions such as car sharing into transport information systems (such as 'CityMapper') and smart charging systems (such as Oyster).**
- **Metro Mayors and Local Transport Authorities should coordinate 'mobility as a service' solutions across city-regions.**
- **Provide clear leadership on the development of connected and autonomous vehicles,** with a more coherent joined-up strategy. Government should conduct further research into the consumer acceptance of connected and autonomous vehicles, and the likely benefits in terms of emission savings.
- **Carry out further research to better understand the communication network requirements associated with connected autonomous vehicles,** in order to future-proof investment in communications and transport systems.
- **Develop a set of standards and regulations concerning the safety, security and data privacy aspects of connected and autonomous vehicles,** drawing on best practice from around the world.