Emission Trends in the UK Passenger Car Fleet: A Policy Perspective

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Abstract

The passenger car fleet is one of the greatest contributors to domestic greenhouse gas emissions in the UK. This research explores the extent to which a number of policy mechanisms have reduced emissions in this sector. Manufacturer trends are examined in relation to the EU fleet average emission regulations and demonstrate they have reduced emissions through dieselisation and reduced engine capacity. At a consumer level, cost is the most important driver of demand and this is reflected in an increased focus on fuel consumption. Company car fleets are reducing the average gCO_2/km due to the aggregate financial benefits of increased fuel economy and reduced company car tax. In addition to CO_2, other regulated emissions are examined showing that real world emissions of NO_x from new diesel vehicles have not reduced in line with the Euro standards. The research concludes that progress has been made in reducing emissions over recent years, but improvements are required in the policy environment for substantial emission reductions to be maintained.

Introduction

The transport sector is one of the highest greenhouse gas (GHG) emitters in the UK, accounting for over 20% of total emissions and over a quarter of CO_2 emissions in 2011. It is the only sector that has not seen an overall drop in emissions since 1990. Passenger cars are responsible for 58% of this total (DECC, 2011). Although CO_2 emissions on a per car basis have been decreasing, reaching an average of 140gCO_2/km in 2011, increases in demand for passenger cars have offset improvements (Department for Transport, 2011a). Therefore the UK must address this sector to achieve the 2050 targets of an 80% reduction in emissions of GHGs.

To date there have been a number of policies, both at a national and European level, that have had the specific purpose of decreasing emissions from passenger cars. The European Commission (EC) introduced regulation (EC) 433/2009 after it became apparent that the voluntary agreement preceding this would not reduce emissions to the desired targets. The key component of the legislation is an average fleet target of 130gCO_2/km to be achieved in 2015, with an additional target of 95gCO_2/km by 2020. Commencing on 1 January 2012 manufacturers are liable to financial penalties if they fail to meet individually set targets (European Commission, 2009). In addition, other vehicle pollutants, including carbon monoxide (CO), nitrous oxides (NO_x), hydrocarbons (HCs) and particulate matter (PM), are regulated through European standards, with tighter restrictions with each period.

There are two types of consumers within the car market; fleet, business and company cars, and private consumers (SMMT, 2011). Policy measures can be applied to both of these sectors in order to try and stimulate emission reductions. Taxation of transport fuel can help to reduce emissions in the sector. Whilst in the short term transport demand is very inelastic, over the long term more elastic demand means that an increase in price of 1.25% can result in a 1% drop in demand (Kesicki and Anandarajah, 2011). The UK currently has one of the highest transport fuel prices in the world with the Government following an aggressive fuel tax escalator in the 1990s. By 2010, fuel tax had driven up its untaxed price by over double. Vehicle Excise Duty (VED) is payable on all passenger cars. In 2001 VED became dependent on CO_2 emissions where it had previously been based on horsepower and car size. For company cars, changes to the calculation of company car tax (CCT) to be dependent on CO_2 emissions in 2002 and the introduction of a 10% rate for 'Qualifying Low Emission Cars' (QUALECS) which applied to any vehicle under 120gCO_2/km in 2008, aims to drive emission reductions for these consumers. Further changes in 2011/12 saw removal of discounts for alternatively fuelled and diesel vehicles, focussing on CO_2 emission for calculations of CCT.

This study explores the impact that the aforementioned policies have had on GHG emissions from passenger cars. Beginning with an outline of the methods used and data sources, the impacts of policy on manufacturers, private and company consumers and emissions of regulated pollutants are examined. The results of this are then discussed, and the study concludes by making some policy recommendations.

Methodology

This study relied on a number of reliable sources for analysis of trends over previous decades. Data regarding trends in manufacturer's fleets was obtained from EC monitoring data. Detailed datasets are available under Article 8 of Directive (EC) 433/2009, as well as data collected as part of Directive No 1753/2000/EC, which provides data prior to 2009. Only limited data was available for the UK, so trends are shown on an EU wide basis.

In terms of data used of the analysis of private consumer trends the primary resources were the Society for Motor Manufacturers and Traders (SMMT) and the UK Department of Transport (DfT). Both publish extensive datasets on the state and evolution of the UK vehicle fleet. SMMT data was also used for analysis of company car trends. Another important resource was data made available through a research partnership with Zenith. They are one of the largest fleet providers in the UK, with approximately 36,000 vehicles across a range of corporate clients. The research utilised Zenith's historic fleet data since 1999, as well as data on specific strategies used for reducing emissions.

For the analysis of non-CO_2 emissions, remote sensing data was utilised that provided a snapshot of the vehicles on road. This data was provided by the work of Carslaw et al. (2011), where a full collection methodology can be found.

Analysis

Manufacturers

It is clear that there has been a significant reduction in emissions, with an overall decrease of 19% between 2001 and 2010, with the sharpest decrease being observed since 2007. This corresponds to the release of the draft EC legislation regarding regulation of their emission targets. If the average rate of emission reductions of 3.7% per annum seen since 2007 continues, the 2015 target of 130gCO_2/km fleet average could be met as early as 2013. However, the target of 95gCO_2/km will just be missed in 2020, at 98.9 gCO_2/km.

Looking at how emissions have been reduced over the last decade there were three factors that could be readily evaluated from the data available; engine capacity, weight and fuel type. There has been an overall decrease in engine capacity since 2007. Engine capacity for diesels has been steadily decreasing since 2001 although a sharper drop is seen after 2007. However the overall decrease since 2007 can mainly be attributed to petrol cars, which had not seen a significant change in engine capacity until this point. This corresponds with the sharpest drop in emissions that has been seen over the last twenty years. It can therefore be assumed that downsizing has become a popular choice for a reduction in emissions for most manufacturers, which is one the most straightforward ways of achieving their targets. Reduction in vehicle weight should have also been another simple way to reduce their emissions. However, there is no clear overall trend. Whilst diesel car weights have steadily increased between 2001 and 2010 petrol car weights have decreased slightly. Whilst it appeared for both diesel and petrol fuelled cars that weights dropped after 2007, both fuel types have seen an increase since between 2009 and 2010.

There has been an increasing trend in dieselisation, with the share of total fuel type for new car registrations rising from just over 30% in 2000 to nearly 50% in 2010. As diesel engines tend to be more CO_2 efficient than petrol, this has proved to be an easy solution for almost all major manufacturers to lower their fleet average CO_2 emissions. However, it should be noted that the gap between CO_2 emissions from petrol and diesel fuels has closed in recent years. Hybrids have been growing in popularity; however, at present CO_2 benefits are questionable as some small petrol/diesel-only cars can also achieve lower emissions. There has been a steep rise in

the number of electric cars from almost zero in 2007. However, this number is still only a tiny proportion of total registrations, demonstrating that cost and lack of infrastructure is still a major barrier to mass roll out of this technology.

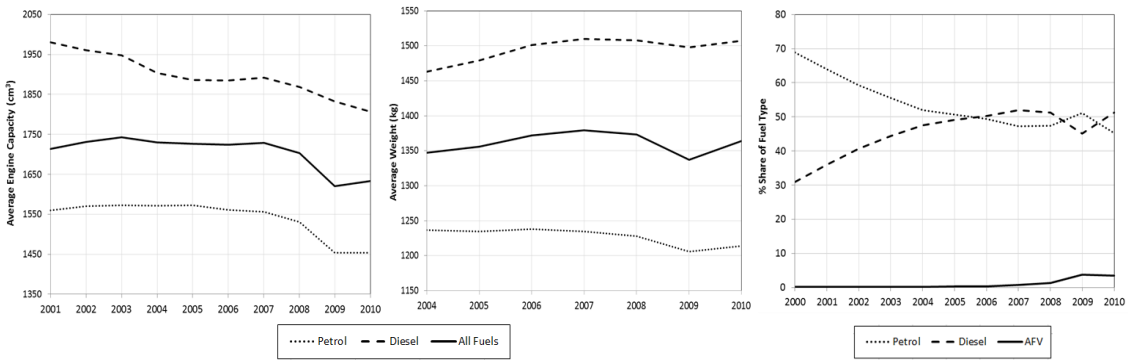

Figure 1-Trends in (a) average engine capacity, (b) average weight and (c) share of fuel type between 2001 and 2009 for EU-27

Consumers – Private

The consumer's decision of which car to buy is based on a large number of both logical and emotional factors. The premium brands are considered highly emotional choices and so they focus on factors such as style, status, gadgets and aesthetics, whereas most of the volume brands are considered to be rational choices based on the physical performance of the car (Trend Tracker, 2011). Far more volume brand cars are bought each year, meaning that the majority of cars are bought based on performance figures. Reliable information is essential as it is used to guide the market choice; unreliable figures have the potential to skew which cars consumers choose to buy.

Table 1 shows what factors consumers consider to be important when they are choosing a car. Most environmentally relevant factors are considered of low importance by consumers and so selling cars on environmental benefits has limited merit. However fuel consumption has direct emissions connotations and is considered highly important by consumers. This makes it a promising metric to encourage consumers to choose low emission cars (Lane and Banks, 2010). As fuel prices rise, the benefits of higher fuel economy become more apparent. With the recent economic downturn and record high fuel prices, half of the motorists interviewed for the most recent RAC motoring report said that the increasing cost of fuel has been the single biggest influence on changing their driving behaviour (Royal Automobile Club, 2008a).

Table 1-Factors affecting consumers' choice of vehicle (Anable, Lane et al. 2006)

Most Important	Medium Importance	Least Important
Price	Performance/Power	Depreciation
MPG/Fuel Economy	Image	Personal Experience
Size/Practicality	Brand names	Sales Package
Reliability	Insurance Cost	Dealership
Comfort	Engine Size	Environment
Safety	Equipment Levels	Vehicle Emissions
Running Costs		Road Tax
Style/Appearance		Recommendation
		Alternative Fuel

Cost, whether in the form of purchase price or running cost, is the most influential factor in consumer choice. When comparing figures from a survey done by the DfT with actual costs it was found that consumers perceive running costs to be over twice as important as they really are, whereas the purchase cost and depreciation are significantly underestimated (Department for Transport, 2012b). The way people pay for running costs (direct payment, often in person, not automated) and the regularity of the expenses make them more memorable which is why people exaggerate their actual cost in their minds. This information can be used by policy makers to target costs that the public are particularly aware of.

The RAC report (Royal Automobile Club, 2008b) shows that the cost of driving a car has decreased significantly over the last twenty years. This has had a knock on effect in the cars consumers buy. While total cars sales have dropped over the last decade, not all segments have been affected equally. The majority of the reduction has come from the super mini, lower medium and upper medium segments. While the less fuel efficient dual purpose and MPV segments have grown rapidly (The Society of Motor Manufacturers and Traders, 2012).

Consumers – Companies

There are a range of approaches for reducing emissions from company cars including increasing shares of low emission vehicles, adopting electric vehicle (EV) fleets, programmes of smarter driver training and schemes such as salary sacrifice, which provide incentives to choose lower emission cars.

By shifting the mix of vehicles within a fleet towards lower emission vehicles, for example by including hybrid vehicles, or more efficient petrol or diesel models, then the emissions impact of that fleet can be reduced. In the UK around 50% of new car sales are diesel fuelled and 1.3% alternatively fuelled (SMMT, 2011). Zenith has seen higher penetration of alternatively fuelled vehicles, at 2%, and 87% of their vehicles are diesels, demonstrating that greater efficiency can be achieved within the company car sector.

EV fleets could substantially reduce the emissions from company cars and there are support mechanisms available, though perhaps, at present, they are insufficient to fully incentivise companies to adopt EVs. There are concerns about the whole-life benefits of EVs, due to the electricity used in charging being drawn from fossil fuel sources (Zenith Provecta, 2010). However, an integrated approach to roll out onsite renewable energy generation with EV charging infrastructure to support EV fleets could help to address some of these concerns. Zenith are beginning to see an initial interest in EVs from their clients, demonstrable by the initial presence of zero emission vehicles.

Salary sacrifice is a strategy for providing cars to employees, utilised by Zenith, to provide vehicles to any employee whether or not they are entitled to a company car. A higher percentage of diesel and alternatively fuelled vehicles are again seen compared to the wider UK passenger car fleet. The CO_2 emissions for a sample of salary sacrifice schemes operated by Zenith demonstrate that significantly lower than average emissions profiles can be obtained by using this technique. In addition to the utilisation of emission caps and vehicle choice restriction, the greatest incentive for adopting a lower emission vehicle is the additional savings made through lower rates of tax that these vehicles attract.

Regulated Emissions

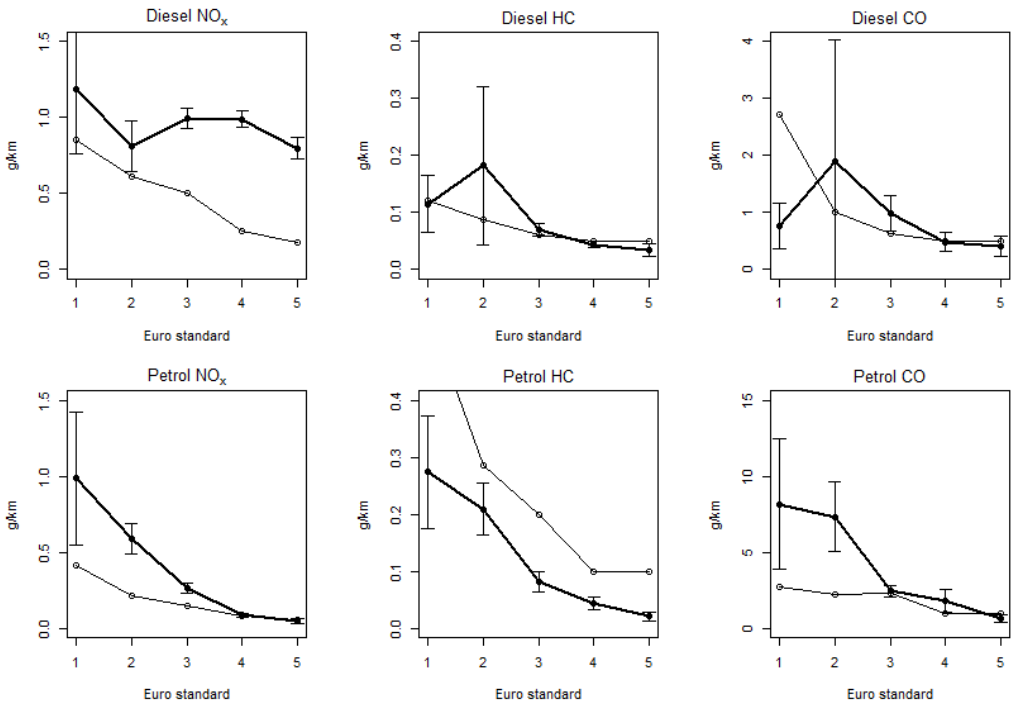

Figure 2-Real world emissions of NOx, HC and CO for petrol and diesel cars of Euro 1—5 standards in Leeds remote sensing data. Thin black lines represent the legislative maxima

There are increasing numbers of diesels on the road in the UK (Department for Transport, 2011a, Department for Transport, 2011b) and, while this is potentially good for fuel consumption and CO_2 emissions, real world concentrations of NO_x have not declined over the last decade or so (Carslaw et al., 2011). Alongside NO_x, emissions of HC, CO and PM were analysed from roadside remote sensing in Leeds, UK.

The real world pollutant estimates in g/km were compared to the maximum allowable emissions on the legislated EU cycle. It can be seen that the results from this dataset confirm the findings of Carslaw et al. (2011), in that there has been no statistically significant decrease in NO_x from Euro 1 to Euro 5 diesels. For other pollutants and petrol cars, there is a general downward trend, although in general only Euro 4 and Euro 5 cars are close to or below the legislated maximum for pollutants in the real world, possibly due to degradation of catalysts.

The error bars for Euro 1 and Euro 2 cars tend to be large due to a low number of observations in these subsets, in addition to outliers. It is not possible to tell from this dataset whether the number of outliers observed is representative of the population of Euro 1 and 2 cars, as some very high individual values were observed, perhaps indicating a malfunctioning catalyst.

Discussion

There is no doubt that emissions have been decreasing over the last decade, with the most considerable emissions reductions seen since 2007. There are a number of reasons that can be attributed to these decreases in emissions. Firstly, it seems no coincidence that the most significant reductions in CO_2 correspond with the development of mandatory targets for manufacturers under Regulation (EC) 433/2009. Although the formal regulation was not released until 2009, draft legislation was made available in 2007 and it was known as early as 2005 that the voluntary scheme was not going to be a success.

There has also been an increase in demand from consumers for more fuel efficient cars. This is especially true for companies who are increasingly sensitive to the costs of travel within their businesses. Changes to align CCT with CO_2 emissions seemed to have had an encouraging effect on companies to reduce emissions in their fleets, through measures such as salary sacrifice schemes. This has been shown to be effective when looking at schemes managed by Zenith, with significantly lower than average emissions profiles being observed. Although not as pronounced, there also appears to be an increase in the demand from private customers for fuel efficient vehicles, largely because motorists view the increasing cost of fuel as the single biggest influence on changing their car purchasing behaviour.

In terms of how this decrease has been achieved several strategies have been employed. It is clear that dieselisation has been a key strategy in reducing emissions. All manufacturers examined in this report have used this as either a primary or supporting strategy in reduction of their average emissions. It is also of no surprise that dieselisation is being seen increasingly in fleets; due to the greater distances company cars are driven.

There is also evidence that private consumers are increasingly choosing diesel cars over petrol cars, seen with preference shown for MPV and dual purpose segments, where most of the dieselisation occurs. However, there is also evidence that dieselisation is reaching a saturation point as the average emissions from diesel and petrol fuels has been converging in recent years from a difference of 17.1 gCO_2/km benefit of diesels to 3.3 gCO_2/km in 2010 (European Environment Agency, 2011). This is also backed up by research by Fontas and Samaras (2007) and Sullivan et al. (2004).

However, caution is required with using dieselisation to such an extent, as although it may bring down CO_2 emissions, other pollutants also need to be considered. The analysis of vehicle emission remote sensing data in Leeds 2011 has shown that there has been no statistically significant reduction in NO_x from Euro 1 to Euro 5 diesels, backing up by the findings of Carslaw et al. (2011).

In terms of alternatively fuelled vehicles, whilst most major manufacturers have, or plan, to introduce hybrid and/or full EVs into their fleets, infrastructure and cost still represent major barriers to uptake of these vehicles. Hu and Green (2011) describe this as a ‘chicken and the egg’ problem with consumers having no incentive to buy an EV unless there are convenient

places to charge it. However, there needs to be a substantial number of these vehicles on the road in order to justify the expense of providing the infrastructure.

It has also been demonstrated that there has been a significant decrease in engine size, which has been shown to have a significant correlation with decreasing CO_2 emissions. This has been the result of increasing use of technologies, such as direct injection petrol, turbocharging and dual clutch transmission, which increases overall specific power and therefore allowing for engine downsizing.

However, one area that has not seen a significant downward trend is the overall weight of cars. This has been proven to be an important factor in reducing emissions (Zervas and Lazarou, 2008, Cuenot, 2009, Carslaw, 2006). This being said there are some manufacturers who are embracing light weighting in order to reduce their emissions. For example, Kia has seen the biggest reductions of all of the 15 major manufacturers analysed with this decrease showing a strong correlation with a decrease in average weight of their fleet. It appears that demand for small cars is increasing with the mini segment seeing an increase in sales, although this has been outweighed by a larger increase in the sales of MPVs and dual purpose vehicles.

The issue of weight is a reminder of the conflicting priorities in consumer choice and therefore, manufacturer's decisions regarding CO_2 mitigation. It would appear that in most cases perception of safety and luxury items in new vehicles has taken precedent over reduction in weight. Whilst it may appear that the issue of luxury may be overcome, safety is not something that can be compromised. Although there is evidence that there may be a link between increased safety with heavier cars (Tolouei and Titheridge, 2009), there is now a growing number of studies that have started to dispute this link (Hutchinson and Anderson, 2010, Zachariadis, 2008). Volvo demonstrate the strong coupling of safety and weight, as the only year that their vehicle weights did not increase was 2008 when no new safety feature was introduced.

One of the biggest barriers to uptake remains the purchasing behaviour of consumers. Whilst we have seen that companies generally behave in a rational way, the behaviour of private consumers is much more complex. This is due to the fact that the choice of a car often represents just as much of an emotional decision as a rational one. This is complicated by the fact that many of the factors which consumers hold in high importance when buying a car are conflicting. For example, factors such as comfort, size and safety are likely to increase the CO_2 emissions of a car and conflict with the desire of consumers for increased fuel efficiency. There is also the complicated issue of price and running costs. Further complexity is found as it has been shown that there is a substantial difference between perceived costs and actual costs (Department for Transport, 2012a, Department for Transport, 2012b).

So whilst it is clear that significant emissions reductions are starting to be seen, the question remains as to whether this is sufficient, even where targets are being met. It is quite apparent from this analysis that manufacturers have used a variety of different measures to achieve their emissions reductions. Therefore, this suggests that further emissions reductions could be made if manufacturers utilised all approaches. There also needs to be questions asked about whether the method of setting reduction targets is optimum. At present a weight based system is used to represent the utility of the vehicle, which has had the effect of discouraging light weighting, as less stringent targets are given to manufacturers with higher average weights. There also remains a question of the reliability of test cycles reflecting real world emissions, which is a significant barrier to accurate consumer information (Pelkmans and Debal, 2006).

Policy Recommendations

In order for effective policy, it is essential to ensure that the CO_2 emission values for individual vehicles are accurate and emission reduction targets are stringent. More research is needed into improving test cycles, particularly in the case of alternatively fuelled cars, and improvements should be made to the EC regulation that would replace the measure of utility from weight to a footprint based standard. It is also important that consumer information, in general, is improved with CO_2 emissions and fuel consumption becoming the major selling point for any vehicle.

Whilst an increase in tax rates is a controversial issue, there is evidence that increasing the tax rates for the highest emission vehicles could help to discourage their uptake, and this could be applied to both VED and the rateable value of company cars. It has been found that a 10%

increase in circulation tax could result in a short term decrease in fleet CO_2 emissions of around 0.3 g/km and 1.4g/km in the long term (Ryan et al., 2009); however, these taxes could disproportionately affect the poor. The approach of increasing the rates of circulation taxes could be particularly useful for CCT, as the welfare impacts of increasing this tax are less concerning than for general circulation taxes and company cars tend to be driven further, increasing the benefit of a lower emission vehicle being selected.

There could be an opportunity for roll out of EV fleets by adopting an integrated approach of support to companies for onsite renewable energy generation with charging infrastructure. This could help to stimulate demand for EVs by providing a positive signal to manufacturers and reduce costs for private sales of these cars. This would also help to bridge “the chicken and the egg” dilemma of whether uptake of EVs proceeds investment in charging infrastructure or vice versa, facilitating wider roll out.

Overall, long term policy signals are required to stimulate development and uptake of low carbon vehicles. For manufacturers, providing targets in advance, which are sufficiently ambitious, will facilitate emissions reductions that can deliver substantial reductions in the transport sector. In addition, long term policy for consumers, particularly for companies, could help to encourage uptake of lower carbon vehicles. For example, at present the lowest emission vehicles will only attract the lowest rate of CCT until 2015-16, and the decision to invest in an EV fleet for example, would require the cost savings to be maintained into the future, in order to see a significant return on the upfront capital.

Conclusion

Whilst this analysis has shown that there has been some positive progress in reducing CO_2 emissions from passenger cars, it has also highlighted several areas where major barriers exist in terms of future reductions in emissions. The EC regulation for manufacturers and CCT have been shown to be the most successful policies. However, private consumers remain more difficult to influence, as emotional decisions are just as important as rational ones here.

There have been a number of methods used to reduce CO_2 emissions, most notably dieselisation and reduction in engine capacities. However, there will be a limit to how far these technological solutions can further reduce emissions, with evidence that dieselisation may be reaching a saturation point. Other means to reduce emissions do exist, such as light-weighting and use of zero-emission vehicles, but have not been seen to a significant extent at present.

This analysis has also highlighted the dangers of focusing solely on CO_2 emissions with the case of NO_x being increased with dieselisation. It is also important to question the ease at which targets are being met and whether information of individual vehicles emissions is accurate and representative. Therefore, policy must first approach this. Beyond this, it appears that policy concerning manufacturers and companies has the potential to be very successful if directed appropriately. However, the bigger challenge will be understanding private consumers and developing policies that will invoke rational rather than emotional decisions for car choice.

It is also important to remember that decreasing emissions from passenger cars alone will not be enough to achieve the significant emissions reductions that are needed in the transport sector. In order for the UK to reach its legislated target of an 80% reduction in CO_2 emissions by 2050, it will be vitally important that policy also addresses the ever increasing demand for car use, which has historically outweighed reductions in individual vehicle emissions. Only then will we be on a path to a truly low carbon transport sector.

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