CHAPTER 7:

REDUCING DOMESTIC TRANSPORT EMISSIONS

This chapter covers domestic (primarily road and rail) transport in the first three budgets, i.e. to 2022. Issues relating to aviation and shipping are dealt with in Chapter 8: *International aviation and shipping*; and the longer term technological vision for surface transport was discussed in Chapter 2: *Meeting a 2050 target*.

The chapter presents estimates of emissions abatement opportunity: these feed in to our conclusions on feasible overall emissions reduction scenarios (Current Ambition, Extended Ambition and Stretch Ambition) which were set out in Chapter 3: *The first three budgets*. It also notes the policy levers which are already in place or which would need to be in place to grasp these abatement opportunities. The key conclusions are that:

- Abatement opportunities from surface transport could lie between 5 $MtCO_2$ and 32 $MtCO_2$:
  - These opportunities are dominated by the scope for improving fuel efficiency of cars (both due to technology innovation and changing car purchase behaviour), but there are also opportunities for improving fuel efficiency of vans and HGVs based on conventional technologies.
  - On the demand side, there is significant emissions reduction potential from a range of measures including eco-driving (e.g. smoother acceleration and braking), modal switch, and better journey planning.
  - There is additional abatement potential from more far-reaching measures including widespread introduction of electric and plug-in hybrid technologies to vans, and possible reductions in and effective enforcement of the speed limit.
- The abatement achieved in practice will reflect the rigour of the policy levers used.
  - Unlocking the full potential for emissions reduction from cars will require a legally binding EU target that fuel efficiency of new cars is no more than 100 gCO_2/km in 2020, supported by a range of domestic policy measures (e.g. awareness raising, fiscal levers). Unlocking the full potential in vans will also require a legally binding framework at the EU level. The Committee's view is that the UK Government should strongly support development and subsequent implementation of these European frameworks which will help us to be on the path to meeting our 2050 emissions reduction goals.
  - On the demand side, a range of levers (e.g. better information, driver training) will be important in delivering deep cuts from changed driver behaviour, modal shift and better journey planning.

The quantity of abatement that we have identified is based on detailed modelling and reviewing the literature. It is not, however, exhaustive of all options for reducing transport emissions. Policies for transport infrastructure access and land use planning could, for example, be designed in ways that would further reduce emissions. It is our intention to explore scope for emissions reduction via these levers as part of our work programme going forward.

The analysis that we have carried out feeds in to the Current Ambition, Extended Ambition and Stretch Ambition scenarios for economy wide emissions reduction in Chapter 3.

The analysis that we have carried out is set out in five sections:

1. Present transport emissions, historic trends and reference emissions projections.
2. Abatement opportunities: supply side improvements in carbon efficiency.
3. Rebound effects and demand side policy levers to achieve supply side potential.
4. Abatement opportunities: possible dimensions of demand side reduction.
5. Overall conclusions: reasonable assumptions on attainable abatement for budget purposes.

1. PRESENT EMISSIONS, HISTORIC TRENDS AND REFERENCE EMISSIONS PROJECTIONS

While the UK has achieved reductions in emissions overall, domestic transport emissions have increased 9% from 1990 to 2006 and now account for over 130 $MtCO_2$ (i.e. about 24%) of all CO_2 emissions in the UK's national inventory[1] as shown in Figure 7.1 (in addition, the UK's share of aviation emissions, considered in Chapter 8, amounts to around 38 $MtCO_2$).

Private road transport (cars, vans and HGVs) currently accounts for 86% of total transport emissions, with 4% from buses, 2% from rail and 2% from domestic aviation (Figure 7.2). Our main focus in Sections 2 to 4 below is therefore on abatement opportunities in private road transport, covering cars, vans and heavy goods vehicles (HGVs). But we also consider the issue of whether modal shift to less carbon intensive public transport can contribute to emissions reduction, and refer briefly to abatement potential in rail.

We now cover in turn historical trends and reference emissions projections for:

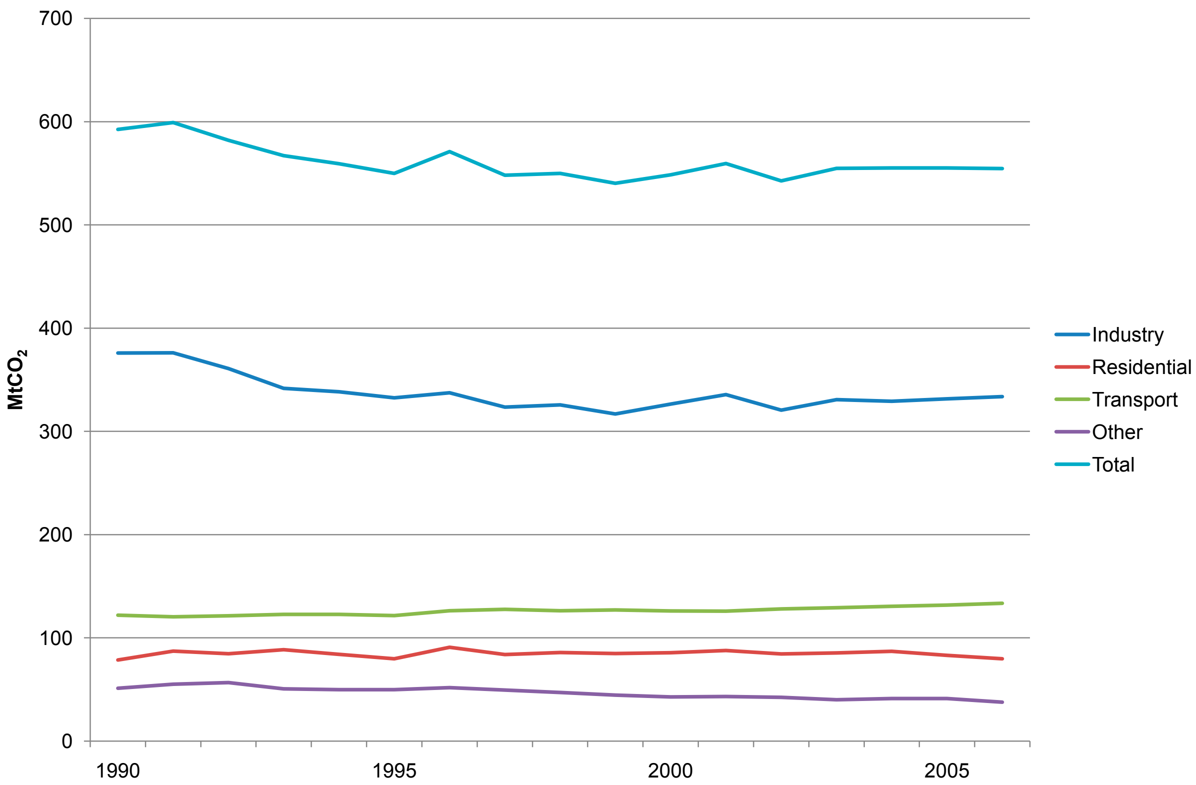
(i) Cars, vans and HGVs

(ii) Bus and rail

(iii) Domestic aviation

(iv) Overall reference emissions projections

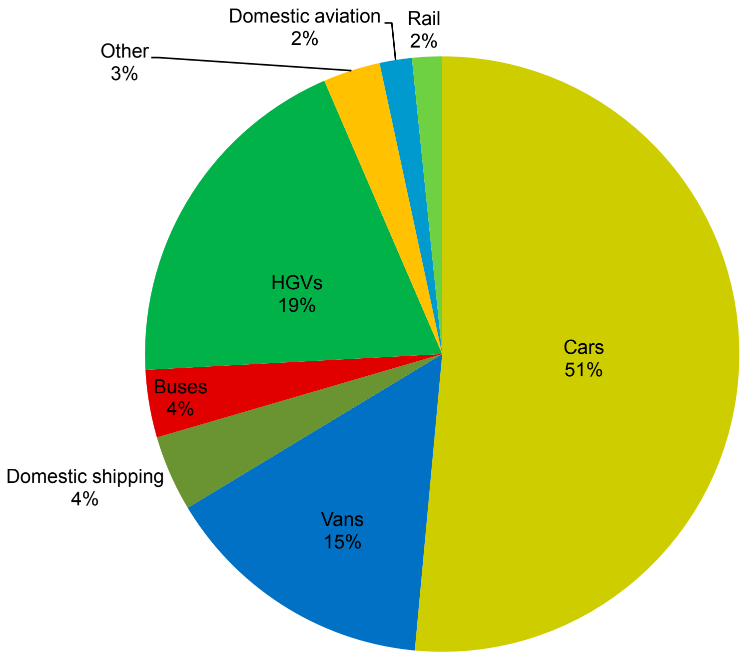
Figure 7.1 Total UK Emissions from all sectors 1990-2006



Source: NAEI.
Note: Emissions by source.

1 UK National Atmospheric Emissions Inventory (NAEI); emissions data by source category.

Figure 7.2 Breakdown of transport emissions by mode, 2006



Source: NAEI

(i) Cars, vans and HGVs

For each of these categories of private road transport it is useful to distinguish clearly between trends in demand growth (vehicle-km or tonne-km) and trends in carbon efficiency (gCO_2/vehicle-km or tonne-km) which together drive total emissions.

- **Passenger cars:** Demand for passenger car travel, whether measured in passenger-km or vehicle-km, increased by 20% between 1990 and 2006, and is on a trend growth path of 1% per annum. Demand growth has, however, been offset by falling gCO_2/vehicle-km travelled, with total emissions as a result on a roughly flat trend. Falling gCO_2/vehicle-km have been achieved through the Voluntary Agreements to reduce new car emissions between the EU and car manufacturers, supported by measures aimed at raising customer awareness and differentiation of both company car taxation and Vehicle Excise Duty (VED) by carbon intensity (Box 7.1). Looking forward the reference emissions projection reflects a modest trend increase in carbon efficiency[2], but assumes no successor policy to the Voluntary Agreements; mandatory EU targets currently being negotiated – discussed in Section 2 below – are not included in the reference case. In the reference emissions projection, demand growth is likely to more than offset a declining rate of carbon efficiency improvement, with total emissions therefore rising as Figure 7.3 illustrates.

- **Vans:** Vehicle-km travelled by vans (also called light goods vehicles; defined as non-passenger cars with a weight of less than 3.5 tonnes) have grown very rapidly over the last 15 years, and projections suggest that they will continue to grow at 2% per annum (Figure 7.4). The precise causes of this growth are not well understood. Usage of vans is balanced between delivery journeys and travel to and between jobs by a wide variety of business trades (Figure 7.5) but it is unclear which categories have contributed most to the growth. Available data on gCO_2/km suggest an erratic pattern, which may reflect imperfect information, but it is clear that there is not a strong downward trend in carbon intensity equivalent to that seen for cars. Although much of the technology for cars developed under the VAs could have been

2 The reference emissions projection is generated from DfT's National Transport Model (NTM). It includes use of biofuels rising to 5% by volume in 2013/14 and then staying at this level until 2022; biofuels are discussed in Section 2 below.

used to reduce emissions from vans, the lack of a clear European policy framework to drive change in this area has meant that efficiency improvements have been offset by increasing van size and weight. If new policy measures are not taken, emissions can be expected to grow significantly over the next 10 years, reaching as much as 22 $MtCO_2$ by 2022.

- **Heavy goods vehicles (HGVs):** Over the long term, HGV traffic has grown, with vehicle-km up 17% since 1990, but with a roughly flat trend over the last 5 years (Figure 7.6). Tonne-km have however continued to grow slightly (Figure 7.7). Looking forward reference projections for demand suggest further growth, but at a considerably slower pace than for cars or vans. Carbon efficiency for HGVs has improved with a long-term trend of around 0.8-1% per year[3], but there is a question over the extent to which this will continue given negative carbon impacts from EU legislation aimed at air quality improvements[4]. On balance, emissions are projected to be roughly flat over the next two decades. HGVs are therefore less likely to be a key cause of emissions increase than cars and vans, but a clearer policy framework would still be desirable to ensure emissions reduction.

Box 7.1 Current EU framework on reducing new car emissions

The decrease in new car gCO_2/km since 1998 is due to the existing EU framework. This ensures that the demand side supports the supply side changes agreed by manufacturers, as it is based on three pillars:

- targets for new car emissions
- Member States' fiscal frameworks
- improved information to consumers on emissions of cars.

The current **targets on new car emissions**, in place since 1998, are Voluntary Agreements (VAs) between the EU and vehicle manufacturer associations to reduce the EU-wide sales-weighted average new car emissions to 140 gCO_2/km in 2008-09. The VAs are between European, Japanese and Korean manufacturer associations which sell cars in the EU with the target applying to cars only (M1 vehicles).

As the target is for the sales-weighted average new car emissions, there is not a specific target by Member State and progress will depend on the performance of models sold by each manufacturer and the fuel used across the whole of the EU.

Fiscal frameworks are within the competency of individual Member States. In the UK, since 2001, car tax has been linked to emissions through Vehicle Excise Duty and since 2002 company car tax has been linked to emissions. These tax systems support consumers willing to purchase the lower emissions vehicles on offer through the VA.

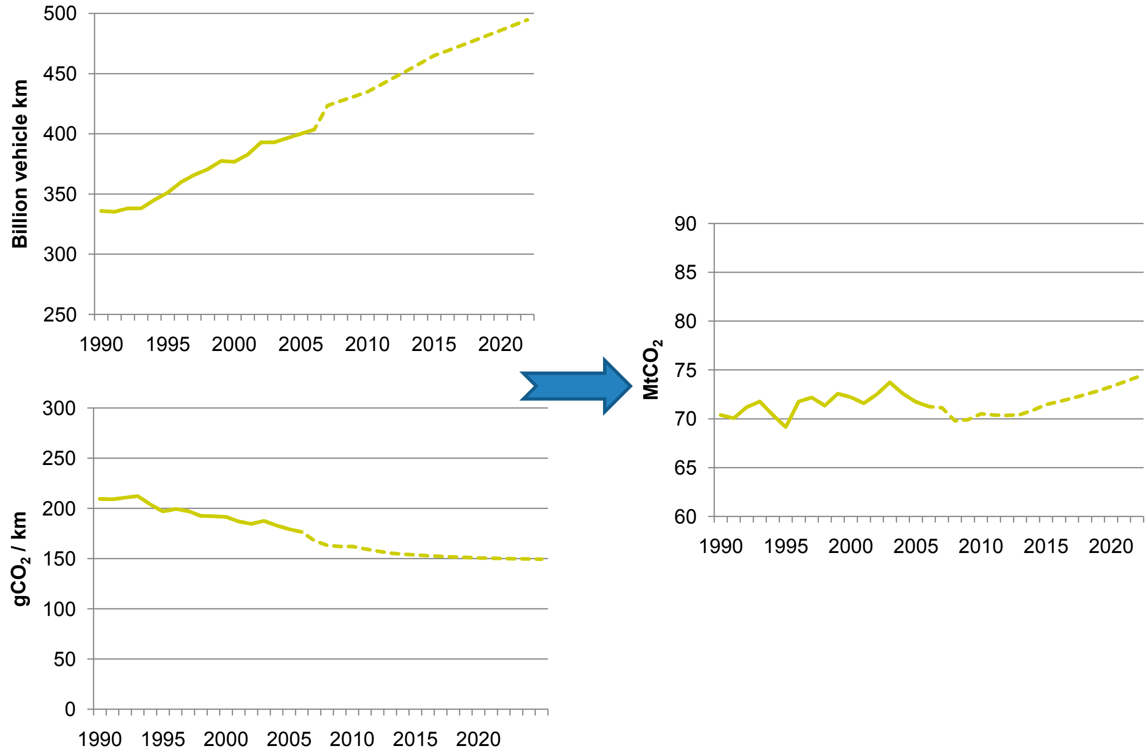
The **improved information to consumers** takes the form of fuel efficiency labelling for new cars. This is covered in more detail in Section 3 below.

Although the EU framework has reduced new car emissions, it is now recognised that the VA target will not be met. In the UK, new car emissions have fallen from 190 gCO_2/km in 1997 to 165 gCO_2/km in 2007, an improvement of 13%. The EU-average new car emissions have fallen from slightly lower starting levels to 160 gCO_2/km in 2007.

Source: http://ec.europa.eu/environment/air/transport/co2/co2_home.htm

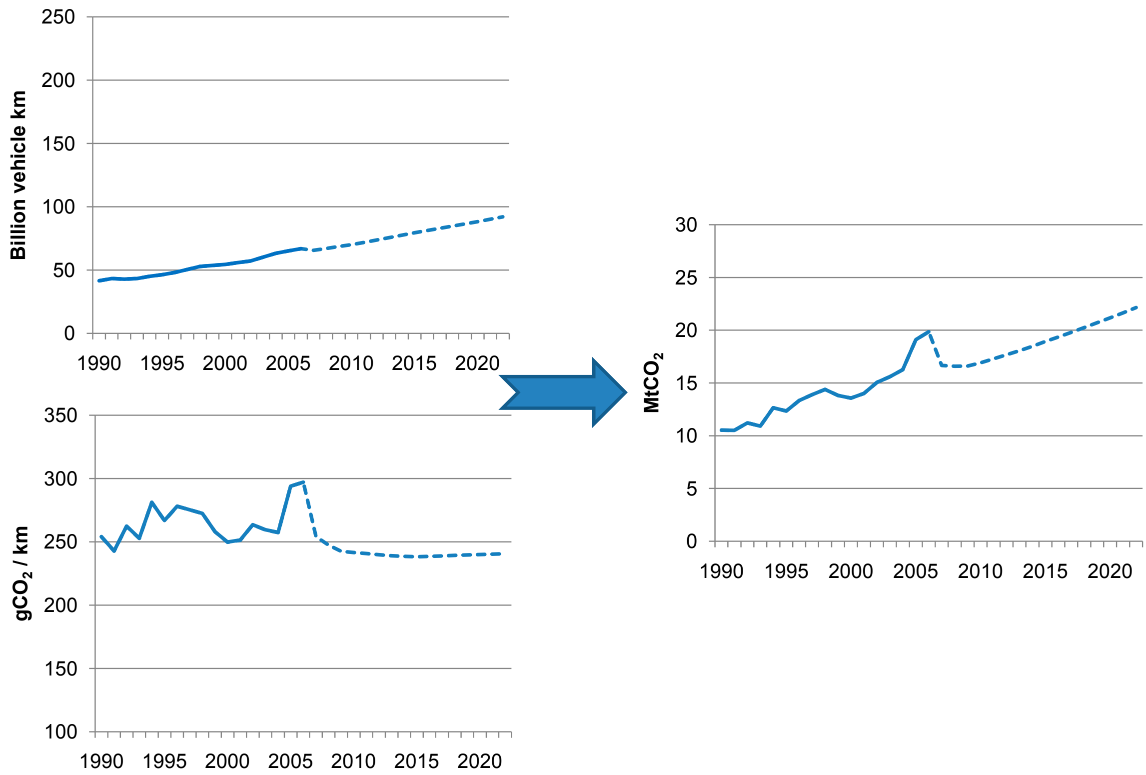
3 McKinnon, A (2008) *Advice on CO_2 Emissions from the UK Freight Transport Sector.* Committee on Climate Change.
4 The Euro standards are aimed at reducing emissions from diesel vehicles, such as vans, HGVs, buses and coaches, which reduce air quality. The filters introduced on new vehicles to ensure that emissions meet Euro standards to improve air quality work to increase CO_2 emissions.

Figure 7.3 Historical trends and reference projections of vehicle-km, $MtCO_2$ and gCO_2/km for cars



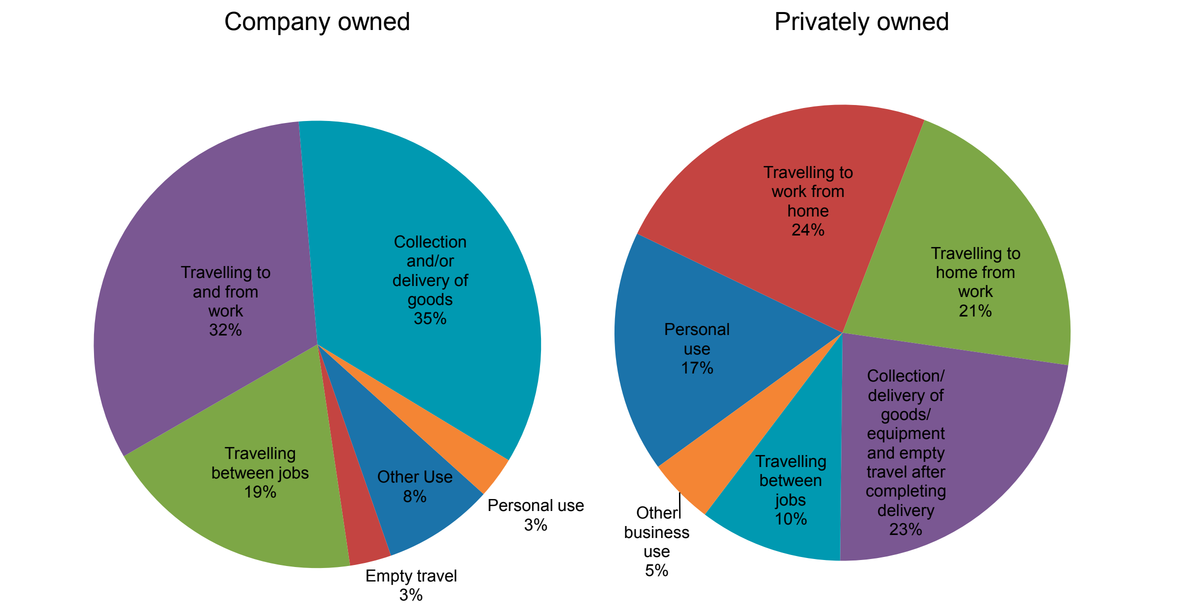
Source: DfT, NAEI.

Figure 7.4 Historical trends and reference projections of vehicle-km, $MtCO_2$ and gCO_2/km for vans



Source: DfT, NAEI.
Note: The jump in emissions is due to moving from historically recorded to modelled figures.

Figure 7.5 Breakdown of van vehicle-km by purpose of travel

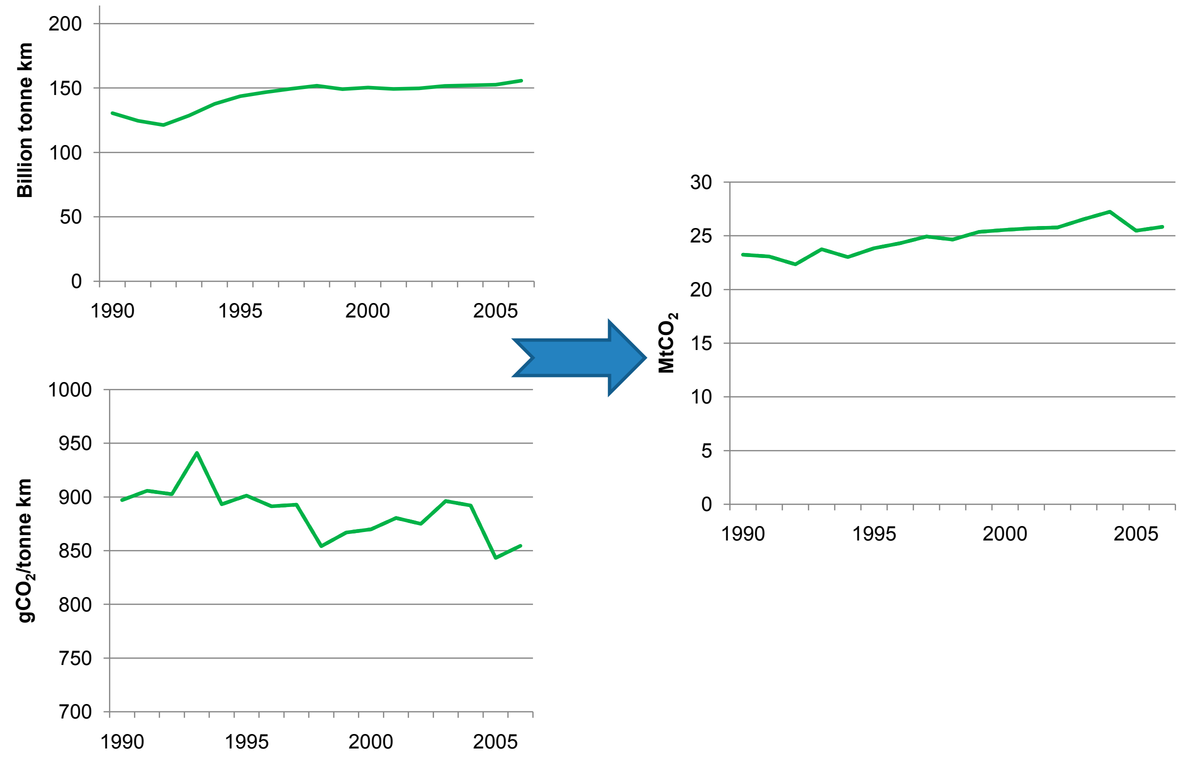


Source: DfT (2003/4).

Figure 7.6 Historical trends and reference projections of vehicle-km, gCO_2/km and $MtCO_2$ for HGVs

Source: DfT, NAEI.
Note: Note the fall in projected gCO_2/km is due to moving from actual to modelled figures and use of biofuels; slower improvements from 2014 are due to the Euro fuel standards.

Figure 7.7 Historical trends in HGV tonne-km, gCO_2/tonne-km and $MtCO_2$



Source DfT, NAEI.

(ii) Bus and rail

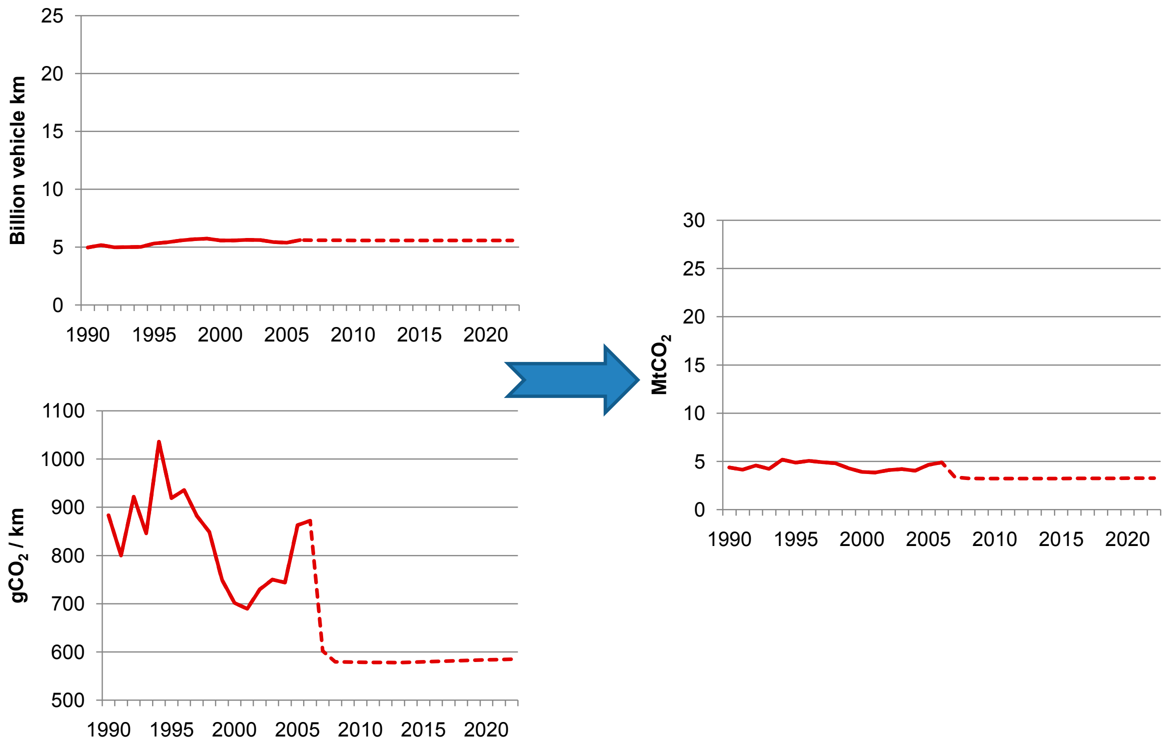
As we have shown in Figure 7.2, private road vehicles (cars, vans and HGVs) are responsible for 86% of all domestic transport emissions, and our key focus must therefore be abatement opportunity in that sector. Other transport modes are of interest, however, given scope for efficiency improvements to reduce emissions by mode; and modal shift which could reduce total transport emissions, even if emissions from lower emitting modes increase.

Bus transport vehicle-km have been relatively stable historically, while average carbon efficiency has steadily improved; emissions have therefore fallen slowly, as shown in Figure 7.8. Reference projections suggest that emissions will remain flat, as there is little projected change in vehicle-km or efficiency.

Passenger rail km, after declining to the mid 1990s, are now on a strong upward path, growing at over 4% per year, and could be up 40% by 2022 relative to 2006 (Figure 7.9). Freight tonne-km are growing at over 4% per year[5]. The historical data does not allow us to distinguish between passenger and freight emissions, but it is likely that the former dominate total rail emissions given that passenger services account for the vast majority of total train km. The overall trend is that rail emissions have grown 29% over the period 1990-2006, driven by increasing demand. Looking forward, reference emissions are projected to increase by 14% over the period from 2006 to 2020 (Figure 7.10).

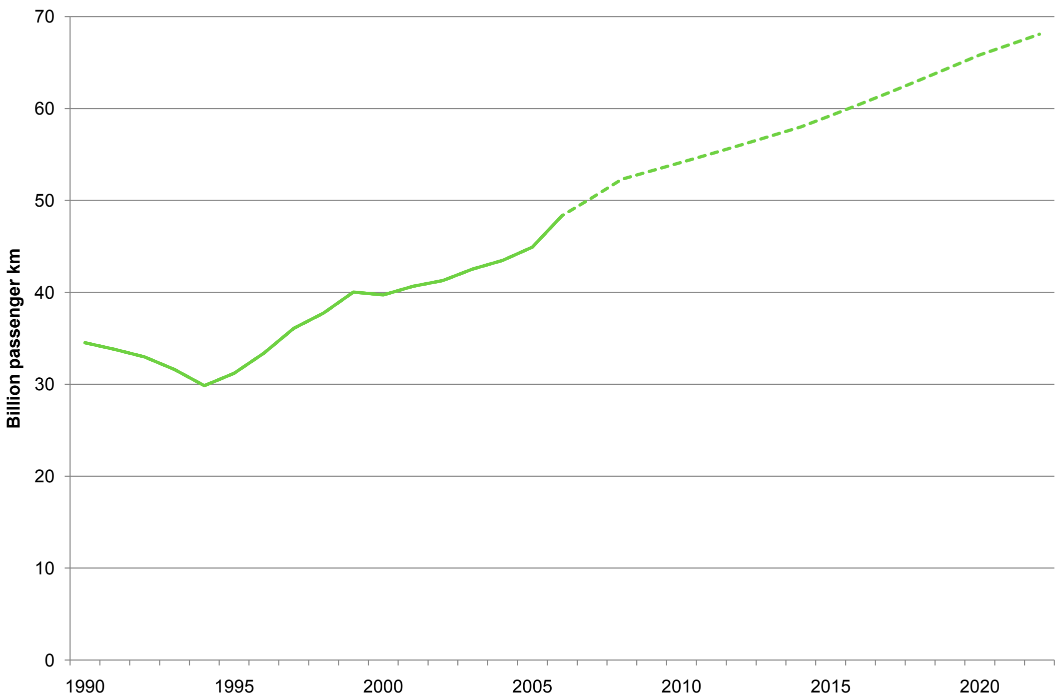
5 Passenger-km and tonne-km figures are average annual growth 2003-2006.

Figure 7.8 Historical trends and reference projections for bus vehicle-km, gCO_2/km and $MtCO_2$



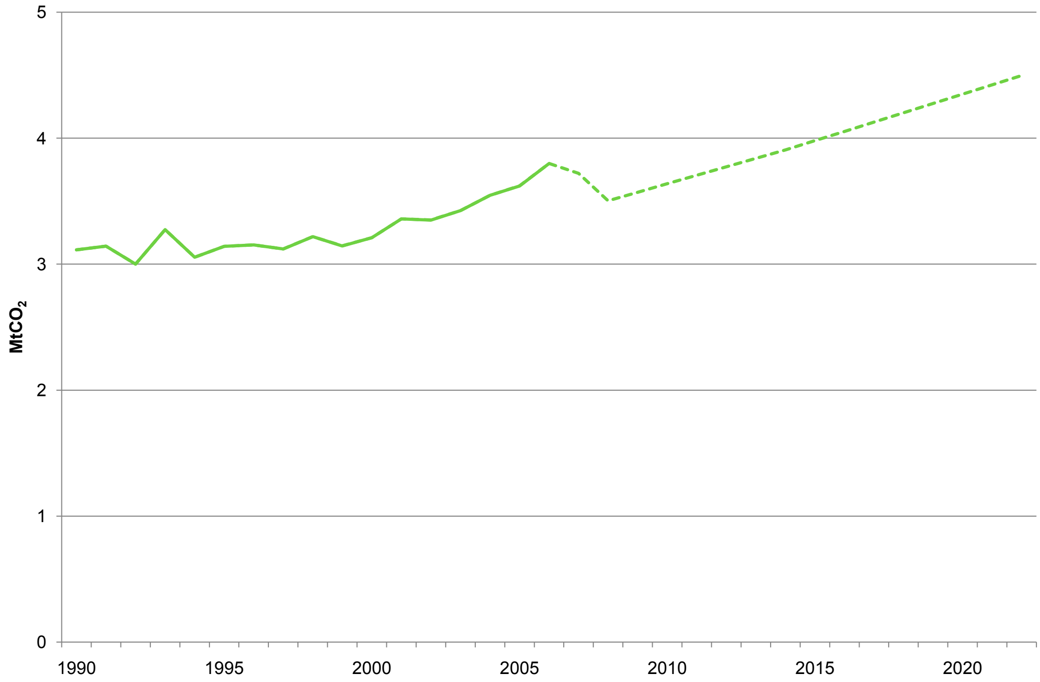
Source: DfT, NAEI
Note: Fall in carbon efficiency due to move from actual to modelled figures.

Figure 7.9 Historical trends and reference projections for rail passenger-km



Source: DfT; Excludes London Underground and other urban metros

Figure 7.10 Historical trends and reference projection of CO_2 emissions from rail

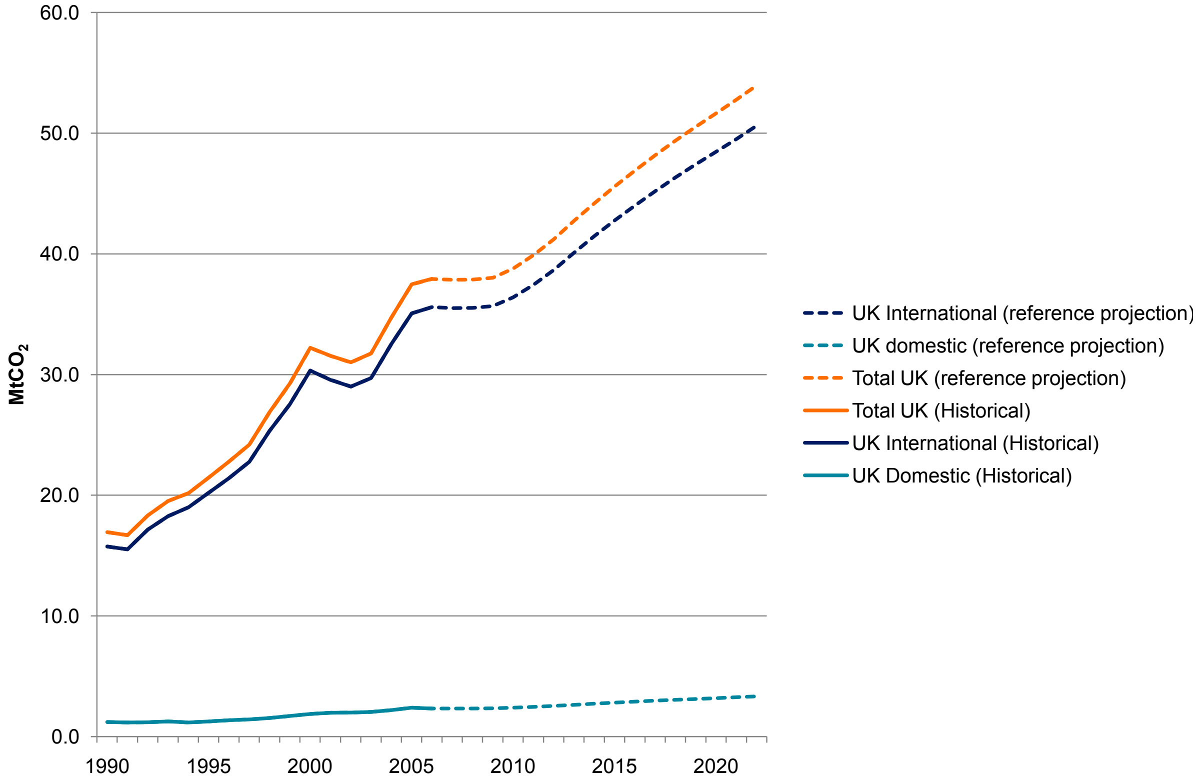


Source: DfT, NAEI
Note: There is a mismatch between inventory data and projections that causes the drop 2006-2008. Total rail emissions from diesel and electric rail.

(iii) Domestic aviation

UK aviation emissions are dominated by international travel flows (Figure 7.11). The trends in total aviation emissions (domestic and international) and the opportunities for abatement are considered in Chapter 8. We mention it here to provide a context for the discussion of modal switch in Section 4 and, in particular, possible scope for switching domestic aviation to rail. Domestic aviation accounts for about 2.3 $MtCO_2$ of emissions, rising at around 2% per annum as demand grows.

Figure 7.11 Historical trends and reference projections of CO_2 emissions from domestic and international aviation

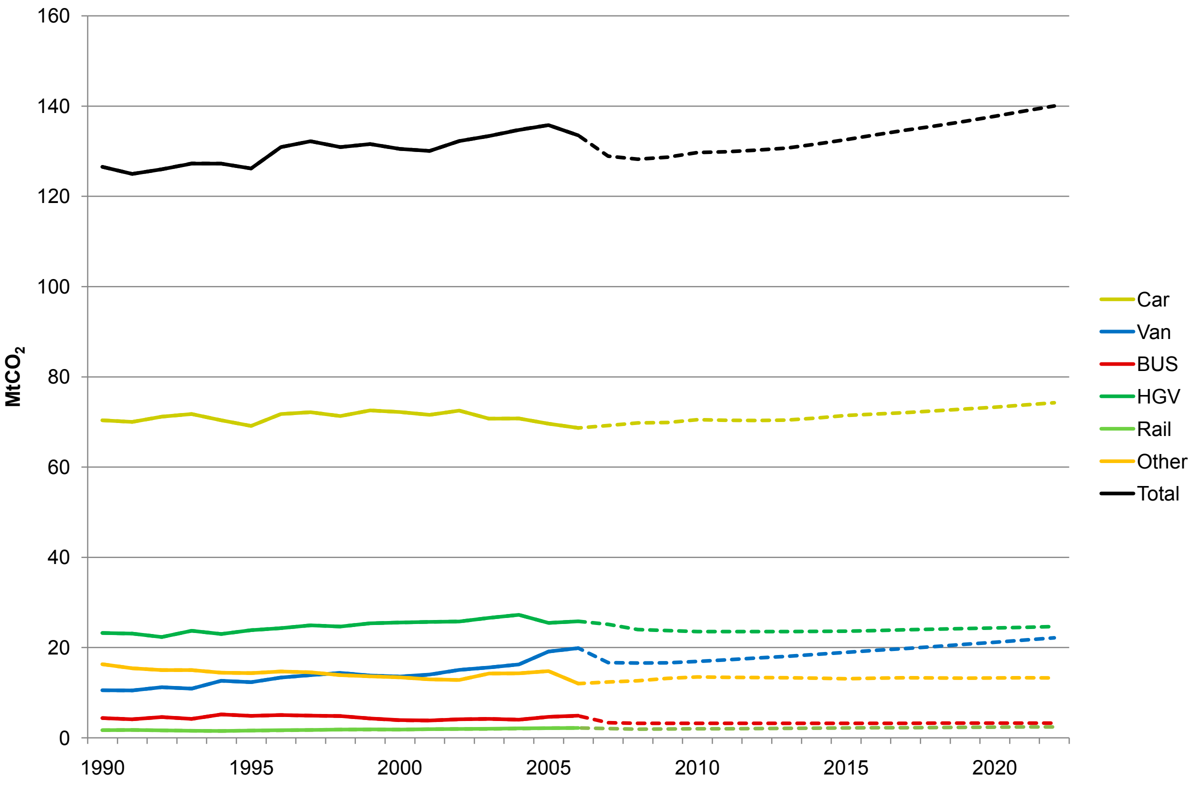


Source: DECC, NAEI.

(iv) Overall reference emissions projections

The overall trend in reference emissions projections is illustrated on Figure 7.12. If abatement opportunities are not achieved beyond those implied by reference projection assumptions, emissions from domestic transport will grow from 134 $MtCO_2$ to 140 $MtCO_2$, with transport's share of total emissions increasing from 24% in 2006 to 30% in 2022.

Figure 7.12 Breakdown of historical trends and reference emissions projections of transport by mode



Source: DfT, NAEI.
Note: Reference projections are not calibrated to the NAEI.

2. ABATEMENT OPPORTUNITIES: SUPPLY SIDE IMPROVEMENTS IN CARBON EFFICIENCY

A wide range of opportunities exist to reduce emissions via supply side measures (i.e. by improving the carbon efficiency of transport without changing either the total level of transport demand or the balance between different modes). The opportunities are largest for cars, but major potential may also exist in vans and HGVs.

We cover below:

(i) Key technological developments in road transport

(ii) Supply side abatement opportunities in cars

(iii) Supply side abatement opportunities in vans

(iv) Supply side abatement opportunities in HGVs

(v) Supply side abatement opportunities in rail

(i) Key technological developments in road transport

There are a range of technology developments which can drive improved carbon efficiency in road transport, and which are, to different degrees, applicable to cars, vans and HGVs.

Possible long-term technological developments in road transport have already been discussed in Chapter 2. In the first three budget periods, three categories of technology development are relevant.

Improvements in carbon efficiency without a change in energy source. Within this category there are opportunities for:

- More widespread penetration of diesel vehicles, which are more fuel efficient than petrol vehicles. For example, a medium car with a conventional diesel engine would have average emissions around 15 gCO_2/km lower than the same vehicle with a conventional petrol engine[6].

- Improvements in the efficiency of petrol and diesel internal combustion engines. For example, compared to a conventional petrol engine in a medium sized car, emissions could be reduced by around 20 gCO_2/km using a second generation advanced petrol engine, and by around 25 gCO_2/km using a stop-start engine.

- Wider use of hybrid engine technologies, which improve the fuel and carbon efficiency of engines by capturing the energy otherwise dissipated in decelerating and braking. A full hybrid petrol engine (for a medium car) would have around 50 gCO_2/km fewer emissions than a conventional petrol engine.

- Non-powertrain measures including improvements in aerodynamic design, weight reduction, and more widespread use of gear shift indicators and low rolling resistance tyres, which together might have potential to reduce emissions by around 10-15%[7].

6 All efficiency figures in this section were provided by the consultants Ricardo as part of the assignment to develop a model of supply side opportunity, discussed in subsection (ii) below.

7 A conservative estimate is that each non-powertrain measure can save around 2% of emissions. Reductions in emissions are not, however, additive across measures, given falling fuel consumption as more measures are added.

All of these types of technology development can be applied to cars, vans and HGVs.

The use of electricity as an energy source. Chapter 2 described the potential role of two different new vehicle technologies: electricity-based and hydrogen. In the long-term, either may play a significant role, but in the first three budgets, hydrogen vehicles are unlikely to be deployed on a significant scale because of the lack of low-carbon sources of hydrogen and an associated hydrogen supply infrastructure.

Electrical power however could play a significant role in the new car market, whether as an ancillary energy source to petrol or diesel (plug-in hybrids) or in fully electric vehicles.

As discussed in Chapter 2, electric cars have inherent performance and carbon efficiency advantages; and the only – but important – issue holding back their growth is battery capacity, weight and cost. But progress is being made on battery performance, and there are some major manufacturers planning new electric car launches. A major role for plug-in electric cars and for full electric cars in the new car market is possible by 2020.

Electric technologies (whether plug-in or full) are also potentially applicable to some of the van market, particularly where distances travelled are relatively small and where there are central depots to facilitate recharging. Electric technology is however unlikely to make any significant contribution to HGV emissions reduction in the first three budget periods, given the large distances travelled and the limitations of battery capacity. There is some potential for electric technology for small HGVs, which we consider in our Stretch Ambition scenario as described below.

Biofuels as an energy source. Chapter 2 described some of the issues relating to the potential growth of biofuels as an alternative energy source. At present fossil fuel prices, some variants of 'first generation' biofuel are already at or close to competitive, as shown in Box 7.2.

There remain, however, significant issues relating to the true carbon efficiency of some biofuels and there are concerns about their impact on other aspects of environmental sustainability and food supply. These issues have been addressed in the Gallagher Review[8], which recommended a range for use of sustainable biofuels in the UK from 5%-10% of total fuel consumption (4-8% of total energy for road transport) in 2020 (Box 7.3).

The Committee concurs with the judgements reached by the Gallagher Review and has therefore treated recommended targets in the review for biofuel penetration as a reasonable basis for carbon budget setting[9]. EU and UK policies, which have set targets above the Gallagher recommended use, are currently being reconsidered following the Gallagher Review (Box 7.4).

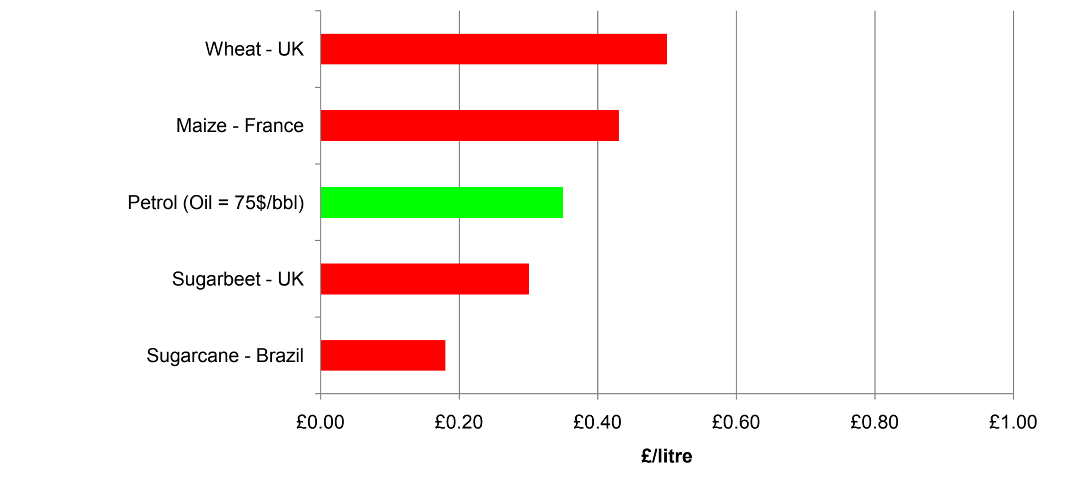
Biofuels are equally applicable to cars, vans and HGVs, and may be particularly important in the long-term in the HGV sector, given the greater difficulties of applying electricity in that sector than in cars and light vans; in the analysis below, we assume that biofuels are used for each of these vehicle types.

8 Gallagher, E.(2008) *The Gallagher review of the indirect effects of biofuels production*. Renewable Fuels Agency.

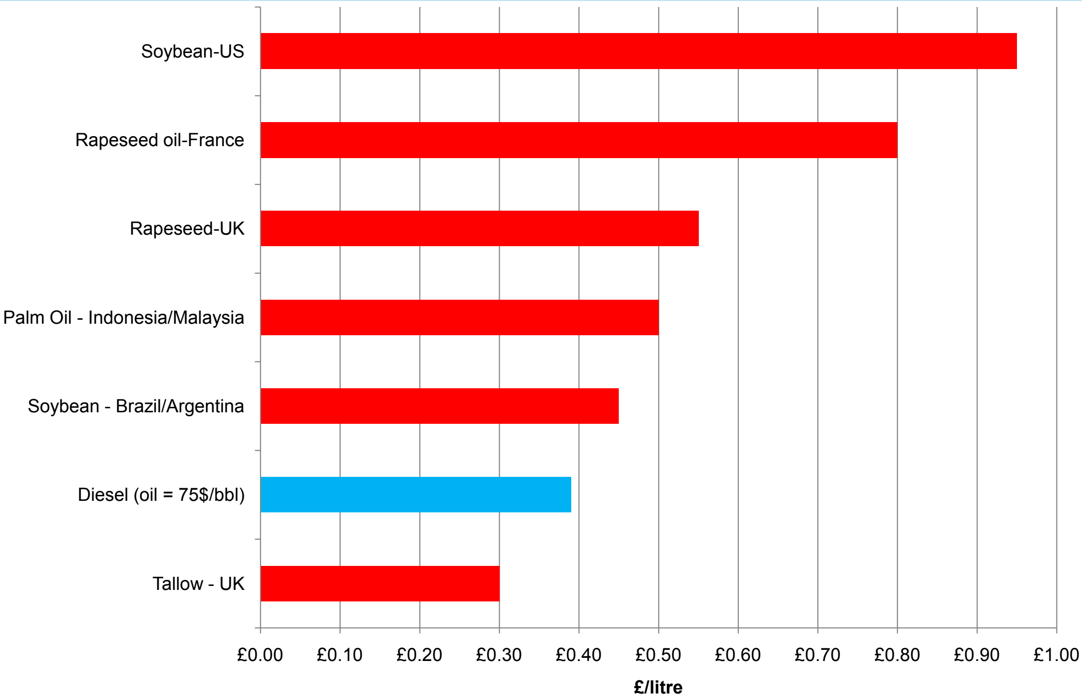
9 Specifically, our reference emissions projections include 5% biofuels by 2014. Our Current Ambitiion scenario assumes no additional biofuels relative to the reference projection. The Extended Ambition scenario includes additional uptake, which reaches a total of 10% by volume (8% by energy) in 2020.

Box 7.2 Comparison of the pre-tax costs of biofuels with conventional fuels

Comparison of the unit pre-tax cost of bioethanol with conventional petrol



Comparison of the unit pre-tax cost of biodiesel with conventional diesel



NB: $/£ exchange rate of 1.75 is assumed

Source: E4Tech, DECC

Box 7.3 Recommendations of the *Gallagher Review of the Indirect Effects of Biofuels*

The Gallagher Review called for a slow down in the growth of the use of biofuels. This recommendation was grounded on uncertainties surrounding the role of biofuels in rising food prices, its contribution to deforestation, the future availability of land for cultivation of feed stocks and doubts about the net greenhouse gas impact of biofuels when indirect land use change is considered.

The specific recommendations are as follows:

- The current Renewable Transport Fuel Obligation (RTFO) target for 2008/09 should be retained. This means 2.5% (by volume) of fuel sold on UK forecourts should be biofuels.
- The proposed per annum rate of increase under the RTFO of biofuels should be reduced to 0.5% (by volume); rising to a maximum of 5% (by volume) in 2013/14. Under the RTFO 5% (by volume) would be reached in 2010.
- The RTFO is reviewed in 2011/12 to complement and coincide with the 2011/12 EU review of Member States' progress on biofuels targets.
- Targets higher than 5% (by volume) should only be implemented beyond 2013/14 if biofuels are shown to be demonstrably sustainable. Failure to deliver demonstrably sustainable biofuels should result in a reduction in the target after 2013/14.
- The proposed EU biofuels target of 10% by energy is unlikely to be met sustainably and the introduction of biofuels should therefore be slowed. New targets should be set of between 5% and 8% (by energy) for the EU for 2020 including 1-2% from advanced technologies.
- There should be a specific EU-wide obligation to encourage advanced or second generation technologies to commence in 2015 rising to 1-2% by energy in 2020.
- If a global policy framework were in place to ensure sustainable production of biofuels **and** new evidence was to provide further confidence in the net greenhouse gas savings of biofuels then a higher trajectory could be embarked upon starting in 2016 and rising to 10% by energy in 2020.
- However, if the industry fails to deliver demonstrably sustainable biofuels by 2013/14 the level of the target could also be reduced for subsequent years with a portion of growth from advanced technologies implemented in 2015 rising to 1-2% by energy in 2020.

Source: Renewable Fuels Agency.

Box 7.4 Current EU and UK policy on biofuels

In 2003, the EU Biofuels Directive on the promotion of the use of biofuels or other renewable fuels for transport set a reference target of 5.75% (by energy) of biofuels of all petrol and diesel for transport placed on the market by 31 December 2010. This aim of increasing the use of biofuels was extended in January 2008 when the EU proposed the Renewable Energy Directive on the promotion of the use of energy from renewable sources which includes a mandatory target for all Member States that 10% of transport fuel come from renewable sources by 2020, although the proportion from biofuels or renewable electricity or hydrogen wasn't specified.

In light of evidence and recommendations of the Gallagher Review, in September 2008, the European Parliament's industry committee approved reduced targets for biofuels:

- 2015 goal of 5% of road transport fuel from renewable sources, of which a fifth should be alternatives to biofuels

- 2020 goal of 10% of road transport fuel from renewable sources, of which at least 4% should be achieved through renewable electricity or hydrogen; or from second-generation biofuels from waste. The remaining 6% would come from biofuels from crops.

In the UK in 2007, the government had committed to a national target of 5% biofuels sales by volume of total road transport fuel sales by 2010, in its Renewable Transport Fuel Obligation (RTFO) policy. This is lower than the reference target set out in the EU Biofuels Directive, due to continuing government concerns about the sustainability of increased biofuel supply and existing EU fuel quality standards on biofuel blends.

In light of evidence and recommendations of the Gallagher Review, the UK Government now believes a more cautious approach to biofuel production than currently implied in the RTFO may be necessary. It has recently launched a consultation which considers three options:

(i) Leaving the RTFO unchanged

(ii) Freezing the RTFO at 2.5%

(iii) Adopting the Gallagher recommendations (reaching 5% by volume in 2013).

If further legislation is appropriate, a draft of the Renewable Transport Fuel Obligations (Ammendment) Order will be laid before Parliament in early 2009.

Source: Euractiv.com; DfT.

(ii) Supply-side abatement opportunities in cars

Given the range of technologies outlined above, we believe that it is possible that the carbon intensity of new cars purchased[10] could be reduced from the present UK average of around 164 gCO_2/km to below 100 gCO_2/km by 2020. This could drive average fleet (old and new cars) carbon intensity from over 170 gCO_2/km to around 130 gCO_2/km, and could result in emissions 12 $MtCO_2$ tonnes lower than in the reference emissions projection.

10 Assuming that people continue to buy the same size vehicles as currently but that more people buy the fuel efficient vehicles within size category.

We arrived at this conclusion using a model which we developed in conjunction with a consortium of consultancies including AEA, Ricardo, Metronomica, E4Tech, IEEP and CE Delft. Specifically, we developed a model which provides Marginal Abatement Cost Curves (MACCs), relating emissions reductions and associated costs for a range of technology options, and for cars, vans and HGVs.

Focusing first on cars, the model works by defining various technology bundles, with each bundle comprising a set of technology options (e.g. 10% more efficient conventional engines, 5% more hybrids, non-powertrain measures applied to 75% of new vehicles). The model can be used to generate scenarios based on technology bundles for new cars which are absorbed into the car stock as this turns over.

Working with the consortium, we defined a range of scenarios reflecting judgements on feasible production and uptake rates of technologies under various possible policy frameworks. These should not be regarded as predictions of how the car industry will develop, but rather plausible indicative scenarios. The range of scenarios we have developed feeds into the Current Ambition, Extended Ambition and Stretch Ambition presented in Chapter 3[11].

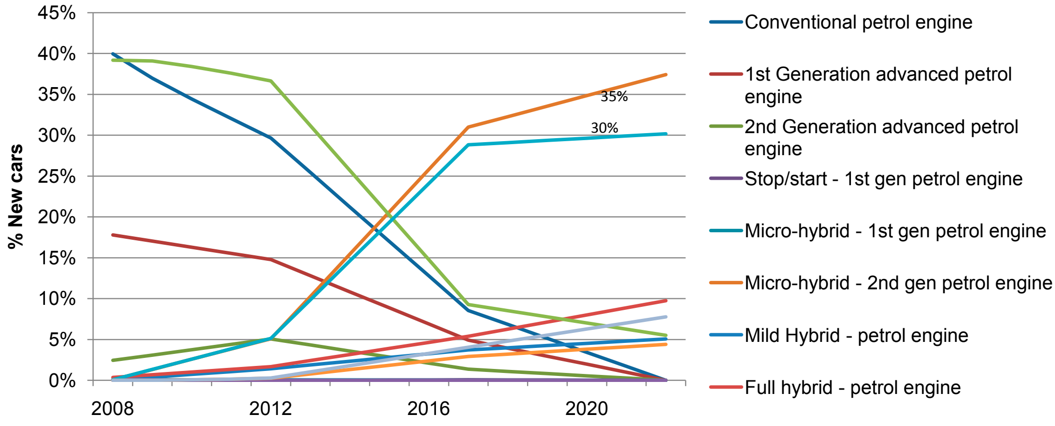
Focusing first on the Current Ambition scenario, this is defined by increasing uptake of hybrid vehicles and limited use of non-powertrain technologies (Figure 7.13). There are no plug-in hybrids or electric cars in this scenario. This scenario delivers an emissions reduction of 4 $MtCO_2$ in 2020, and an average new car fuel efficiency of 130 gCO_2/km.

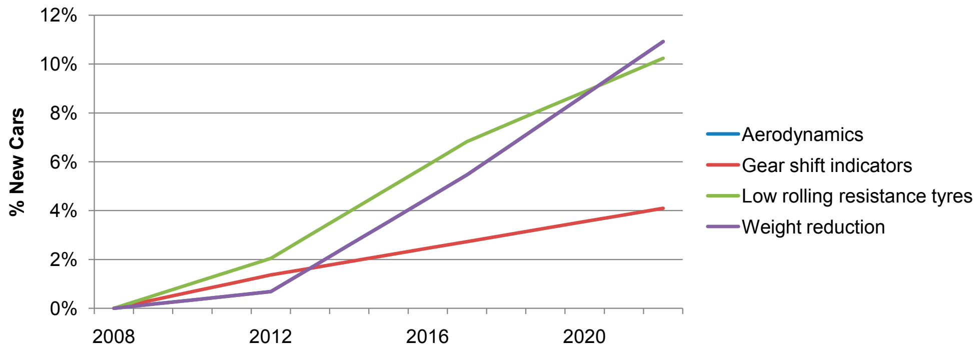
The Extended Ambition scenario is defined by increased uptake of hybrid vehicles and the introduction of plug-in and electric vehicles in later budget periods, with extensive use of non-powertrain technologies (e.g. widespread incorporation of improved aerodynamic design) in new vehicles by 2020 (Figure 7.14). This scenario delivers an emissions reduction of 12 $MtCO_2$ in 2020, and an average fuel efficiency for new cars of 95 gCO_2/km[12].

11 In this chapter, we have used the 'Current' and Extended' terminology not to indicate current and extended policy ambition but to ensure consistency with other chapters.

12 Both the Current Ambition and Extended Ambition estimates for emissions reduction are adjusted to take account of possible rebound effects, discussed more in Section 3 below.

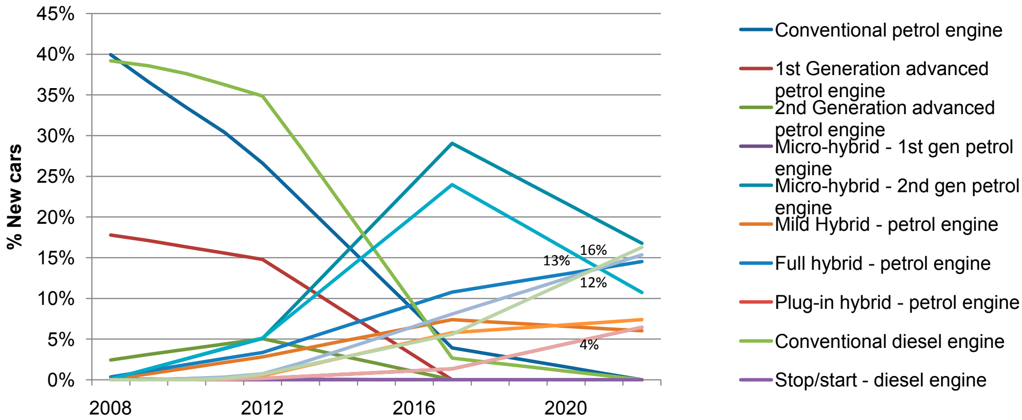
Figure 7.13 Car technology uptake rates (Current Ambition)

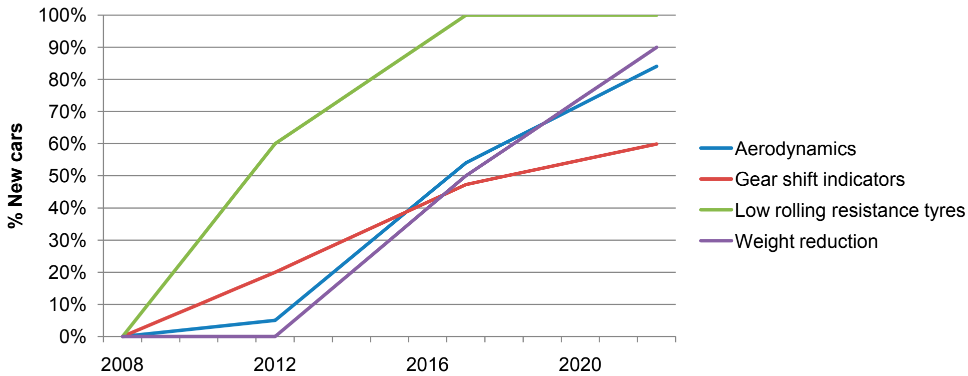




Source: CCC.

Figure 7.14 Car technology uptake rates (Extended Ambition)





Source: CCC.

Box 7.5 Summary of EU framework on new car emissions 2012 and 2020

Mandatory EU target of 120 gCO_2/km in 2012

In December 2007, the European Commission adopted a proposal for legislation for a mandatory successor to the VAs, with a target of 120 gCO_2/km sales weighted average new car emissions for the EU by 2012. This target is to be achieved through:

- a mandatory objective of 130 gCO_2/km for the EU-average new car fleet through improvements in vehicle motor technology.
- additional specific measures (including non-powertrain technologies such as low rolling resistance tyres) and use of biofuels contributing 10 gCO_2/km. These could apply to vans as well as cars.

Setting targets for manufacturers

As the 130 gCO_2/km target is the responsibility of the manufacturers, under the proposed legislation the Commission will produce specific emissions targets for each of the manufacturers, based on a linear relationship between vehicle emissions and mass. Under the proposed legislation, the Commission sets the curve such that heavier cars will have to reduce emissions more than small cars, as the costs for emissions reductions are likely to be lower for these cars. Each manufacturer (or pool of manufacturers) needs only to meet its own target, rather than reach 130 gCO_2/km from its own sales.

Penalty charges

If manufacturers (or pools of manufacturers) do not meet the target in 2012, from that year onwards they will have to pay penalty charges. The charges are based on the amount that the manufacturer's emissions are above their own target and the number of vehicles sold. The excess emissions premium is 20 Euros in 2012, rising to 95 Euros in 2015 and subsequent years.

The level of penalties is expected to be crucial in determining whether or not the 2012 target is met. It is possible that the level of fines will not incentivise introduction of technologies for emissions reduction in 2012 as this is likely to still be below the cost of the technologies to manufacturers. There is some expectation therefore that the 130 gCO_2/km target will be met in 2015.

2020 target

In March 2008, Part II of the King Review of Low Carbon Cars recommended an EU target of 100 gCO_2/km on the basis that it is realistic technologically. In September 2008, MEPs indicated support for a 2020 target of 95 gCO_2/km, subject to a review to take place in 2014. As with the 2012 target, it is expected that the structure of the target and levels of penalties will be important in delivering technological improvements.

The EU framework: The EC is presently finalising mandatory standards for fuel efficiency of new cars that will apply across the EU. The current proposal is that average emissions from new cars should on average be 120 gCO_2/km in 2012[13]. In addition, the EU is considering setting a legally binding target that average emissions should fall to 95 or 100 gCO_2/km by 2020 (Box 7.5).

Our analysis suggests that the UK could meet a 100 or 95 gCO_2/km target in 2020. Meeting this target would require mandatory rules on manufacturers at the EU level. It would also likely require the use of other policy levers (e.g. taxation incentives). Fiscal and other measures might also be required to prevent the rebound effect of increased efficiency (i.e. people travelling more because improved fuel efficiency reduces cost per km travelled). These issues are therefore discussed in Section 3 below.

Meeting this target is desirable in the context of introducing new technologies to the mix that will be increasingly required on the path to an economy-wide 80% emissions reduction in 2050 (see Chapter 2). From a nearer term perspective, meeting the target would be very helpful in providing emissions reduction to meet the non-traded budgets that we have proposed in Chapter 3. It is the Committee's view, therefore, that the UK should strongly support the setting of a legally binding EU target of at the most 100 gCO_2/km for new cars in 2020, which would drive required technology innovation, and that the UK should then aim to meet this target[14].

Abatement costs. The cost of meeting this target for cars (and for reducing emissions from vans, HGVs or biofuels) varies dramatically according to whether we take a 'social' or 'private motorist' perspective. In particular:

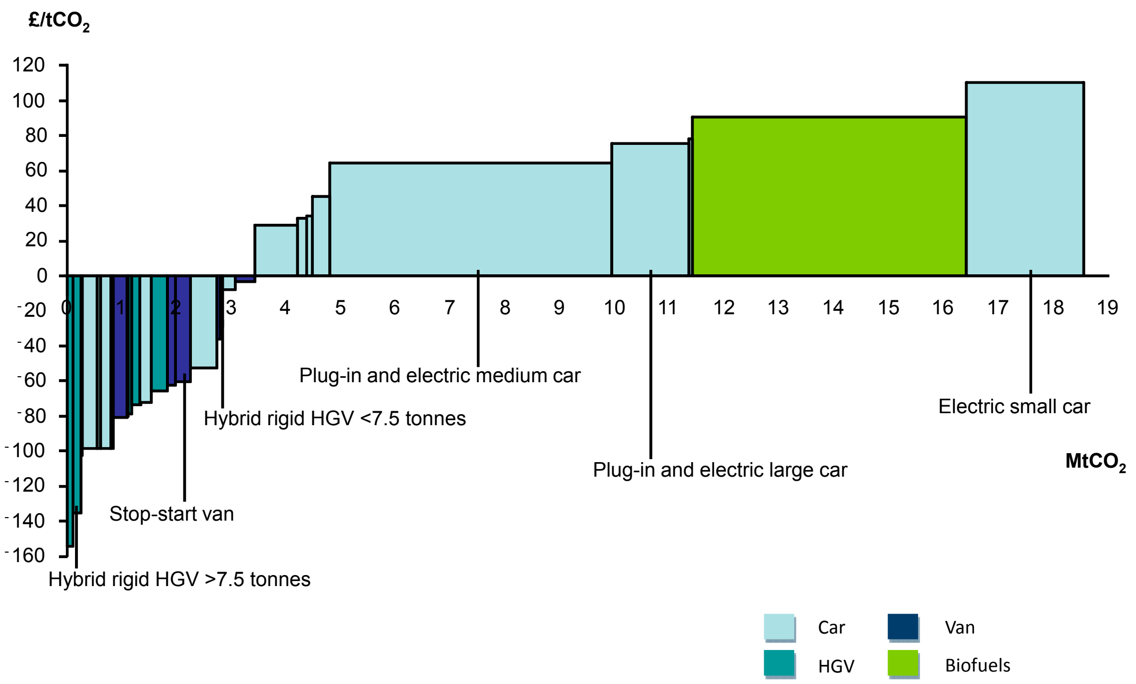
- In the 'social' perspective MACC, we use a real discount rate of 3.5%[15] but we do not count reduced fuel duties as a cost saved, since at the level of the overall society there is no cost saving (the individual motorist gains, but government loses). On this basis, there are up to 4 $MtCO_2$ of abatement which have a negative cost (i.e. net benefit), and then a series of positive cost actions ranging up to £110 per tonne saved (Figure 7.15). Although this is above the marginal cost of abatement theoretically implied by the carbon price estimated in Chapter 4: *Carbon markets and carbon prices*, the Committee believes it appropriate to pursue these higher cost opportunities given the need to drive new technologies and given that, unlike in some other areas with theoretically cheaper abatement opportunities, there exist feasible and effective policy levers to achieve these abatements.

- The 'private motorist' perspective MACC differs in two respects. First, it assumes a higher real discount rate of 7% (equivalent to around 11-12% nominal): this tends to make abatement options look more costly. But, secondly, it counts fuel duty saved as a benefit, which significantly improves the attractiveness of any options which reduce fuel purchase, whether through improved internal combustion engine efficiency or through use of electricity. The net effect is to improve dramatically the apparent attractiveness of all options, except biofuels[16] (Figure 7.16).

These dramatic differences, and the reduction in fiscal revenues which could result (discussed in Chapter 11: *Economic costs and fiscal implications*) suggest complex issues relating to the long-term taxation of different transport energy sources, balancing the need for revenue and the desirability of creating incentives for low-carbon transport. In the immediate future however, it illustrates that the existing fiscal regime creates strong incentives for the adoption of fuel efficient technologies and in particular for plug-in and fully electric cars.

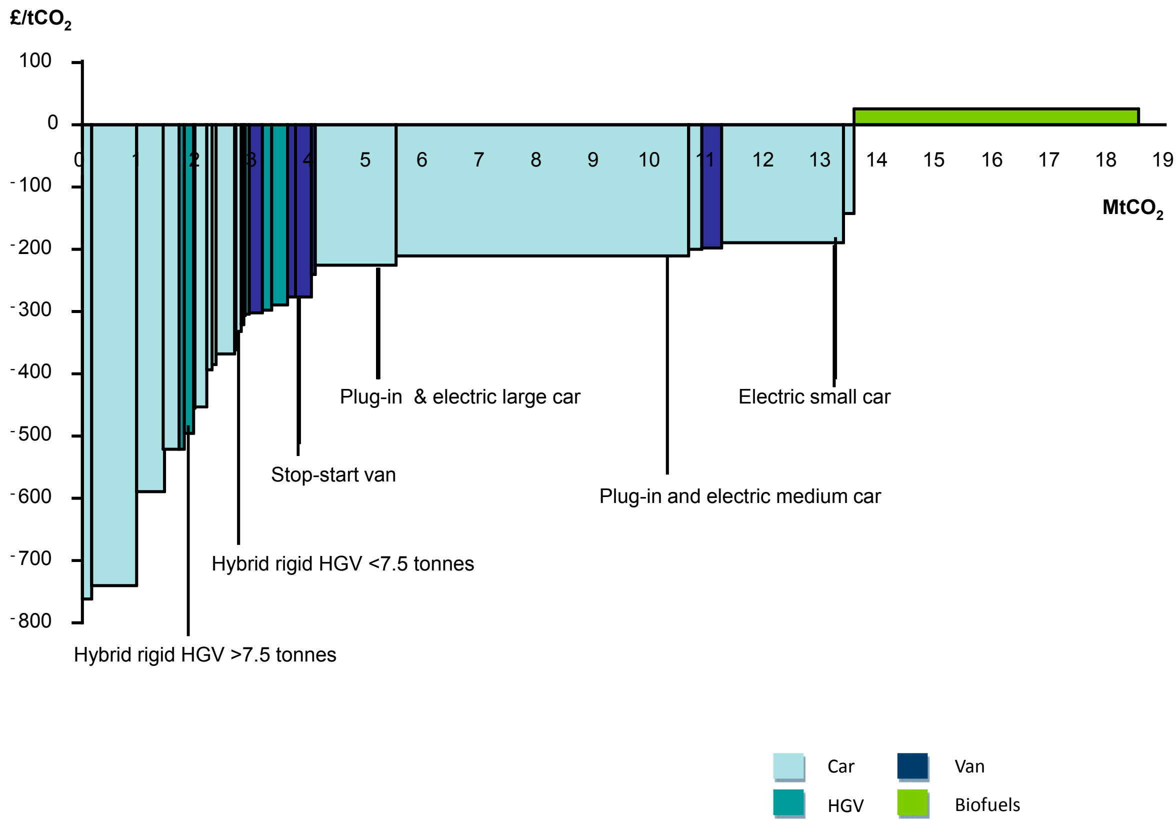
13 Consisting of a 130 gCO_2/km target for the vehicle, plus an additional 10 gCO_2/km through other measures, for example non-powertrain technologies such as low rolling resistance tyres.
14 The fact that EU targets apply across Europe allows the possibility that individual Member States could be above the EU average, discussed more in Section 3 below.
15 This is the Treasury Green Book discount rate that we have used more generally, see Chapter 3.
16 The marginal difference in costs is the same for biofuels in both cases. The difference in discount rates between social and private perspective changes costs.

Figure 7.15 Marginal abatement cost curve for road transport (2020, social perspective)



Source: CCC.

Figure 7.16 Marginal abatement cost curve for road transport (2020, private perspective)



Source: CCC.

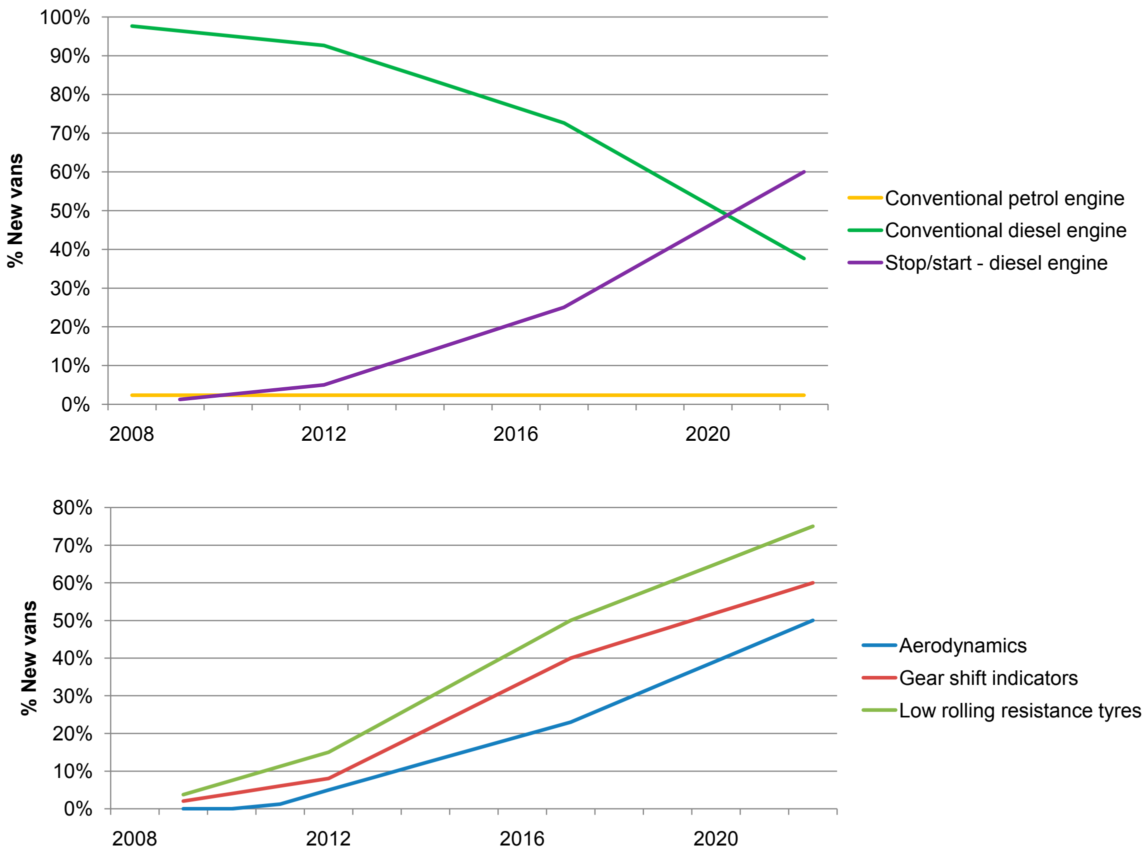
(iii) Supply side abatement opportunities in vans

Many of the technical possibilities which can drive supply side abatement opportunities in cars are also relevant to vans. We have used our model to illustrate emissions reduction that might be available from these opportunities using a similar approach to that described for cars above. In particular, we have defined sets of technology bundles, and an illustrative range for emissions reduction.

Our Current Ambition scenario assumes that there is only limited uptake of technologies for improving fuel efficiency. Specifically, we have assumed that only those abatement options with negative cost (i.e. where any upfront cost is more than offset by reduced fuel bills over time) are deployed[17]. In this scenario, which is characterised by stop-start engines and non-powertrain measures (see Figure 7.17), emissions reduction is 0.4 $MtCO_2$ in 2020 (Figure 7.18), with average emissions for new vans falling from 271 gCO_2/km in the reference emissions projection to 249 gCO_2/km.

Our Extended Ambition reduction scenario includes more aggressive deployment of stop-start and non-powertrain measures (Figure 7.19). Emissions reduction in this scenario is 1 $MtCO_2$ in 2020 (Figure 7.20), with average emissions of new vans falling to 240 gCO_2/km.

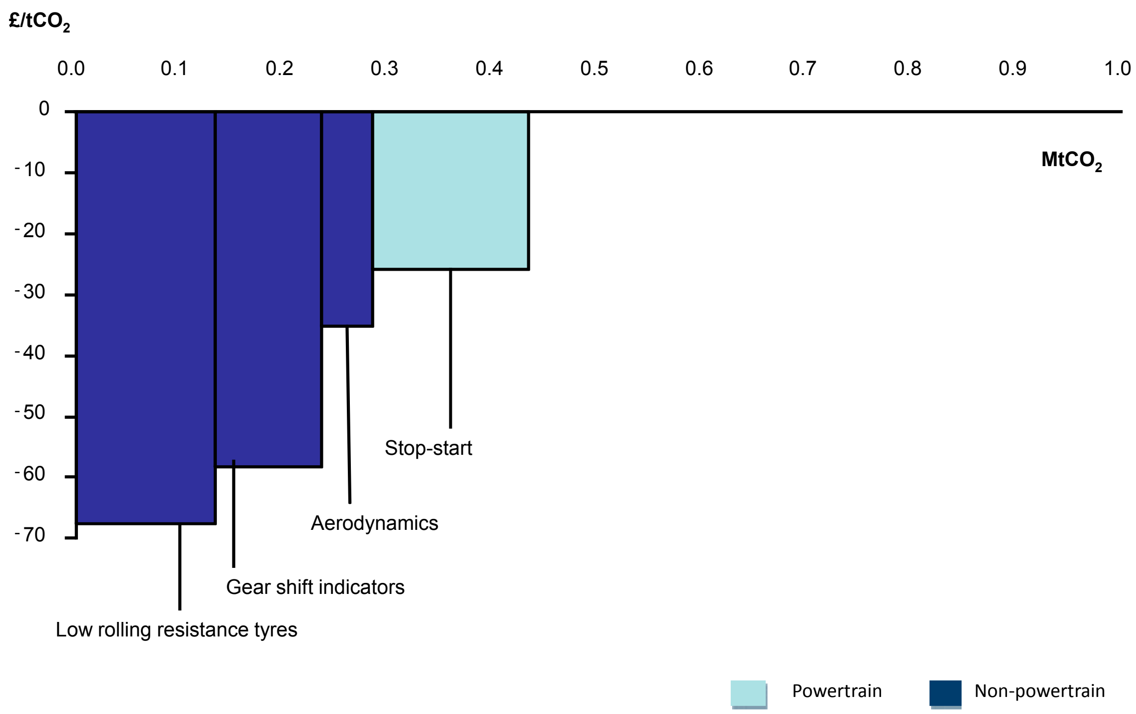
Figure 7.17 Van technology uptake rates (Current Ambition scenario)



Source: CCC.

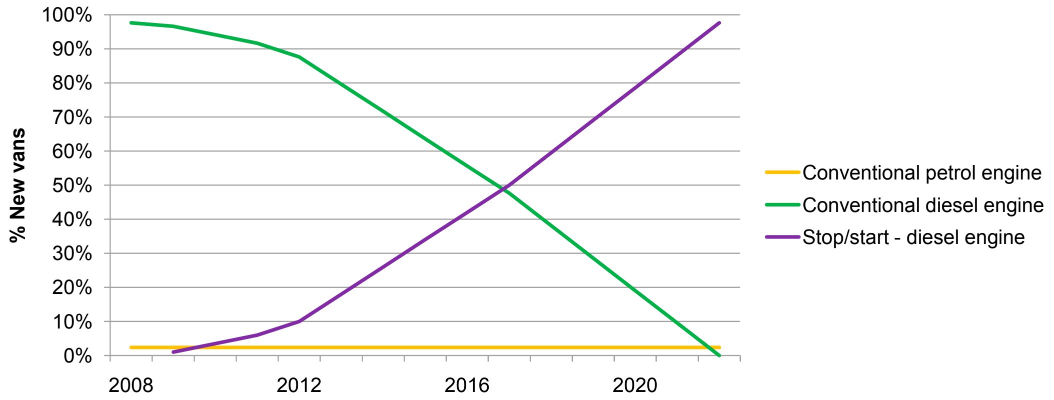
17 Measures included are negative cost from both the social and private perspectives.

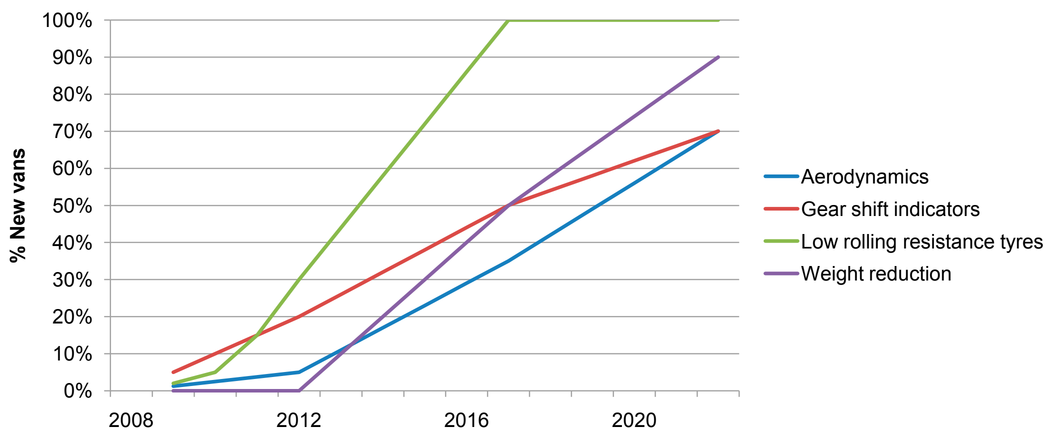
Figure 7.18 Marginal abatement cost curve for vans Current Ambition scenario (2020; social perspective)



Source: CCC.

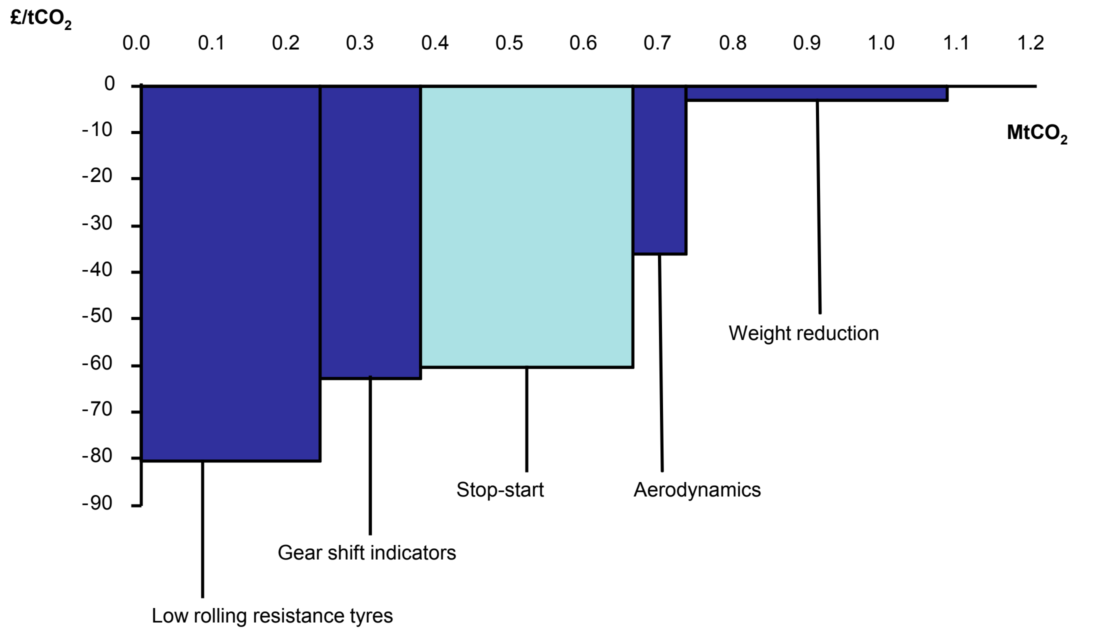
Figure 7.19 Van technology uptake rates (Extended Ambition scenario)





Source: CCC.

Figure 7.20 Marginal abatement cost curve for vans Extended Ambition scenario (2020; social perspective)



Source: CCC.

There is in fact more potential for abatement potential than is illustrated by these scenarios. In order to model this, we have developed a Stretch Ambition scenario where there is widespread deployment of plug-in and hybrid vans. In this scenario, emissions reduction in 2020 is 3 $MtCO_2$ and emissions of new vans fall to 196 gCO_2/km.

Which of these or other scenarios prevails in practice will depend on the policy framework. Currently this is undeveloped, with weak incentives for uptake of lower emission technologies; our Current Ambition and Extended Ambition scenarios may be a reasonable approximation of the likely range of outcomes in this world. There is, however, the possibility that stronger policy levers such as a mandatory target for new van efficiency could be introduced, and the EU is currently considering what a framework for vans might look like.

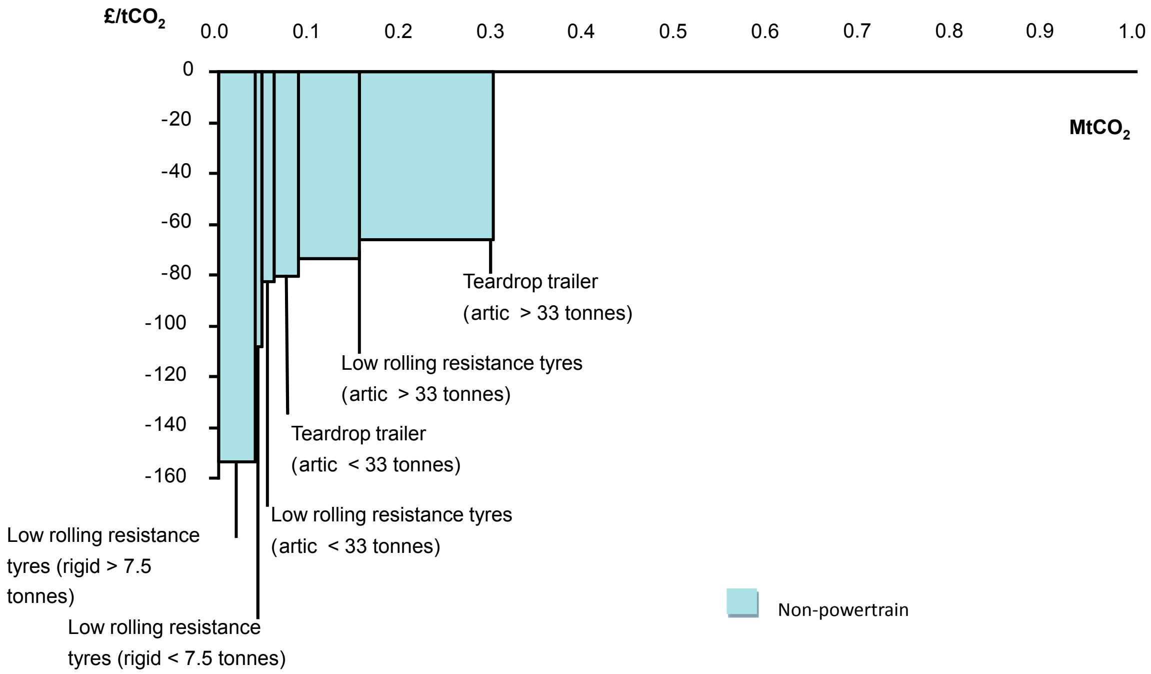
Given the potential for emissions reduction that we have identified, it is the Committee's recommendation that major focus be placed on developing a framework for van fuel efficiency at the European and UK levels. Significant reductions may be possible within the first three budget periods and will almost certainly be necessary to maintain transport sector abatement in subsequent budgets.

(iv) Supply-side abatement opportunities in HGVs

It will be inherently more difficult to achieve a major supply side emissions reduction in HGVs than in cars or vans given more limited potential for application of some technologies. Some emissions reduction is, however, available, through uptake of non-powertrain technologies and the introduction of hybrid rigid HGVs. As for cars and vans, we have developed Current Ambition and Extended Ambition emissions reduction scenarios for HGVs. The Current Ambition scenario is characterised by some uptake of non-powertrain technologies and achieves emissions reduction of 0.3 $MtCO_2$ in 2020 (Figure 7.21). In the Extended Ambitiion scenario, there is more aggressive uptake of non-powertrain technologies, and rigid hybrids are introduced, resulting in emissions reductions of 0.8 $MtCO_2$ in 2020 (Figure 7.22).

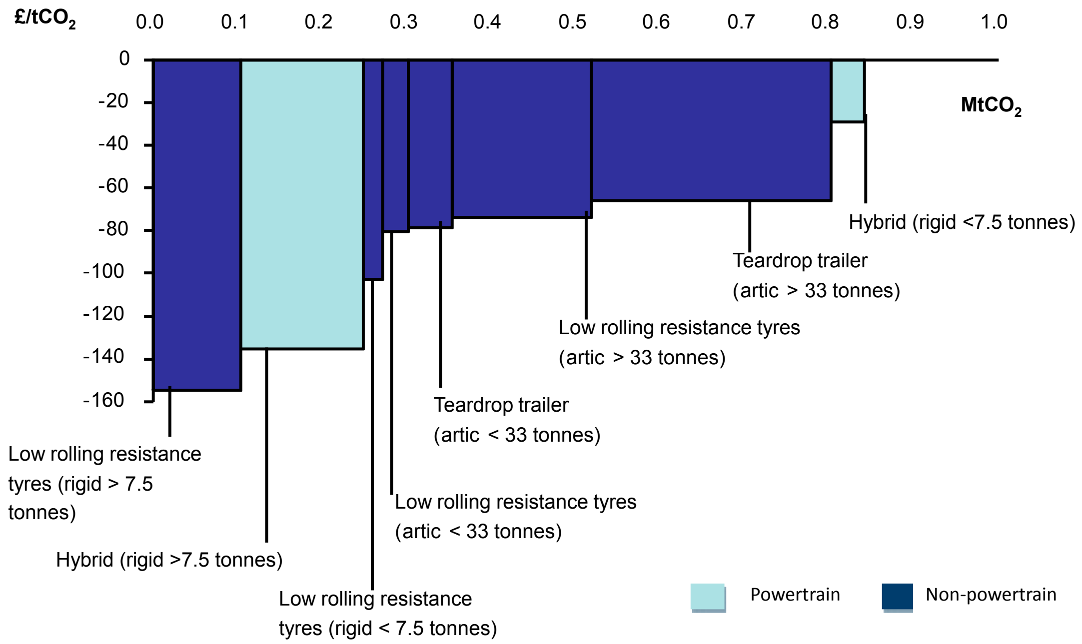
These scenarios represent the likely range of outcomes under the current lack of a policy framework for HGVs. It is possible, however, that a European policy framework could be introduced and additional measures involved. We have modelled a Stretch Ambition scenario in which there is aggressive uptake of non-powertrain technologies and some uptake of plug-in and electric small HGVs (Figure 7.23), which together reduce emissions by 1 $MtCO_2$ in 2020. And in the longer term, if concerns about biofuel sustainability can be resolved, their deployment in the HGV sector may be the key to significant decarbonisation. The Committee will therefore look in detail at the options for the HGV sector in our work relating to the fourth budget (2023-27) which we need to complete by 2011.

Figure 7.21 Marginal abatement cost curve for HGVs Current Ambition scenario (2020; social perspective)



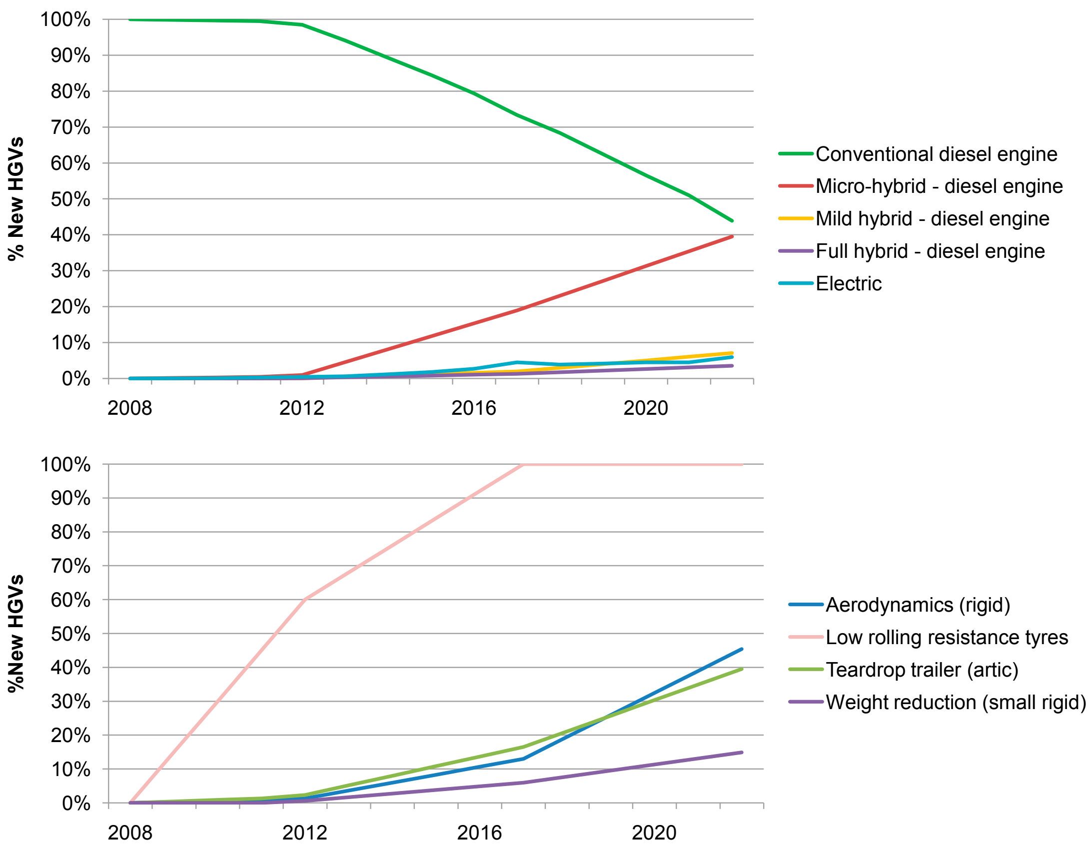
Source: CCC.

Figure 7.22 Marginal abatement cost curve for HGVs Extended Ambition scenario (2020; social perspective)



Source: CCC

Figure 7.23 HGV technology uptake rates (Stretch Ambition scenario)



Source: CCC.

(v) Supply-side abatement opportunities in rail

Rail is not part of the MACC model discussed above, but carbon trajectories for rail to 2022 have been developed by a cross-industry working group, chaired by the Department for Transport, which has submitted a report to the CCC[18]. This group covers passenger and freight rail, and has assessed abatement opportunities from electric and diesel traction rail.

Compared to a reference emissions projection ('do nothing'), there is abatement opportunity of 0.6 $MtCO_2$ in 2020, which is included in our Extended Ambition scenario. This abatement comes from an increased emphasis on energy efficiency – through new trains that come into service and from passenger and freight operating companies introducing a range of energy saving initiatives. It is also assumed that diesel rail (passenger and freight) will use biofuel blends, in line with the reference assumptions on biofuels outlined above.

There are other short-term abatement opportunities in rail:

- Additional efficiency measures; for example, energy metering, such that operators have better information on how their trains use energy and have incentives to improve efficiency, and further introduction of regenerative braking[19].

- Improved performance of the existing rolling stock, including upgrading to more efficient diesel engines and introducing on-board energy storage (analogous to hybrid car technology).

In the medium to long term there is further scope for abatement from rail, including:

- Opportunities for efficiency improvements through new rolling stock replacements. These are limited before 2022, due to the long life of rolling stock (30-35 years) and the currently young age of rolling stock in the UK.

- Network optimisation around energy efficiency and emissions.

- Increased electrification. Even given the current average carbon intensity of electricity generation, electric rail is much more carbon efficient than diesel rail, with emissions of around 50 gCO_2/passenger-km compared to 75 for diesel. This advantage will increase as electricity is decarbonised. An accelerated programme of electrification could therefore deliver significant emissions reduction.

The Committee has not quantified abatement potential from these additional opportunities, but intends to assess these more closely in subsequent work.

18 Department for Transport et al. (2008) *Rail transport submission to the Committee on Climate Change*. Committee on Climate Change.

19 Regenerative braking is a system that recovers energy from trains as they brake that would otherwise have been wasted. This system is already in place on all trains capable of regenerative braking (AC electric trains). It could be rolled out to all electric trains, including the DC network with time as technical obstacles are overcome; and possibly to diesel trains over the longer term.

3. REBOUND EFFECTS AND DEMAND SIDE POLICY LEVERS TO ACHIEVE SUPPLY SIDE POTENTIAL

In Section 2 we have identified up to 12 $MtCO_2$ of supply side abatement opportunity relating to cars; this could be achieved if new car carbon intensity could be reduced to 95 gCO_2/km by 2020, with average fleet intensity down from 170 to 130 gCO_2/km. But it also referred to two complexities which require us to link supply and demand side considerations: (i) the fact that to achieve this carbon efficiency improvement we may need to pull demand side levers (e.g. fiscal incentives); (ii) the danger of a rebound effect, with improved fuel efficiency reducing the marginal cost of travel and thus inducing more demand.

This section therefore considers in turn:

(i) Achieving reduced carbon intensity: technical potential and customer car purchase

(ii) Non-price levers in customer car purchase decisions: information and awareness raising

(iii) Price elasticities, fiscal incentives, and choice of car

(iv) The rebound effect

(i) Achieving reduced carbon intensity: technical potential and customer car purchase

The European policy for mandatory corporate average carbon efficiency is a vital policy lever to achieve carbon-intensity reduction. But other levers may also be important, especially since the average carbon-intensity reductions can be achieved via customer car purchase changes as well as via technical improvement.

- The cost curve analysis presented in Section 2 suggested that very significant improvements in carbon intensity could be achieved via technological progress without customers having to accept smaller size or lower performance vehicles. The estimates of the cost per tonne of carbon saved presented in Figures 7.15 and 7.16 are based on the assumption that customers continue to buy the same type of car – defined by size and performance – as today.

- It would also be possible however to achieve the required emissions reduction via a change in customer choice, i.e. customers buying slightly smaller cars or ones with lower performance (speed and acceleration).

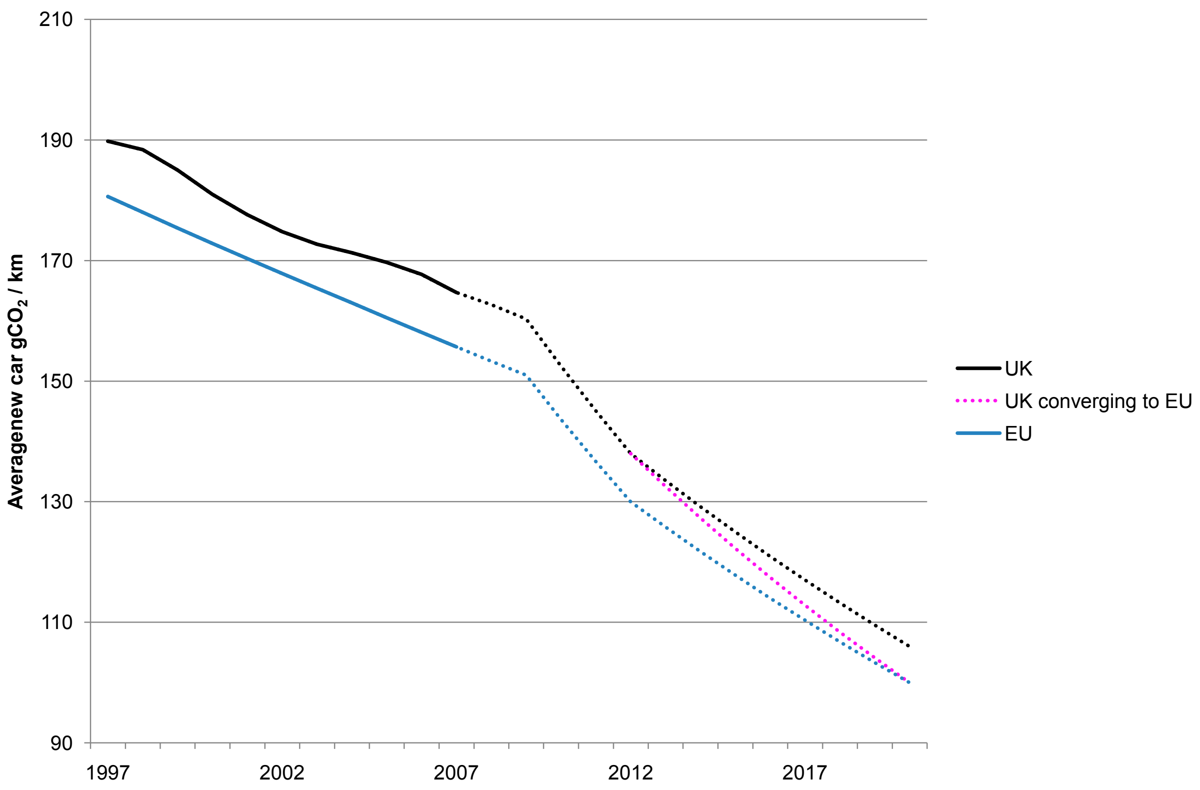
- European industry standards on average new car emissions could drive change on either dimension[20]. In practice, manufacturers are likely to meet their targets both by producing more fuel efficient cars with unchanged performance (i.e. through technology) and by shifting the relative mix of their production towards smaller cars.

20 We assume that these are alternatives for meeting a given fuel efficiency target, rather than opportunities for going beyond a target.

- Targets will be delivered in part through marketing and pricing policies of manufacturers. There will also be an important role, however, for information and policy levers to encourage customers to purchase the lowest emitting vehicles without changing vehicle class, and to reach additional potential from changing customer choice.

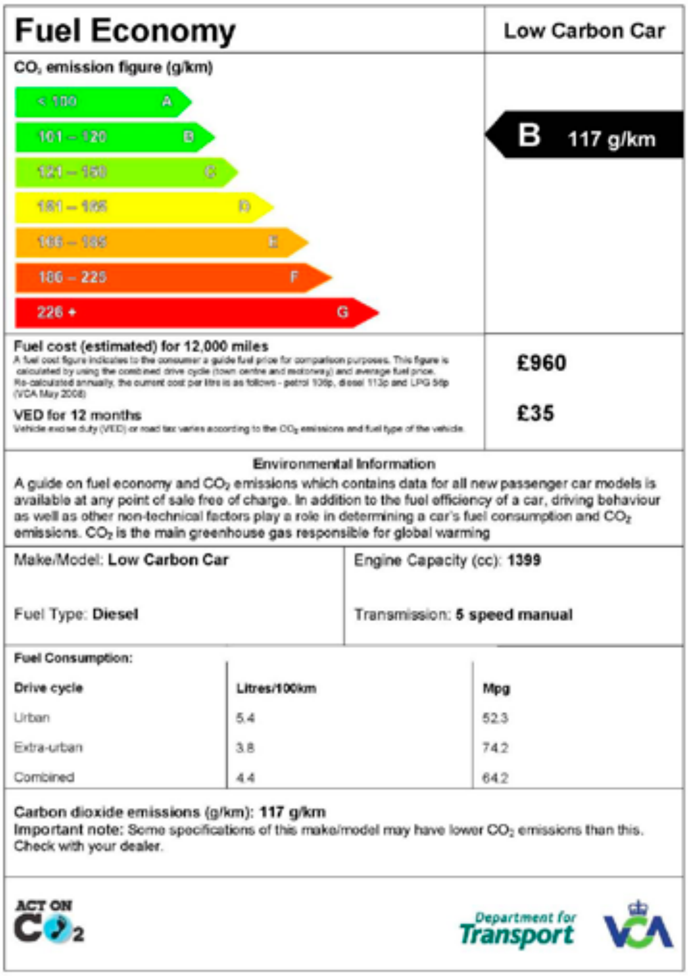
- These levers may be particularly important in the UK given that the UK currently tracks above the EU average for new car efficiency due to a relatively low proportion of diesel cars and a relatively high proportion of larger cars, and could fail to narrow the gap between its carbon intensity and the European average (Figure 7.24); indeed without other policy levers the gap could widen.

Figure 7.24 Possible pathways for future new car CO_2 emissions



Sources: Society of Motor Manufacturers and Traders, DfT

Figure 7.25 An example of a fuel efficiency label for new cars



Source: Low Carbon Vehicle Partnership

(ii) Non-price levers in customer car purchase decisions: information and awareness raising

Car purchase decisions, whether on efficiency, size or performance, could be influenced by information provided at point of sale. The EU has recognised this, and has put in place legislation that requires dealers selling new passenger cars to display information on vehicles' fuel consumption and CO_2 emissions. Colour-coded fuel efficiency labels, showing average fuel efficiency and fuel expenditure over 12,000 miles of typical use, matching the graduated VED (Vehicle Excise Duty) structure, were introduced into UK car showrooms in 2005 (Figure 7.25). The 'Act on CO_2' campaign, launched in 2007, also promotes information about purchasing more fuel efficient vehicles.

Evidence suggests, however, that it may take some time before the benefits of colour-coded fuel efficiency labels are felt. Salesroom staff knowledge is variable, coverage is incomplete and consumer awareness of labels is limited[21]. In addition, evidence shows that buyers are more likely to be influenced by the cost of purchase and driving performance rather than environmental concerns[22], though there is some evidence that fuel efficiency (which correlates closely with carbon efficiency) is an important factor in recent car purchasing decisions amongst UK drivers[23].

21 Society of Motor Manufacturers and Traders (2007) *Motor Industry facts – 2007.* London: SMMT.
22 Anable, J., Lane, B. and Kelay, T. (2006) *An evidence base review of attitudes to climate change and transport.* Report for the UK Department for Transport
23 Angle, H., Brunwin, T., Gosling, R. and Buckley, K. (2007) *Climate Change campaign benchmark stage: Driving behaviour and car purchasing*. Report by British Market Research Bureau (BMRB) to the Department for Transport

On balance, therefore, better information alone is unlikely to result in changed purchase behaviour, but is still likely to have an important role to play as part of a package of mutually supporting interventions.

The potential impact of the labelling scheme could be increased if it were made mandatory and also covered second-hand vehicles. The King Review[24] proposed that a colour-coded tax disc would also reinforce the link between vehicle model, CO_2 emissions and fuel use by enabling people to see how emissions vary between and within vehicle class. Subsequently the Government in the Budget 2008[25] signalled its intention to explore this idea and the possibility of making compulsory the current fuel efficiency label. If successfully implemented, these measures would support meeting of EU targets for fuel efficiency.

(iii) Price elasticities, fiscal incentives and choice of car

Both consumer choice of car and the extent of car use (km travelled per car per year) are likely to be significantly influenced by the taxation regime. Analysis of estimates of price elasticity (through which fiscal measures operate) suggest that:

- **Fuel duties** can be quite powerful levers to affect choice of car, especially over the long-term and against the background of high awareness of oil prices.
  - A major review of elasticity studies conducted for the erstwhile Department for Transport, Local Government and the Regions (DTLR) in 2002[26] suggests the elasticities shown in Table 7.1 The overall long-term effect of a 10% increase in prices (whether driven by oil prices or the impact of taxes) could reduce fuel use by 6.4%. The effect derives from (i) a non-trivial (-2.5%) decrease in car ownership: this is likely mainly to take the form of families deciding to forego a second or third car, but also includes a proportion of people who choose to live in areas where owning a car is less essential; (ii) a (-3%) decrease in km travelled per car; (iii) a significant (-4%) decrease in fuel used per kilometre, achieved via choice of more fuel efficient cars.
- Price elasticity may be itself a function of the price level. The price elasticity observed in the high oil price period of the late 1970s was significantly higher than that observed in the low oil price 1980s and 1990s. The recent high oil price environment and extensive public discussion of its implications for motorists may therefore have increased the sensitivity of consumer buying behaviour to any given difference in price. Anecdotal evidence over the last six months suggests that an increased awareness of future motoring costs may have produced a bigger switch in buying behaviour towards smaller cars (in both Europe and US) than previously observed elasticities would have predicted; Box 7.6 presents some data on car purchases over the last year.

Table 7.1 Fuel Price elasticities

If the real price of fuel goes up and stays up by 10%:		
	Short run (1yr)	Long run (around 5yrs)
Total number of vehicles owned	-0.8%	-2.5%
Total volume of traffic	-1.0%	-3.0%
Total efficiency of fuel used	1.5%	4.0%
Total volume of fuel consumed	-2.5%	-6.4%
Vehicle kilometres per vehicle	-1.0%	-3.0%

Source: Hanly, Dargay and Goodwin.

24 King, J (2008) *The King Review of low-carbon cars Part II: recommendations for action*. HM Treasury.
25 HM Treasury (2008) *Budget 2008 Sustainability and opportunity: building a strong, sustainable future.* HM Treasury
26 Hanly, Dargay and Goodwin (2002), Review of Income and Price Elasticities in the Demand for Road Traffic: Final Report, 2002.

Box 7.6 Impacts of high fuel prices and the credit crunch on car purchase and driver behaviour

Changes in car purchase behaviour can be seen in some indicators for 2008, as people respond to high fuel prices and the credit crunch financial crisis.

UK: The latest monthly sales figures produced by the Society of Motor Manufacturers and Traders (SMMT) show that new car registrations fell 21.2% in September with year-to-date volume down 7.5%. In September, new car registrations fell for the fifth consecutive month.

Alternatively fuelled vehicles saw their market share rise from 0.7% to 0.8% of the market, with volumes up 1.5% over the year to date.

US: In July 2008, the *Economist* reported that sales of cars and light trucks in America in June fell by 18% compared with the same period a year earlier. Chrysler's sales were down by 36% and Ford dropped by 28%. Honda sales, by contrast, increased by 1.1% – probably because it is not part of the American pick-ups market.

- Annual fixed charges (e.g. VED or company car tax) that are differentiated by carbon intensity, may also have a significant effect – indeed there is some evidence to show that private customers may weight fixed annual costs (which includes VED along with insurance premiums) more than future prospective fuel costs in their decision making[27]. Evidence on the emissions-linked company car tax reform suggests that average emissions of company cars bought in 2004 fell by around 15 gCO_2/km (compared to a no-reform counterfactual) although there was some reduction in the number of company cars, with those opting out of company cars buying private vehicles with emissions on average 5 g higher[28].

- Finally, it is possible that upfront charges (e.g. first year VED) differentiated by carbon intensity could also impact on car purchase decisions. In the UK, these are planned to be introduced from 2010/11[29]. Whilst the evidence is not comprehensive; the introduction of upfront charges, with a very strong differentiation between high and low-carbon-intensity cars in some European countries appears to have produced major shifts in buying behaviour. Box 7.7 describes the experiences of the Netherlands and France.

Overall, therefore, it is likely that the tax regime, whether in the form of fuel duties or differentiated VED charges (ongoing or first year), will need to play a key role, alongside information provision, in incentivising consumer choice of car consistent with the target of achieving an average below 100 gCO_2/km for cars purchased in 2020.

27 Eftec (2008). *Demand for cars and their attributes. Final report to DfT.* DfT
28 HMRC (2006), *Report on the Evaluation of the Company car tax reform: Stage 2.* HM Revenue and Customs.
29 HM Treasury (2008) *Budget 2008 Sustainability and opportunity: building a strong, sustainable future*. HM Treasury

Box 7.7 Impacts of purchase prices and tax incentives in Europe

The Netherlands

In 2002 the Dutch government introduced a scheme whereby buyers of the lowest emitting passenger cars labelled 'A' and 'B' received an incentive: 1,000 euros for 'A' labelled cars and 500 euros. for 'B' labelled cars.

- The percentage of purchases of class 'A' cars increased disproportionately from 0.3% in 2001 to 3.2% and class 'B' from 9.5% in 2001 to 16.1%
- In January 2003 the Dutch government abolished the fiscal incentive again for budgetary reasons. The market share of 'A'- and 'B'-labelled cars in 2003 decreased substantially after abolishing the incentives: 'A' fell to 0.9% and 'B' to 11.5%

The French 'Bonus-Malus' scheme

The French Government recently introduced a scheme that involves taxing purchases of new cars with high-carbon intensity heavily and offering a subsidy to drivers who scrapped their old cars in favour of a car with a low carbon intensity.

- The amount of the bonus or malus depends on the gCO_2/km emitted by the vehicle:
  - *bonus*: 200-1,000 euros for vehicles emitting a maximum of 130 gCO_2/km and 5,000 euros for those emitting no more than 60 gCO2/km. It will be higher still for even greener vehicles.
  - *malus*: 200-2,600 euros for those emitting over 160 gCO_2/km and even more for the least green vehicles.
- The scheme was designed so that income from the *malus* strictly matches the cost of the incentives to buy clean cars and so reduces the number of polluting vehicles on French roads. However, the scheme has been far more successful than expected and cost to the exchequer is projected to be around 200 million euros.
- Sales of cars emitting no more than 130 gCO_2/km have risen by 50% compared with the same period in 2007 and sales of cars emitting more than 160 gCO_2/km have fallen by 40% overall sales have risen by 3%.
- However, the dramatic effects seen may also be due to high oil prices and the credit crunch financial crisis, rather than from the efficacy of the scheme of itself.

Source: Les Echos, ADAC, Low Carbon Vehicle Partnership.

(iv) The rebound effect

If a combination of technical progress and consumer choice drive the significant reduction in gCO_2/km which is required to achieve our proposed budget assumption, the marginal cost of additional km travelled will on average fall. There is therefore a danger of a 'rebound effect', with increases in km travelled offsetting some of the emissions reduction from efficiency improvements. The economics and the carbon impact of this effect will differ by type of car.

- In the case of petrol and diesel engine cars, km per litre will increase and costs per km travelled fall, so distance travelled will increase.
- In the case of plug-in hybrids and full electric cars, this effect would also ensue, although the carbon impact of this would be less than for conventional engines given the relatively lower emissions of electricity.
- And in the long run, once electricity is fully decarbonised, a rebound effect focused on electric cars would be less concerning from an emissions point of view than one which involved greater use of petrol and diesel engines.

The modelling results presented for road transport in Section 3 above were already adjusted to take account of the potential rebound effect from increased distance travelled[30]. The adjustment was made based on an elasticity of vehicle-km to fuel cost consistent with estimates from the literature. It reduced our estimates of emissions reduction by around 15% in 2020 (e.g. whereas in our Extended Ambition scenario for cars we estimated an emissions reduction of 12 $MtCO_2$, this would have been 14 $MtCO_2$ had we not made the adjustment for the rebound effect).

There are a range of policy options for limiting the rebound effect on distance travelled which could be deployed to ensure greater abatement from improved vehicle emissions performance. For example:

- Road pricing (varying by time of day and location) would ensure that road users faced the full marginal social costs (including emissions and congestion impacts) of their behaviour encouraging them to use the road network more efficiently. This could help prevent the rebound effect on driving[31], were the challenge of public acceptability to be overcome.
- Non-price levers around network use (e.g. pedestrianisation, dedicated bus lanes, parking policies) could disincentivise increased car travel; these are discussed in more detail in Section 4 below.

The Committee would like to draw attention to the necessity of developing over the long term the policies which ensure that the reduction in supply side emissions is not offset by rebound effects.

30 There are two other possible rebound effects in response to improved efficiency: people could buy larger cars, or people could buy more cars (more likely to impact on second car purchases than owning a car at all). The response to larger car purchase is mitigated by the mandatory EU targets on new car emissions and by supporting policies such as VED. Possible increased car ownership could again be mitigated through policy levers such as VED.

31 Which would not only mitigate emissions impacts, but also tackle the congestion impacts of plug-in and electric cars (where congestion impacts may be more important than emissions impacts).

4. ABATEMENT OPPORTUNITIES: POSSIBLE DIMENSIONS OF DEMAND SIDE REDUCTION

Section 2 considered the potential to reduce transport emissions through supply side improvements in gCO_2/km, without any change in consumer behaviour. Section 3 introduced the possibility of changes in consumer choice over size and type of car. This section considers other possible demand side and consumer behaviour changes under four headings:

(i) Changes in driver behaviour: 'eco-driving' and effectively enforcing speed limits

(ii) Modal shift to less carbon intensive transport and better journey planning

(iii) Network access, land use and planning

(iv) Measures to constrain transport demand.

(i) Changes in driver behaviour: 'eco-driving' and effectively enforcing speed limits

The way in which people drive any mode of transport can have a major influence on fuel efficiency. Two types of change can be distinguished: the style in which people drive, and the speed at which they drive.

Eco-driving: Fuel efficiency can be significantly improved by adopting a smoother style of driving, with less aggressive use of accelerator and brake, even without reducing average or maximum speeds: in certain traffic conditions indeed, if followed by a significant proportion of all drivers, eco-driving of this sort can actually increase average traffic speeds. Greater attention to tyre pressure, the removal of unnecessary weight, and the intelligent use of heating and air conditioning systems can also have an appreciable impact. Evidence suggests that average fuel efficiency can be improved by 5-10% when the range of eco-driving principles are adopted together[32] (Box 7.8).

Box 7.8 Examples of carbon savings from eco-driving

- In 2004 the UK's Driving Standards Agency carried out eco-driving trials by comparing drivers' fuel consumption over a given course before and after they received two hours of eco-driving training. The trials demonstrated average fuel savings of 8.5%[1].

- In 2002 a study was undertaken with a car panel of the Dutch Consumer Organisation, consisting of approximately 6,000 drivers. Members were divided into eco-drivers and non-eco-drivers based on their own self-reported behaviour and the groups were compared against each other. Over the year-long duration of the study the eco-drivers consumed 7% less fuel per km than the non-eco-drivers[2].

Sources:

1. Energy Saving Trust (2005) *Ecodriving: Smart efficient driving techniques*. Based on the orginal produced by SenterNovem for the EU Treatise project. EST
2. ibid.

32 Commission for Integrated Transport (2007) *Transport and Climate Change: Advice to Government from the Commission for Integrated Transport*

There is emerging evidence that a significant proportion of the population is willing in principle to consider changing their driving behaviour both to save money and mitigate climate change; for example, a recent consumer survey by the Energy Savings Trust suggests that just under 50% of drivers would be willing to pay for eco-driving lessons with a view to reducing fuel bills[33]. Some companies maintain improved driving of employees by, for example, providing a fixed fuel allowance per km so that an 'eco-driver' can keep the difference but a less efficient driver is out of pocket. It is also likely that increased awareness of high fuel prices has created a more favourable context for persuading people to change their driving behaviour.

A number of initiatives to provide information and encourage eco-driving are already in place. These include the 'Act on CO_2' advertising and awareness campaign, the inclusion of eco-driving in the theory element of the driving test and more recently in the practical element, and a variety of policies aimed at the road freight sector (Box 7.9). There is a great deal of uncertainty, however, as to what level of emissions reduction these initiatives and policies will deliver. In addition, although the initial effect of eco-driving is well documented it is less clear whether this change persists in the long term. It may, however, be possible to increase the likelihood of lock in by the use of in-car technologies such as fuel economy meters or gear shift indicators[34].

Box 7.9 Driver efficiency policies for vans and HGVs

As part of the Department for Transport's aims on sustainable distribution, it funds:

- the Safe and Fuel Efficient Driving (SAFED) demonstration project providing advanced driver training, for both vans and HGVs.
- the Freight Best Practice (FBP) programme which provides free information to the haulage industry, including guides to saving fuel, developing skills, equipment and systems, operational efficiency and performance management. An impact assessment of FBP found that in 2005-2006, 9% of organisations were using at least one aspect of the programme, resulting in 0.24 $MtCO_2$ of abatement. DfT estimates that across FBP and all industry-led initiatives on best practices, emissions savings could have been 1.7 $MtCO_2$ in those two years. From 2008, FBP will be extended to all modes in the freight sector.

From September 2009, there will be a mandatory HGV driver Certificate of Professional Competence, requiring drivers to undertake 5 days of training every 5 years. It is expected that this will significantly increase emissions reduction from efficient driving techniques. By 2014, all drivers (of HGVs and buses) will have received the training.

SAFED is continuing for both van and HGV drivers. Typical fuel savings during training are 10%, although it is not clear how much of this is retained during normal operation. As there is no equivalent compulsory driver training or certification for vans (unlike HGVs) the take up – and therefore emissions abatement – from van driving efficiency improvements is expected to be smaller and take longer to achieve before a policy is put in place.

Source: DfT.

33 Energy Saving Trust (July 2008) *Running on Empty – Green Barometer Issue 5: Measuring environmental attitude*
34 Anable, J and Bristow, A (2007) *Transport and Climate Change: Supporting document to the CfIT report.* Report prepared for the Climate Change Working Group of the Commission for Integrated Transport.

Given these uncertainties, we have defined three scenarios for emissions reduction through eco-driving. In our Current Ambition reduction scenario, we make a conservative assumption that there is no emissions reduction from eco-driving. In our Extended Ambition scenario[35], we have assumed that car drivers who are trained achieve fuel efficiency increases of 3% (to avoid double-counting with speed limiting and gear shift indicators) and that 1% of car drivers per year adopt eco-driving behaviour, which results in 2020 in emissions reductions of 0.3 $MtCO_2$. The Extented Ambition scenario also includes eco-driving for vans (a 3% efficiency gain taken up by 1% of drivers per year) and for HGVs (a 4% efficiency gain, taken up by 100% of drivers from 2014 as there is a policy on HGV driver certification; see Box 7.9) which results in an emissions reduction of 1 $MtCO_2$ in 2020.

In our Stretch Ambition scenario, we still assume that eco-driving for cars increases fuel efficiency by 3% but that many more car drivers adopt the behaviour, reaching 40% in 2020[36]. This results in emissions reduction of 1 $MtCO_2$ in 2020. The Stretch Ambition scenario also includes eco-driving for vans following these same assumptions for cars (implying a strong policy is introduced), which abates 0.3 $MtCO_2$ in 2020.

Speed limits enforcement and possible reduction: Fuel efficiency falls significantly as car, van or HGV speeds are pushed above optimal levels. A typical petrol fuelled car driven at 70 mph emits about 19% more gCO_2/km than when driven at 50 mph (Table 7.2). We estimate that enforcing the existing speed limit would produce annual emissions reductions of over 3 $MtCO_2$ in 2020[37]. Reducing the speed limit to 60 mph on motorways and A roads where the speed limit is currently above this would result in an additional 2 $MtCO_2$ emissions reduction in 2020 (Box 7.10).

The disadvantage of reduced speed limits would be increased journey times. Standard measures of the value of time used in transport evaluation would suggest that the economic and welfare cost of increased journey times may be high, particularly when business journey times are increased (Table 7.3). But the validity of this value of time analysis can be debated: travel time costs are highly variable, for example, by modal quality and reliability, journey length, and traveller preferences. Not all travel time needs have costs attached: time spent on some journeys may be enjoyable, while commuting journeys (particularly longer journeys by train) can be used to work by laptop or phone[38]. The increase in journey time (and therefore costs) from speed limiting might also be over-estimated because, under certain traffic conditions, lower and more strictly enforced speed limits would not actually reduce average journey time significantly, but would produce more smoothly flowing traffic.

Table 7.2 Change in efficiency with speed for a typical car

Speed (mph)	Emissions gCO_2 / km	% Decrease in efficiency for increase of 10mph
40	157	
50	161	3
60	173	7
70	191	10
80	219	15

Source: NAEI.
Note: This is based on a Euro II 1.4–2 litre petrol engine.

35 Modelling eco-driving has also avoided double-counting with gains from technology, as the eco-driving efficiency improvements are applied to the more efficient vehicle stock resulting from the technologies introduced in the Extended Ambition scenario.

36 This is consistent with assumptions by CfIT that 40% of car drivers could be practicing eco-driving by 2020; assuming a strong policy is in place. Source: Commission for Integrated Transport (2007) *Transport and Climate Change: Advice to Government from the Commission for Integrated Transport*

37 Emissions reductions from speed limiting are applied to the more efficient vehicle stock that results from the abatement technologies taken up in our Extended Ambition scenario. This avoids over-estimating the impact on emissions in 2020.

38 See for example, Institute for Transport Studies, University of Leeds (2003) *Value of Travel Times Savings in the UK: Summary report* (DfT); and Lyons, G. and Urry, J. (2004). The use and value of travel time. Unpublished paper.

Table 7.3 Costs of time

Values of time (£per hour)	Mode of Transport				
	Car	Bus	Walk	Cycle	Rail
Work values - assumed wage cost of traveller	30.3	24.5	35.9	20.6	44.7
Non-work values -estimated by surveys	5.5	5.5	5.5	5.5	5.5

Source: DfT Webtag.

Box 7.10 Indicative abatement from speed limit enforcement

The Department for Transport publish figures for vehicles travelling (and vehicle-km travelled) above the speed limit in a range of speed bands, and the differences in emissions per kilometre for each band. These estimates are averaged across all vehicle engines and measured in free-flowing speeds, so could be over-estimating emissions.

From these figures, we've taken the reduction in emissions per vehicle in 2020 from our Extended Ambition scenario and the change in vehicle-km in 2020, but assumed the same proportions of distance travelled above the speed limit. From this data, we calculate the reduction in emissions from speed limit enforcement from the vehicle-km and efficiency data in each speed band.

The calculation applies to cars and vans (there is not a significant proportion of HGVs in the DfT data travelling over the 70mph speed limit), on motorways and A roads. The following table shows the breakdown of emissions saved from speed limit enforcement in 2020, in addition to the Extended Ambition measures.

Total abatement from enforcement of 70mph speed limit in 2020	
	$MtCO_2$
Car- motorway	1.0
Car- A roads	0.4
Van- motorway	0.9
Van- A roads	1.0
Total abatement	**3.3**

The abatement opportunity from speed limiting depends on the efficiency of engines. As technology improves efficiency, fewer emissions can be saved by reducing speeds to 70mph.

On the other hand, the abatement opportunity could be greater if the improvements in efficiency led to a rebound on behaviour, such that people drove faster because it cost them the same to do this in fuel with a more efficient car engine.

A similar calculation for 2020 which looks at lowering and enforcement at 60mph shows that 5 $MtCO_2$ of potential would be available.

In the longer term, with a greater penetration of electric vehicles, the emissions argument for speed limiting will be weakened. There could still remain, however, strong safety reasons for improved enforcement.

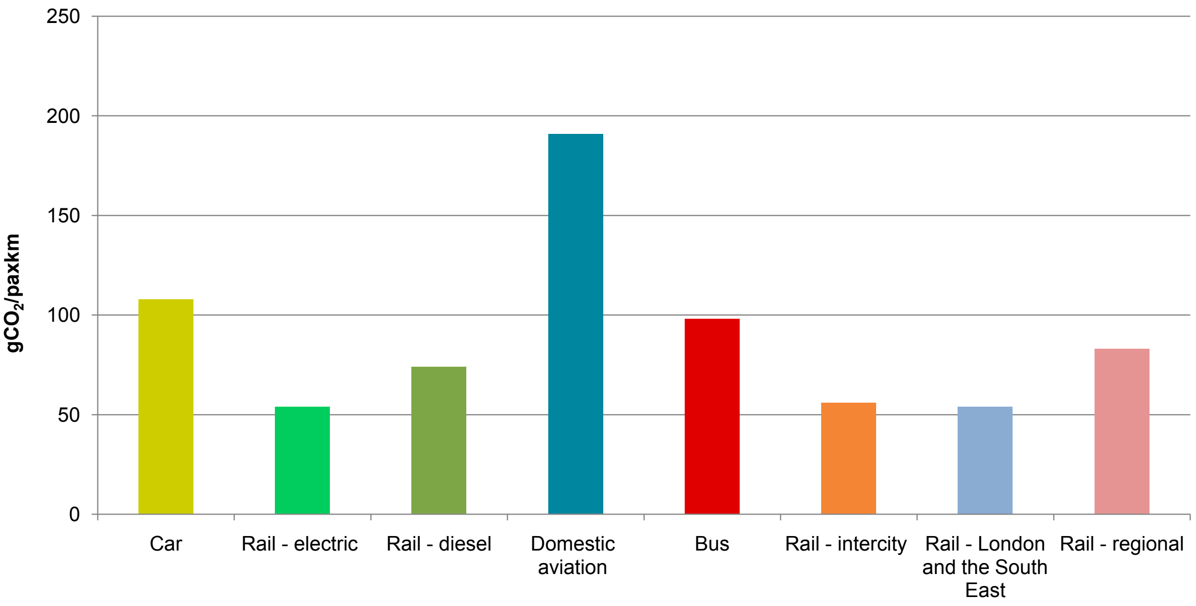
Source: CCC calculations based on DfT data

While recognising that limiting speed is politically contentious, the Committee believes that its potential role in achieving abatement should be kept under review. Motorway speed limits varied in line with congestion levels are likely to play an increasing role. And a more general application of lower speed limits could be a fast acting policy which government could consider if overall carbon budgets were in danger of being breached. We include the possibility of this policy in our Stretch Ambition scenario where 5 $MtCO_2$ is delivered through lowering and effective enforcement of the speed limit, as described above.

(ii) Modal shift to less carbon intensive transport and better journey planning

Different transport modes have very different carbon intensity, (i.e. gCO_2/passenger-km). The figures range from around 190 for domestic air travel, to 53 for electrical rail (given the current electricity generation mix) and zero for cycling and walking (Figure 7.26). If even modest shifts in traffic volume away from high-carbon intensive modes could be achieved useful levels of emissions reduction would result. Box 7.11 presents some purely indicative illustrations of the potential.

Figure 7.26 CO_2 emissions per passenger-km by mode



Source: DfT, Association of Train Operating Companies.

Notes:

1. Rail emissions calculated at current grid carbon intensity;
2. Domestic aviation emissions are calculated not allowing for any impact of additional radiative forcing beyond that produced by CO_2 emissions, see Chapter 8.

Box 7.11 'Ready reckoner' for passenger modal shift from cars

In order to calculate 'ready reckoners' for abatement potential from modal shift the following data and assumptions were used:

- Figures for annual passenger-km by mode are taken from data published by the Department for Transport.
- Figures for total CO_2 emissions by mode are taken from data published by the NAEI.
- It is assumed that all passenger-km for a single mode have the same carbon intensity and that there is a straight transfer of passenger-km from one mode to another with no other effects (e.g. changing load factors or changes in demand for travel)
- It is also assumed that the distance between London and Scotland is 700 km by air and rail and that there are 8 million journeys between London and Scotland per year.

	$MtCO_2$ Abated
Increasing bus and rail passenger kilometres by 50% (all removed from cars)	1.5
Double cycle kilometres (all removed from cars)	0.6
Replace London to Scotland domestic air journeys with rail journeys (current grid mix)	0.7

There are a couple of caveats to these figures:

- An implicit assumption in these figures is that mode switch is possible. Capacity constraints may inhibit switching to buses and rail. Whilst increasing capacity may create additional demand for travel.
- The potential for switch to cycling is limited to short journeys.

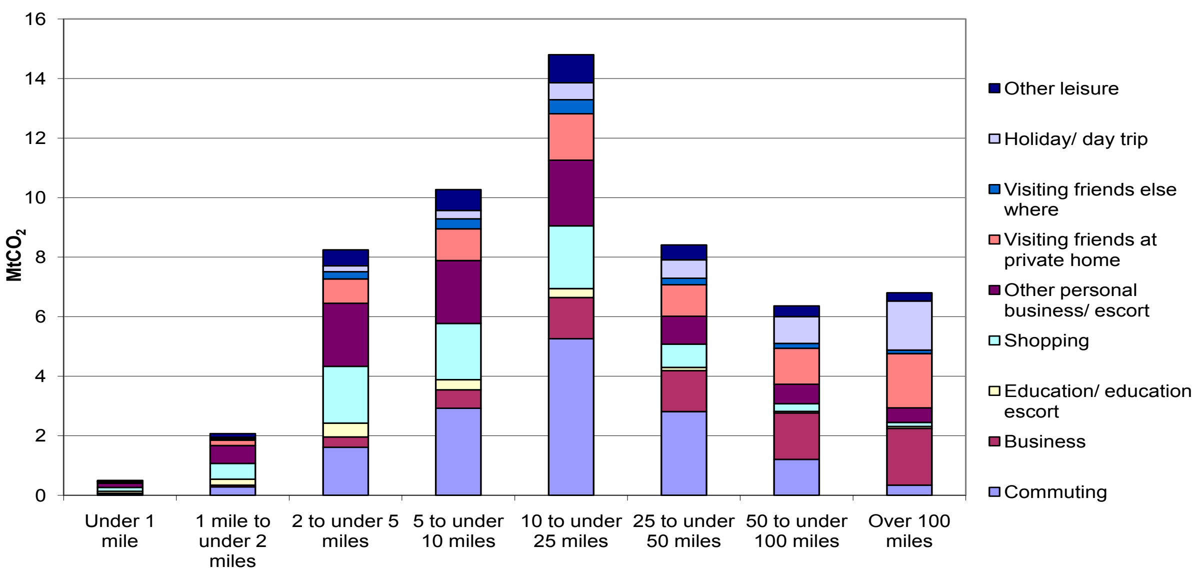
Thus abatement potential from modal switching may be more modest than our calculations reflect.

Source: CCC calculation based on NAEI and DfT data

Estimating realistic potential for modal shift is however a very complex challenge and the Committee has neither had the time nor resources to conduct a detailed analysis. Among the issues which would need to be considered in a detailed analysis are:

- **The pattern of journey lengths and purposes:** which suggest that there are likely to be major differences in the potential for modal shift depending on journey type. Figure 7.27 sets out the distribution of car journeys by journey length and Table 7.4 illustrates the varying importance of different journey purposes. Among the implications of these figures are that:
  - Opportunities to shift journeys to cycling are likely to be limited to journeys less than five miles distance, which are responsible for 19% of emissions.
  - A significant portion of emissions come from longer journeys (over 25 miles) for a wide variety of non business and non commuting purposes (e.g. visiting friends) which may be very difficult to shift given the highly specific and one-off nature of the travel routes.
  - The greatest potential may lie in commuting journeys, and in the large number of medium distance (i.e. 2 to 25 mile personal non commuting) journeys, both through modal shift and better journey planning, but the realistic potential will vary hugely by availability of alternative modes, household and occupation patterns, population density and land use.
  - There may be scope to change trip distribution and modal choice through levers relating to network access and land use planning, discussed in subsection (iii) below.
- **Capacity constraints in public transport systems** and the time which it would take to overcome these. Thus while our 'ready reckoner' illustrates the significant potential for emissions reduction resulting from a 50% increase of rail journeys at the expense of cars (Box 7.11), on many routes this would only be a realistic if there were further investment in capacity, which could result in increasing average gCO_2/passenger-km (for example, if the new capacity was occupied at a lower load factor than existing capacity).

Figure 7.27 Car CO_2 emissions by journey length and purpose



Source: DfT

Table 7.4 Trends in km travelled per year per person (all modes; by purpose of travel)

Journey Purpose	1995/1997	2006	Percentage Growth: 1995/1997 - 2006
Commuting	2,294	2,239	-2
Business	1,176	1,097	-7
Education	310	330	6
Escort education	142	162	14
Shopping	1,476	1,491	1
Other escort	648	785	21
Personal business	770	786	2
Visiting friends at private home	1,889	1,804	-4
Visiting friends elsewhere	377	471	25
Entertainment/public activity	507	597	18
Sport: participate	232	174	-25
Holiday: base	752	845	12
Day trip	582	622	7
Other inc. just walk	80	77	-4
All purposes	11,234	11,479	2

Source: DfT.
Note: 'Escort education' refers to accompanying someone to a place of education. For example the school run.

There are, however, already initiatives in place to incentivise modal shift, encourage better journey planning and reduce the need to travel. The Smarter Choices approach, for example, is aimed at influencing people's travel behaviour toward more sustainable options (Box 7.12). First implemented in the UK in the early 1990s, this approach has now been significantly implemented by around 30% of local authorities[39].

As with eco-driving, however, the level of emissions reduction that will ensue from these policies is uncertain. In addition it is not clear whether Smarter Choices can be implemented on a wider scale and evidence is limited about the persistence of behaviour change. It is clear, though, that harnessing the potential of Smarter Choices is likely to require a mixture of policy levers to lock-in the benefits such as reallocation of road capacity or parking control[40].

Given these uncertainties, in developing a range for potential emissions reduction from modal shift and better journey planning we have drawn on the Smarter Choices analysis used by DfT[41]. This analysis includes low and high scenarios, the former modelling continuation of Smarter Choices at current levels, and the latter modelling much wider implementation of current practice; in a central case, emissions reduction in 2020 is estimated to be 2.9 $MtCO_2$. We have built this central case estimate into our Extended Ambition scenario[42], and adopted a conservative approach in our Current Ambition scenario where we have assumed no savings from Smarter Choices. The Committee will revisit estimates from Smarter Choices policies in light of new evidence and when we look at the demand side in more detail from next year.

39 Department for Transport (2007) *Review of the Take-Up of Smarter Choices in Local Transport Plans*. Case Study Findings prepared by the Operational Unit for Sustainable Travel Initiatives Branch. London: DfT
40 Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A. & Goodwin, P. (2004) *Smarter Choices – Changing the Way we Trave*l. DfT
41 Defra (2007) *Synthesis of Climate Change Policy Appraisals*. London: Defra
42 We note, however, that even this 2.9 $MtCO_2$ estimate may be cautious, firstly because this assumes 'central' implementation of the policy; and secondly because further abatement is possible from network access and land use planning policies, which also would 'lock in' Smarter Choices. These are discussed in the next section.

Box 7.12 Smarter Choices: influencing people's travel behaviour towards more sustainable options

- Smarter Choices influence people's travel behaviour towards less carbon intensive alternatives to the car such as public transport, walking and cycling by providing targeted information and opportunities to consider alternative modes.
- Smarter Choices can include workplace and school travel plans; personalised travel planning, travel awareness campaigns, and public transport information and marketing; car clubs and car sharing schemes and; teleworking, teleconferencing and home shopping.
- Research commissioned by DfT, based on case study evidence, estimated that Smarter Choice measures under a 'high intensity scenario' have the potential to reduce nationwide traffic volumes by 11% based on a commitment to a programme building up over a ten year period. Under a 'low intensity scenario' a nationwide reduction in all traffic of 2-3% could be achieved[1].
- The DfT has funded three Sustainable Travel Towns in Peterborough, Darlington and Worcester to assess the results of the intensive implementation of packages of Smarter Choices in one locality. The three towns are sharing £10 million of DfT funding over the five years of the project 2004/05 – 2008/09. The evidence to date implies significant modal shift is possible with falls in traffic of over 10% in just two years[2].

Sources:

1. Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A. & Goodwin, P. (2004) *Smarter Choices – Changing the Way we Travel.* DfT
2. Merron, Gillian. Former Parliamentary Under Secretary of State for Transport. (Letter to Chief Executives on the success of the Sustainable Travel Towns, 23rd May 2007). [Online] Available from: http://www.dft.gov.uk/pgr/sustainable/demonstrationtowns/lettersustainabletraveltowns

(iii) Network access, land use and planning

We recognise that there may be emissions reduction over and above that set out above through a range of levers including changes to network access and land use planning, which could potentially result in deep emissions cuts both within and beyond the first three budget periods:

- **Network access**. Within the existing built environment, it is difficult to change relative locations of residences, amenities, businesses and transport links, but when the network is used and by whom can be altered relatively quickly, changing transport patterns and reducing emissions. For example, road network and town centre access can be designated by use (e.g. buses; deliveries to shops and businesses) and time of day and day of week (e.g. during the school run; or market days) to give priority to people and to lower emitting modes of transport. There has been a significant trend towards implementing such policies, such as dedicated bus or cycle lanes; pedestrianised streets or town centres; and even emissions differentiated parking charges. While, in general, network designation is motivated by factors such as congestion, safety, noise or air quality, CO_2 emissions gains may be an equally important factor to consider.

- **Land use and planning.** New construction presents an opportunity to build in from the start a pattern of transport activity associated with shorter journeys and less emitting modes. Key considerations are settlement size; population density; location of residences, amenities and businesses; and accessibility of public transport modes[43]. As settlement size increases, trips become shorter and the proportion by public transport increases; and as density increases, car trips decrease. Mixed use developments could reduce trip lengths and car dependence. Location of developments near public transport interchanges and corridors, with provision of public transport links at both the journey origin and destination, is also important.

43 Banister, D (2008) *Land Use, Planning and Infrastructure Issues in Transport*. Committee on Climate Change.

We have not yet quantified abatement potential from network access, land use and planning measures. Going forward, however, we will consider further what scope for emissions reduction these may offer in the first three budget periods and beyond. We will do this both as part of our ongoing work programme, and in the context of our advice on the fourth budget to apply from 2023-27 which we will provide in 2011.

(iv) Measures to constrain transport demand

Given increasing travel demand and emissions, there is an important public policy question about whether and to what extent public policy should plan to constrain total growth.

The Eddington Transport Study considered this issue, questioning in particular whether further road building should continue. Its overall conclusion was that there was a case for some limited additional road building, but that in the medium term constraints on total capacity should be accepted, with road pricing used to ensure that constrained capacity is used as efficiently as possible rather than relying on congestion to limit demand growth (Box 7.13). While the Committee has not developed a detailed point of view on long-term transport capacity and demand, it concurs with the Eddington Study judgement that unconstrained growth of capacity is not economically desirable and that road pricing is likely to have a significant role to play both in city centre environments (congestion charges) and on motorways.

Box 7.13 Key recommendations of the Eddington Transport Study

1. To meet the changing needs of the UK economy, Government should focus policy and sustained investment on improving the performance of existing transport networks, in those places that are important for the UK's economic success.

2. Over the next 20 years, the three strategic economic priorities for transport policy should be: congested and growing city catchments; and the key interurban corridors and the key international gateways that are showing signs of increasing congestion and unreliability. These are the most heavily used and economically significant parts of the network.

3. Government should adopt a sophisticated policy mix to meet both economic and environmental goals. Policy should get the prices right (especially congestion pricing on the roads and environmental pricing across all modes) and make best use of existing networks. Reflecting the high returns available from some transport investment, based on full appraisal of environmental and social costs and benefits, the Government, together with the private sector, should deliver sustained and targeted infrastructure investment in those schemes which demonstrate high returns, including smaller schemes tackling pinch points.

4. The policy process needs to be rigorous and systematic: start with the three strategic economic priorities, define the problems, consider the full range of modal options using appraisal techniques that include full environmental and social costs and benefits, and ensure that spending is focused on the best policies.

5. Government needs to ensure the delivery system is ready to meet future challenges, including through reform of sub-national governance arrangements and reforming the planning process for major transport projects by introducing a new Independent Planning Commission to take decisions on projects of strategic importance.

Source: The Eddington Transport Study

5. OVERALL CONCLUSIONS: REASONABLE ASSUMPTIONS ON ATTAINABLE ABATEMENT FOR BUDGET PURPOSES

We have developed three scenarios for transport emissions reduction:

- The Current Ambition scenario includes some increase in vehicle fuel efficiency, but does not include any biofuels above the reference case or demand side emissions reductions; total emissions reduction in this scenario are 5 $MtCO_2$ in 2020.
- The Extended Ambition scenario includes more radical technology options in cars, together with increased biofuels use over the reference case and demand side emissions reduction from eco-driving and Smarter Choices and effective enforcement of the existing speed limit; total emissions reduction in this scenario is 23 $MtCO_2$ in 2020.
- The Stretch Ambition scenario includes more radical technology options in vans and HGVs, emissions reduction due to stronger uptake of eco-driving in cars and vans; and lowering and effective enforcement of the speed limit. Emissions reduction in this scenario is 32 $MtCO_2$ in 2020.

In the Extended Ambition and Stretch Ambition transport scenarios, there is significant potential for emissions reduction. Implementing a domestic and EU framework will be needed to unlock this potential and to meet the economy-wide carbon budgets proposed in Chapter 3.

Emissions reduction from these scenarios, summarised in Table 7.5, is incorporated in economy-wide scenarios for emissions reduction to meet carbon budgets in Chapter 3.

Table 7.5 Abatement opportunities in transport in Current Ambition, Extended Ambition and Stretch Ambition scenarios, in 2020

Measure	Current Ambition	Extended Ambition	Stretch Ambition
Car- powertrain- hybrid	-4.1		
Car- nonpowertrain- large cars	-0.2		
Van-powertrain- stop start (slower uptake)	-0.1		
Van-nonpowertrain (slower uptake)	-0.3		
HGV- nonpowertrain (slower uptake)	-0.3		
Total	**-5.0**		
Biofuels		-5.0	
Car- powertrain- plug-in hybrid and electric		-8.7	
Car- nonpowertrain- all cars		-2.9	
Van-powertrain- stop start		-0.3	
Van-nonpowertrain		-0.8	
HGV- powertrain- hybrid		-0.2	
HGV- nonpowertrain		-0.7	
Rail- efficiency measures		-0.6	
Demand- Smarter Choices		-2.9	
Demand- Eco driving - cars		-0.3	
Demand-Eco driving - vans		-0.1	
Demand-Eco driving -HGV		-0.9	
Total abatement		**-23.3**	
Van-powertrain- plug-in hybrid and electric			-2.4
HGV-powertrain- plug-in and electric			-0.3
HGV- nonpowertrain- incl aero and weightreduction			-0.7
Speed reduction and enforcement at 60mph			-5.2
Eco-driving cars - far reaching			-1.0
Eco-driving vans - far reaching			-0.3
Total			**-31.7**

Source: CCC, DfT