Sustainability Committee: Inquiry into Carbon Reduction in Wales

Submission from the Commission for Integrated Transport

Purpose

Scientific opinion has suggested for some time that by 2050 the UK needs to cut its carbon emissions by 60% as part of a global effort to limit the atmospheric concentration of carbon to levels that would avoid the worst consequences of climate change. Emerging scientific consensus argues 60% may not be enough and cuts more in the order of 80% by 2050 will be required.

In September 2007, The Commission for Integrated Transport (CfIT) published its "Transport and Climate Change" report. The Report looked to establish transport's role as part of wider efforts across the economy to deliver the most cost-effective carbon reductions consistent with the Government's 60% carbon reduction aspiration by 2050.

This written submission provides a summary of the CfIT analysis and raises issues that the Sustainability Committee may wish to consider in its own review of carbon reduction within Wales.

Background

The Commission for Integrated Transport

The Commission for Integrated Transport (CfIT) is an independent advisory body, set up by Ministers in 1998. CfIT provides advice to Government on a wide range of transport policy issues and their interface with economics, the environment, social inclusion, and best practice.

In 2005, CfIT established a Working Group, chaired by Michael Roberts (Director of Business Environment, CBI) with membership drawn from a wide range of industry and policy stakeholders. The Working Group was asked to examine a cost-effective transport response to climate change, consistent with meeting the Government's target to reduce carbon emissions by 60% by 2050. The focus was on mitigation (i.e. action to cut emissions), not adaptation (i.e. action to deal with the consequences of climate change).

The Working Group received written evidence, held a seminar on public attitudes, commissioned new research into public attitudes on aviation and

climate change, consulted with a range of key stakeholders, and commissioned various reports from experts in the transport and climate change fields.

This paper is a summary of the "Transport and Climate Change" report. For further detail on the analysis and findings, please refer to the full report and the supporting evidence available from the CfIT website (www.cfit.gov.uk).

Transport and climate change: The challenge

The Stern Review (HM Treasury, October 2006) notes that global average temperatures are set to rise further by between 1.4C – 5.8C over the next 100 years if no action is taken to reduce greenhouse gas emissions. The result is more dramatic changes in the climate – more variable and intense weather patterns (e.g. floods and droughts) as well as rising sea levels. These weather patterns will in turn bring about major ecological, human, and financial costs. For instance, we can expect to see declining food supplies, increases in communicable diseases, infrastructure damage and the displacement of 5% of the world's population by the middle of the century - between 150 to 200 million people.

Stern argues that action needs to be taken now, given the long lead-in times that some measures require before benefits are felt and to ensure climate change does not cripple economic growth. The dangers of not tackling climate change would be equivalent to losing 5% of global GDP each year - whereas tackling climate change now to reduce the worst impacts of climate change in 2050 would cost 1% of global GDP per year. Stern argues that policy based upon a basket of carrots and sticks of incentives, supported by information and cultural change are required to manage our emissions to a sustainable level.

Work done for the Government suggests that a 60% emission cut *can* be achieved while sustaining overall economic growth (although the associated costs would be distributed unevenly across the economy). This relies on the assumption that the carbon reductions are made in a cost-effective manner.

UK transport trends

The exact share of UK-related transport emissions of carbon dioxide depends on how emissions are apportioned across sectors in the economy, and whether international shipping and aviation are included in the figures.

The first distinction is between '*source*' or '*end-user*' figures. *Source* figures allocate emissions according to where the fuel (e.g. coal, gas, oil, petrol etc.) is consumed and so do not attribute emissions arising from fuel refining or electricity generation to the transport sector but to the energy sector. *End-user* figures include an estimated share of upstream emissions from power stations and refineries allocated back to the sectors using the electricity or fuel (sometimes referred to as ‘well to wheel’).

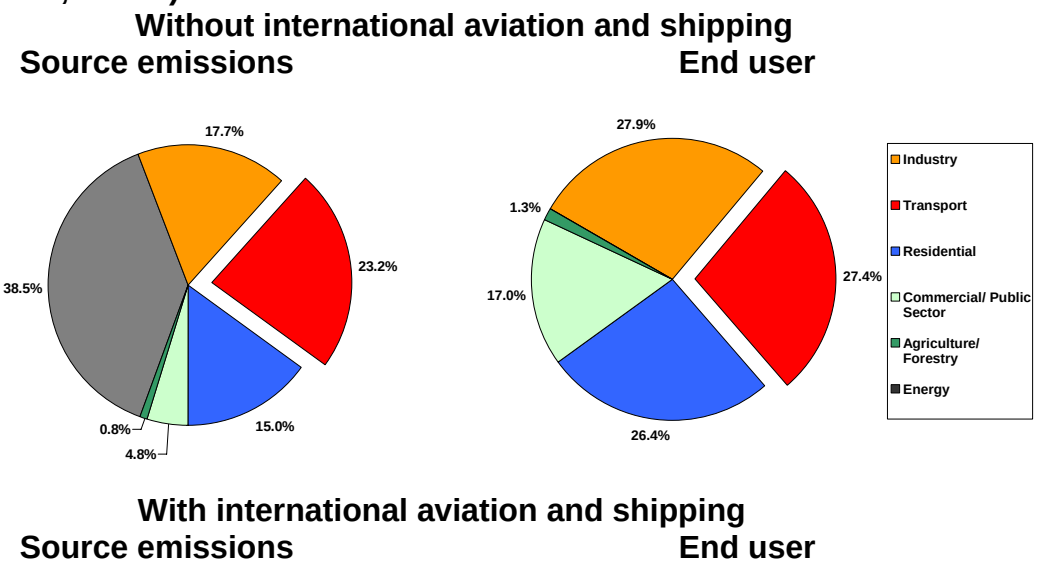
Total UK emissions in both cases are the same - 151.7 million tonnes of carbon (MtC) in 2005, not including international aviation and shipping, but the difference for individual sectors can be substantial. Transport sector figures increase from 35.2 MtC (source) to 41.6 MtC (end user), with the sectoral share of the total rising from 23% to 27%, once upstream emissions are reallocated (Defra, 2007b).

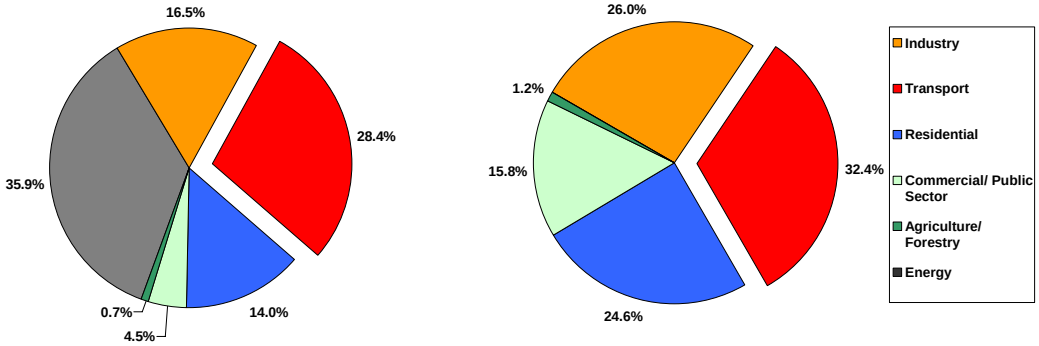
The second distinction is between domestic and international emissions. Government targets, projections and modelling usually exclude emissions from international aviation and shipping, as there is no agreed convention on how to allocate these emissions to individual countries.

A truer picture of the UK's emissions would include at least some emissions from these international movements. Using a method of calculating aviation and shipping emissions based on fuel used in 'international bunkers', this would add 11 MtC to the normally-reported figures, increasing transport's share to 28% (46.3 MtC, as source) or 32% (52.7 MtC, as end user) of an expanded UK total for carbon emissions. It would mean that air traffic would account for approximately 6% (9.5 MtC) of total emissions by source.

The difference between *end-user* and *source* figures, and the contribution that aviation and shipping make to the UK emission profile, is provided in Figure 1 below.

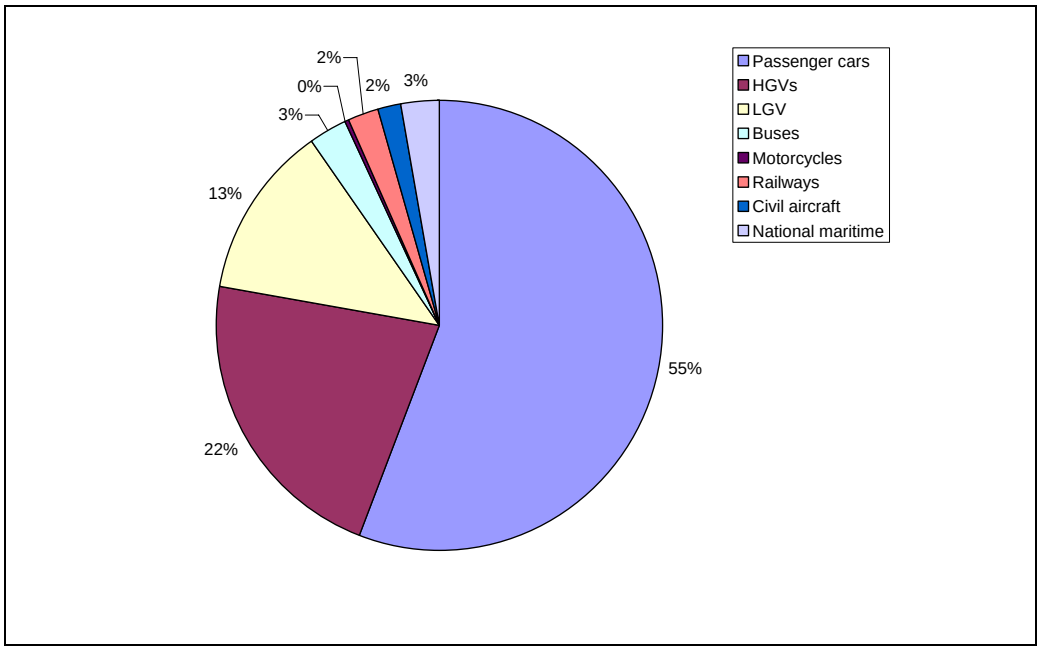
Figure 1 UK carbon emissions by sector as a share of total emissions 2005 (Defra, 2007b)





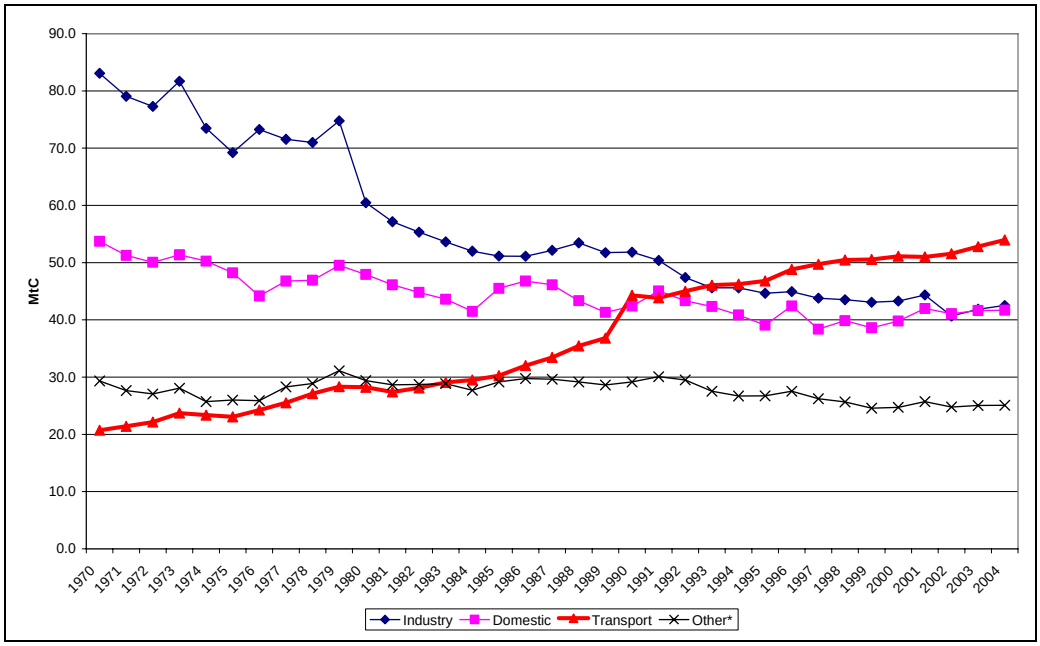
The most significant source of emissions within the transport sector is still road transport, accounting for almost 93% (33 MtC) of domestic transport, with cars making up 55% of the domestic transport total (see Figure 2).

Figure 2 UK Transport Sector carbon emissions by mode 2005 by source (excluding international aviation and shipping (Defra, 2007b)



Transport's share of total UK emissions has increased, but the rate of growth in transport emissions (both the total and for road transport) has flattened in the decade to 2000 (6%, compared with 37% over the preceding decade) – and has been at least partly de-linked from the rate of traffic growth, mainly due to better fuel efficiency in the vehicle fleet and higher diesel penetration (refer Figure 3). Public transport emissions have fallen by 9% since 1990 though this has had marginal impact overall, given public transport's small share of the market (notwithstanding recent growth in rail patronage).

Figure 3 Carbon emissions by sector: 1970 to 2005 by source (Defra 2007b)



Aviation emissions have grown the fastest of all transport modes. Since 1990, domestic aviation has seen emissions growth of nearly 100%; international air travel emissions have grown by 123% (based on figures for fuel used in 'international bunkers' and calculating the emissions related to the burning of this fuel).

According to Defra statistics, use of vans has resulted in steep growth in emissions, up nearly half since 1990 so that they now account for 13% of domestic transport emissions. Lorries currently account for 22% of transport emissions and have grown by almost a third over the same period. However, research carried out for CfIT (McKinnon, 2007) has shown that trend emissions figures for lorries and vans can vary by a factor of 3. This degree of uncertainty highlights an important area for future research.

Modelling a cost-effective response

One relevant piece of analysis on cost-effectiveness of carbon-saving measures is the economy-wide 'MARKAL-Macro' modelling carried out for the 2007 Energy White Paper (EWP) (DTI, 2007a) to identify how the UK could meet future energy demands at least cost to society. By looking at carbon reduction opportunities in transport and non-transport sectors, comparing a 'business as usual' scenario to 2050 with scenarios assuming constraints on carbon emissions in the future, the model provides a framework for evaluating alternative technology pathways and futures.

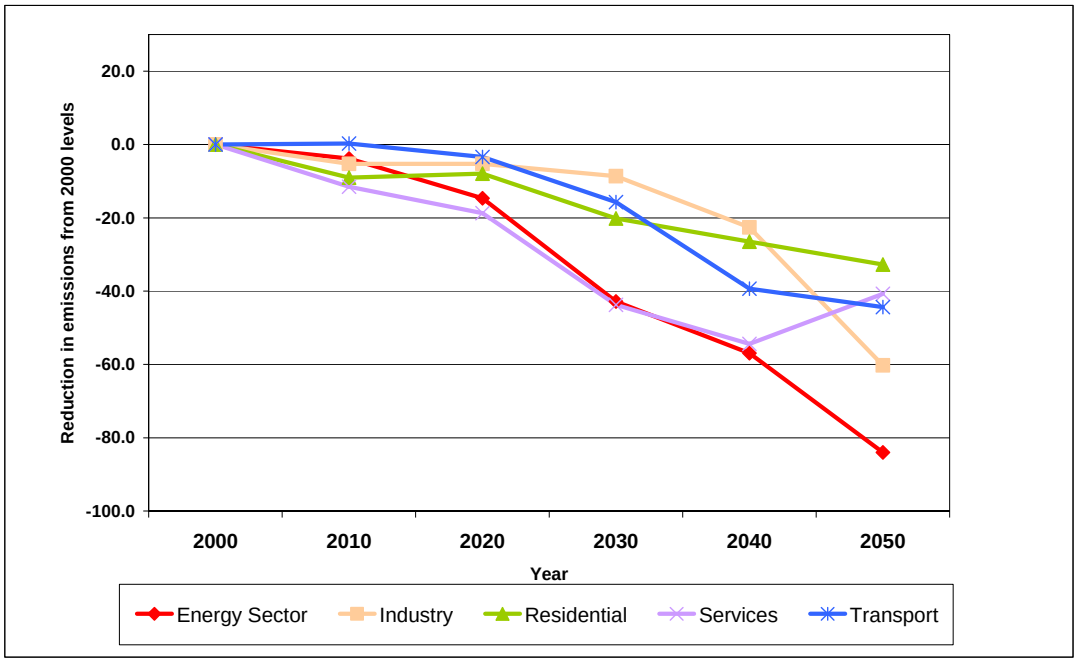
A major outcome from the modelling is that transport measures could make a significant contribution towards a cost-effective, economy-wide move to cut carbon emissions by 60% by 2050, falling possibly by as much as 45% against 2000 levels by the end of the period.

However, in the short to medium term (up to about 2020), the model indicates that there would be little reduction in carbon from the transport sector, with technological developments doing little more than offsetting the rise in carbon

emissions that would otherwise have occurred due to growing demand for transport. More cost effective opportunities for net carbon abatement would be realised in other sectors such as energy, industry, residential and services, as the economy moves towards its long-term target (see Figure 4).

This conclusion from MARKAL provided an important starting point for the CfIT research. We wanted to understand whether it was really the case that there were few cost-effective measures to reduce transport sector carbon emissions in the short to medium term, or whether the MARKAL model's focus on technological solutions might mean that it had missed some cost-effective options for short-term carbon savings.

Figure 4 Cost-effective carbon reductions by sector to 2050 from the MARKAL-Marco model (DTI, 2007a)



As with all economy-wide analyses, the results of the MARKAL-Macro model need to be treated with caution, as modelling such as this is beset with difficulties and uncertainties, and is dependent on the range of base assumptions used. Much rests on assumptions about technology availability, efficiency, and cost, all subject to considerable uncertainty, particularly for technologies such as hydrogen and fuel cells, which are still in their infancy.

The Government's Climate Change Programme

The UK's Climate Change Programme (CCP) was launched in 2000. The Programme detailed how the UK plans to deliver its Kyoto target to cut its

greenhouse gas emissions by 12.5%, and move towards its domestic goal to cut carbon dioxide emissions by 20% below 1990 levels by 2010. A revised Climate Change Programme was published in 2006.

The Government's strategy to reduce greenhouse gases for transport includes a range of technical, fiscal, and behavioural measures. The potential carbon savings from each policy instrument in the programme are regularly re-estimated by Government as underlying modelling assumptions change in the light of experience and new evidence. Table 1 shows the savings attributed to each measure, totalling 10 MtC by 2020, using the most up-to-date published figures.

Table 1 Expected carbon savings from transport measures in the CCP

	2010	**2015**	**2020**
Voluntary agreements package with car manufacturers (includes supporting fiscal measures e.g. VED, company car tax)	2.3	3.1	3.6
Successor to voluntary agreements (based on a target of 135 g CO_2/km by 2020)	0.3	1.1	1.8
Fuel duty escalator (1993 – 2000)	1.9	1.9	1.9
Renewable Transport Fuels Obligation (gross savings based on 5% of fuel sales by 2010 target)	1.6	1.6	1.6
Sustainable distribution in Scotland	0.1	0.1	0.1
10 Year Plan/ Wider transport measures	0.8	0.8	0.8
Smarter Choices behaviour change measures (low intensity)	0.2	0.2	0.2
TOTAL CCP	7.3	8.9	10.0

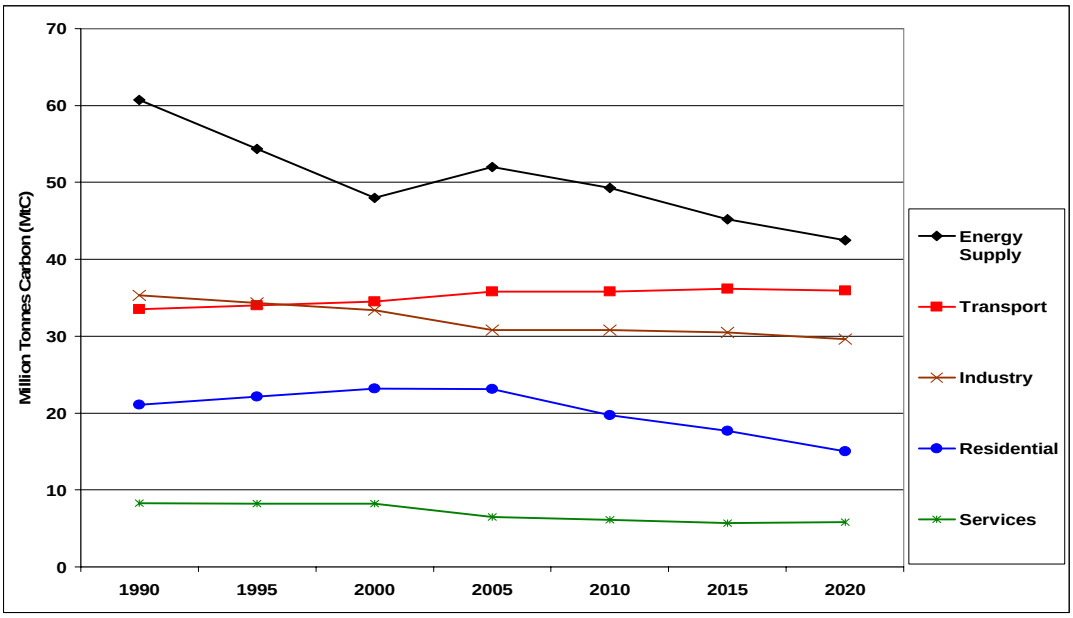
Source: Note these figures are the most up-to-date published estimates of potential carbon savings for each instrument compiled from Defra, 2006b and 2007a and DTI, 2007b. Totals do not sum due to rounding.

In addition to the emissions savings identified above, further developments have been outlined both within and separate to the Energy White Paper (2007). However, these policy areas either do not have carbon savings attached to them or cannot be regarded as currently 'firm and funded' and so the savings attributed to them are not included.

Future projections (to 2020)

Altogether, the impact of the policies (if delivered successfully) means that emissions from domestic transport will be around 22% lower in 2010 than they would otherwise have been. Against this must be set the growth in carbon emissions caused by increased traffic. The overall effect of the programme of measures will be to stabilise transport emissions at broadly 2005 levels by 2020, as savings in the transport sector are expected to offset the growth that would otherwise occur (see Figure 5).

Figure 5 Historic and projected carbon emissions by sector 1990 – 2020 source



Source: Figures pre 2005 from DTI, 2006; forecasts from DTI, 2007a, Table 4.2, p12. Figures for transport exclude 'off road' and savings from inclusion of aviation in EU ETS.

Observations on cost effectiveness

Our review of the priorities for reducing transport-related emissions, throws up four significant observations about the cost-effectiveness of the Government's current approach:

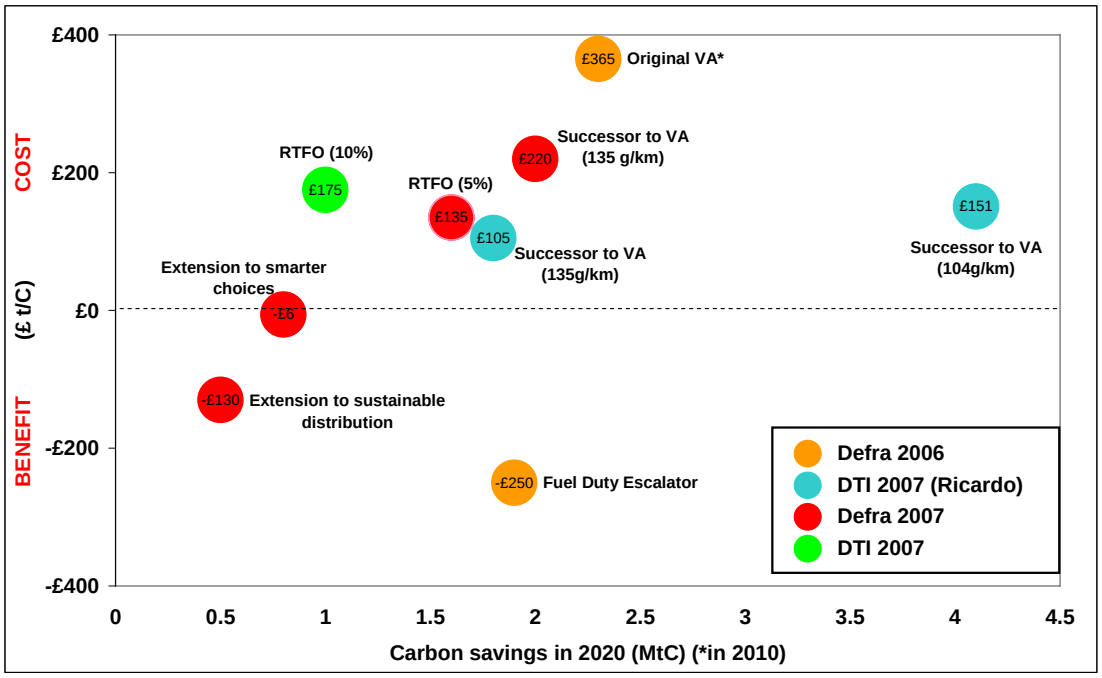
- The transport element of the Climate Change Programme appears to rely significantly on relatively expensive measures to deliver reductions (e.g. voluntary agreement, RTFO - refer Figure 6 below);

- There are question marks over the ability of major elements of the programme to deliver reductions (e.g. the current Voluntary Agreement is unlikely to deliver on its 2008 target and anticipated savings are continually scaled down; the RTFO emission savings figure overstates the net global reduction in emissions by excluding the refining process for biofuels imported from abroad for use in the UK).

- With 70% of the carbon emissions in the CCP due to be delivered by technology, we believe there to be a missed opportunity to capture greater cost-effective carbon savings from transport and 'lock-in' the positive impacts of technological advances using measures to encourage behavioural change through fiscal and non-fiscal means; and

- The role that measures related to international transport can play as part of a wider cost-effective response to tackling emissions remains unclear. The modelling used by the UK Government to review cost-effective options for carbon abatement across the economy does not cover international aviation and shipping.

Figure 6 Comparative Cost data (Climate Change Programme)



In view of these issues, we believe there are significant risks to the Government's ability to deliver transport emissions savings as part of a coherent, cost-effective and economy-wide response to mitigation. We believe the case is even stronger, given that there are challenges facing the delivery of carbon abatement opportunities in other sectors and the scientific evidence pointing to the need for larger carbon reductions to be delivered more quickly than currently anticipated in the Government's apporach.

CfIT's approach to tackling emissions

Our overall approach was to examine the period to 2020, given the urgency of securing early cost-effective emission reductions. We focussed upon tackling either the largest or the fastest-growing areas of transport emissions. We were particularly interested in trying to identify measures that were affordable and acceptable to the public, as we believed these measures had a greater chance of being delivered successfully.

We recommend five packages of reinforcing measures across the transport sector, which by 2020 would see transport emissions fall against 1990 levels rather than stabilise at 2005 levels.

Recommendation 1: The Vehicle Emissions Package
Introduction of a mandatory EU target for new car sales to reduce CO_2 emissions to 100 g/km by 2020, supplemented by measures to complement manufacturers' efforts (Carbon savings: 2.45 MtC in 2020)

Carbon savings from improving efficiency in currently-available engine technologies are likely to be among the lowest cost options which can be delivered from technology in the transport sector over the next 10-20 years. Improving average new passenger car efficiency to 100 g CO_2/km is both feasible and can be relatively cost effective if the deadline for achieving the target is set at 2020 and an integrated approach including supporting measures is adopted.

The difficulties experienced in achieving the Voluntary Agreement target to date demonstrate the need for a stronger policy framework of supporting measures to transform the market for new cars in at least three ways through:

- Incentivising low carbon vehicle purchase (e.g. through greater use of VED differentials, building on the company car tax regime and further promoting the eco-labelling of cars and vans);

- Supplementary vehicle technology (e.g. gearshift indicator lights, tyre pressure monitoring systems, in-car fuel economy meters);

- Changing the official vehicle emissions test procedure (e.g. to include air conditioning, biofuels, electric vehicles, hybrid vehicles).

Recommendation Two: The Driving Behaviour Package
A package to reinforce positive driver behaviour through a combination of measures to promote eco-driving techniques and greater adherence to 70 mph speed limits, as well as giving the planned Climate Change Committee a role in advising on the level of fuel duty (Carbon savings: 0.7 MtC in 2020).

We believe the carbon reductions possible under Recommendation 1 need to be "locked-in" through a carrot and stick approach aimed primarily at influencing driver behaviour, implemented as three integrated measures as follows.

- Enable sustained future fuel prices - Price rises in recent years have been due more to fluctuations in the world price of oil than higher taxation. If world prices were to drop substantially, this would serve to encourage greater vehicle use and so higher CO_2 emissions. We believe that a steady increase in fuel price is essential to help control CO_2 emissions and "lock in" the benefits of the efficiency improvements we are looking for in the vehicle fleet. The new Climate Change Committee proposed by Government in its draft Climate Change Bill should advise Government on whether and by how much fuel duty may need to increase as a part of its anticipated annual review of progress towards carbon targets. It should also have a role in ensuring road pricing schemes are complementary to emission reduction strategies.

- Encourage eco-driving - though an intensification of eco-driver training programmes, supporting technical improvements and securing additional safety and air quality benefits, as well as saving money for motorists and public transport operators. This could be achieved

through (i) subsidised driver-training programme to target existing drivers, (ii) the principles of eco-driving could be incorporated into the practical examination procedure of the standard driving test, (iii) fuel companies to promote eco-driving using opportunities at the point of sale of fuel and other promotional means, (iv) in-car devices to assist eco-driving (econometers, gear shift indicators, cruise-control) could be exempt from VAT.

- Promote greater adherence to the 70 mph speed limit – Speed has a significant effect upon vehicle emissions. For example, a medium-sized diesel car will emit up to 14% more CO2 per km at 80 mph than at 70 mph. We therefore believe greater priority should be given to effective enforcement of the 70 mph limit. If done in the context of controlled motorway speed programmes, better infrastructure management, awareness campaigns and other interventions, we believe this could win wide public acceptance. Research estimates that effective enforcement of the 70 mph speed limit in the UK could save around 1 MtC a year; reducing the limit to 60 mph would almost double this to 1.88 MtC.

Recommendation Three: 'Smarter Choices' Travel Behaviour Package
More intensive promotion of smarter choices to encourage use of public transport, walking and cycling, supported by improvements in the carbon performance of public transport (Carbon savings: 1.0 MtC in 2020).

'Smarter Choice' measures encourage use of less carbon intensive alternatives to the car for passenger travel. These measures include workplace or school travel plans; car clubs and car-sharing schemes; public transport information and marketing, travel awareness campaigns and personalised marketing; and teleworking or home shopping.

Research on the impact of smarter choices found significant modal shift is possible. The 'Smarter Choices' study for DfT (Cairns et al. 2004) concluded that high intensity application of smart measures could reduce national traffic levels by about 11%, with reductions of up to 21% in peak period urban traffic. Research by Sustrans / Socialdata (2005) shows that 50% of all local car trips in non-metropolitan towns could be replaced by walking, cycling and/or public transport. The potential offered by cycling and walking is often underestimated because the bicycle is primarily a mode of transport for short distances. However, nearly a quarter of car journeys are less than 2 miles and over half of all journeys made by car are less than 5 miles (DfT, 2006), a distance over which use of walking and cycling can bring time advantage over the car. Also, vehicle emissions are particularly high over short journeys because fuel consumption is disproportionately high due to the cold engine and because the catalyst is not yet working at full efficiency. For these reasons, the emissions reduction effect, including for local air quality, when journeys otherwise made by car are made by bicycle is particularly high. There are also significant health benefits from the uptake of non-motorised modes.

We believe the Government's recent activity on the range of Smarter Choices initiatives should be rolled out more widely across the country. Actions which would help mainstream smarter choice initiatives include more flexible use of capital funding; grants to facilitate allocation of staff resources; planning and fiscal changes to increase the adoption of workplace travel plans; assisting local authorities to build capacity to run large-scale personal travel planning programmes; and support for newer smart measures such as car clubs, residential travel plans and visitor travel plans.

Recommendation Four: Freight Package
A package of best practice, regulatory and fiscal measures to reduce emissions from van and lorry fleets (Carbon savings: 2.67 MtC in 2020).

This is a sector with significant potential for emissions savings, using existing technology and in many cases delivering financial benefits to the operators. Improvements over many aspects of freight distribution could in aggregate generate significant emissions reduction. A government-funded benchmarking survey in 2002 revealed that if all companies could raise the energy efficiency of their truck fleets to the mean achieved by the top third of companies in their sub-sector, overall fuel savings of 19% could be secured. Incorporating road freight transport as part of proposals for surface transport in the EU emissions trading scheme could provide a further impetus for change.

Incentives to purchase more fuel-efficient or alternatively fuelled vans and large goods vehicles are, at present, solely through the fuel price. Vehicle Excise Duty for lorries could account for CO_2 alongside size and number of axles. An additional measure could be to establish a mandatory regime to improve the carbon performance of new lorries. The first step towards any such agreement would be to establish a database of lorry fuel and carbon performance.

As already noted, a significant growth has occurred in van traffic for road transport emissions. Very little is known about the composition of this demand and up until recently, data has not been collected on the carbon performance of vans sold due to there being no standard test cycle for these vehicles. The latest CEC proposals (2007) propose targets for light vans of 175 g CO_2/km by 2012 and 160 gms by 2020, from 201 gms in 2002. This is a vital part of the proposals for the successor to the current voluntary agreements that should be supported, as in the case of cars, with a package of measures to help transform the market and encourage optimal use of these vehicles on the road. This will include the restructuring in VED, labelling of vans and components and driver training programmes.

Recommendation Five: Aviation Package
Inclusion of aviation in the EU Emissions Trading Scheme and consideration of supplementary measures to secure and develop further the potential reduction in emissions from this sector (not calculated due to insufficient evidence).

Research commissioned by CfIT from Ipsos MORI on attitudes to aviation and climate change found that:

- Most people (59%) saw it as the Government's responsibility to lead in addressing the climate impacts of aviation.
- There was most support for measures that do not restrict individual action, such as education and support for teleconferencing, though rationing on the basis of a carbon tax also received qualified support.
- Measures which showed more support than opposition (while not commanding 50%+ support) included refusing planning permission for additional airports, runways or airport terminals, and increasing the cost of flights to be at least as high as rail.

We believe the Government should develop a range of initiatives to reduce aviation emissions, including:

- Securing early agreement on extending emissions trading to aviation in the EU.
- Considering replacing Air Passenger Duty (APD) with an emissions charge on aviation fuel when international agreement is reached on this issue.
- Using measures targeted at environmental impacts (rather than VAT or increased APD) to reflect the carbon impact of aviation. If VAT or increased APD are pursued, any additional revenue should be used to reinforce positive change by airlines and passengers.
- Reviewing the potential to link air navigation charges and other charges (e.g. airport charges) to CO2 emissions.

Overall impact of our recommendations

The potential reductions delivered by each measure are shown in Table 2 yielding additional savings of around 7.1 MtC in 2020 to those anticipated under the CCP. Policies targeted at aviation and shipping would be additional to this.

Table 2 Proportion of savings from each type of measure in 2020

	CCP (%)	CfIT (%)	Total (%)
Vehicle efficiency	54%	35%	46%
RTFO	16%	0%	9%
Behavioural measures (smarter choices, eco-driving, speed limit adherence, public transport)	10%	28%	18%
Fuel duty escalator	19%	0%	11%
Sustainable distribution/ lorries and vans	1%	38%	16%
	100%	100%	100%

NB In the CCP, behavioural measures also includes sustainable distribution in England at 0.1 MtC.

In total, the package of measures outlined above increases the carbon savings expected from the CCP by 71% by 2020. We assume that none of the measures we have put forward can begin before 2008, and that the majority are implemented from 2009 onwards. Consequently, our recommendations result in modest additional savings by 2010, 11% above the CCP, although we believe our measures will also serve to ensure the CCP savings themselves are more likely to be delivered.

Figure 7 illustrates how the favoured scenario would deliver additional savings from car vehicle efficiency whilst complementing these with savings from behaviour change in the private travel and fleet sectors.

Figure 7 Carbon savings in 2020: CCP/EWP baseline and additional measures proposed by CfIT

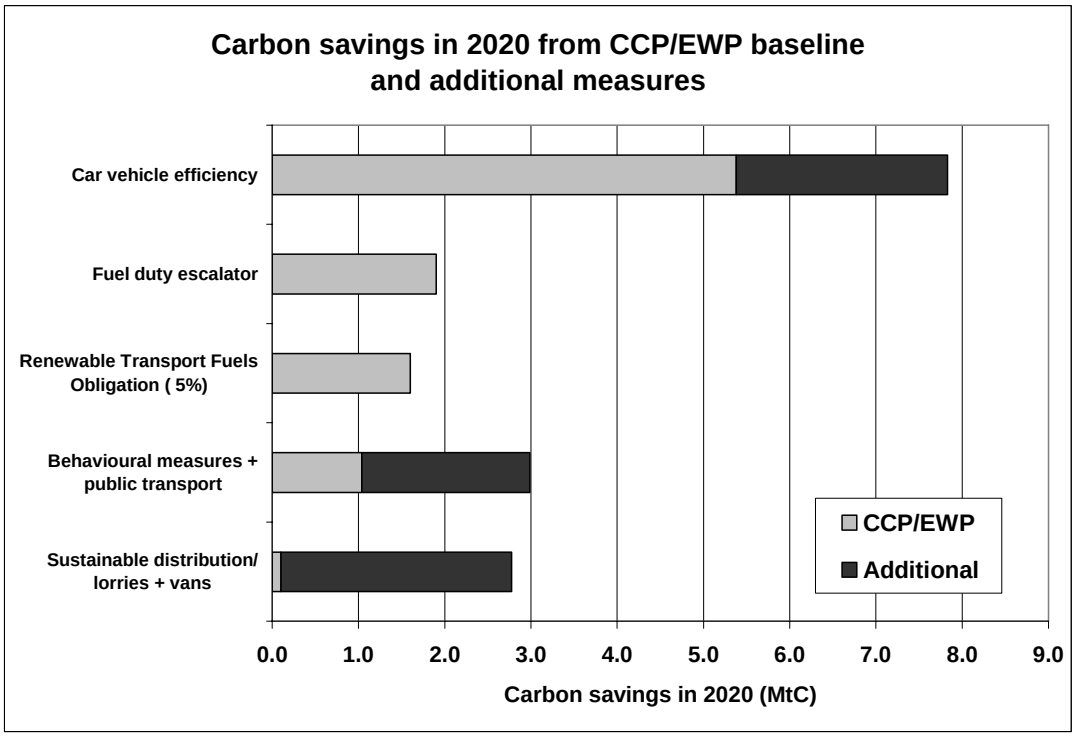
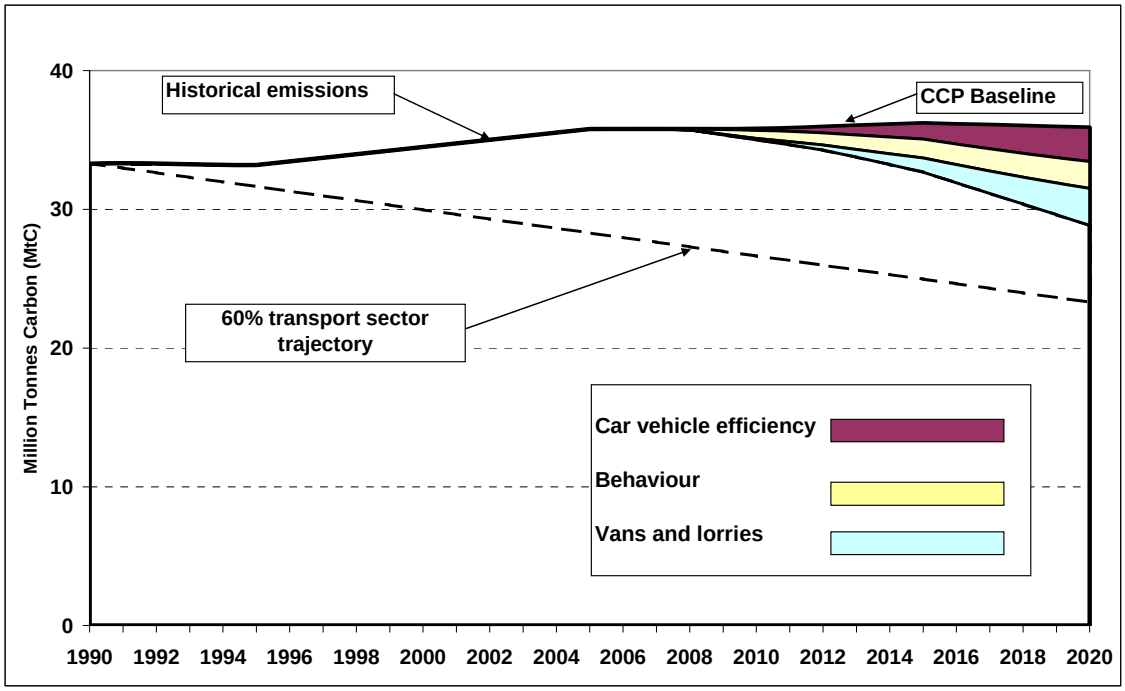


Figure 8 illustrates the CCP baseline to 2020, together with the additional measures proposed by CfIT. Unlike the CCP, the favoured package would ensure emissions from the transport sector start to fall below their 1990 levels, though it does not put the sector fully on a linear path to achieving a 60% reduction. Taken together with the CCP package of measures, the policies we have identified could reduce emissions from the sector to around 29 MtC in 2020 from its present level of around 36 MtC.

Figure 8 Emissions savings to 2020 over the CCP baseline from additional measures proposed by CfIT



Summary

There is an international scientific consensus (and political recognition in the UK) that climate change is happening and that greenhouse gases arising from human activity are a major cause.

Our role has been to understand how, within a UK context, transport has contributed to the problem and what contribution it might make to any response.

Our recommendations include:

- A mandatory EU target for new car sales of 100 g CO_2/km but with a deadline (2020) that allows a more cost-effective response by the industry, combined with measures to stimulate purchaser demand for lower-emission vehicles;

- Promoting more efficient use of cars through the price of fuel, greater promotion of eco-driving and better enforcement of speed limits;

- More intensive promotion of smarter choices to encourage take-up of alternatives to car travel, supported by improvements to the carbon performance of public transport;

- Measures to capture the significant opportunities for carbon reduction in the van and lorry fleets; and

- Measures to supplement the move towards emissions trading to stimulate carbon savings in aviation.

The potential reductions delivered by each measure could yield additional savings of 7.1 MtC in 2020, compared to those anticipated under the CCP. Policies targeted at aviation and shipping would be additional to this.

With regard to surface transport, the proposed package would see a greater balance of contribution towards emissions reduction between technological and behavioural change, and between cars and vans/lorries.

There are gaps to be filled in our understanding about emissions and international transport, light commercial vehicles and freight more generally.

Annex One: Glossary

The following list provides a brief definition of terms referred to within the body of this report:

- **Carbon dioxide (**CO_2**)**: a greenhouse gas produced by the burning of petroleum, peat, natural gas or coal.
- **Carbon dioxide equivalent** (CO_2 eq): Greenhouse gas emissions are typically reported in terms of CO_2 equivalent to provide a common unit of measures, and because CO_2 is the most prevalent of all GHGs.
- **Emission trading schemes**: A country (or group of countries or even regions/ states) caps its carbon emissions at a certain level (this is known as cap and trade) and then issues permits to firms and industries that grant the firm the right to emit a stated amount of carbon dioxide over a time period. Firms can then trade these credits in a free market. The idea behind carbon trading is that firms that can reduce their emissions at a low cost will do so and then sell their credits on to firms that are unable to easily reduce emissions. A shortage of credits will drive up the price of credits and make it more profitable for firms to engage in carbon reduction. In this way the desired carbon reductions are met at the lowest cost possible to society.
- **'End user' emissions**: emission figures that include a share of emissions from power stations and other fuel-processing industries reallocated approximately to the end user according to their fuel use (i.e. as opposed to 'source' classification). This can also be known as 'well-to-wheel emissions'. For the transport sector, this classification adds around 20% to the total CO_2 produced and thus gives the most complete account of the relationship between emissions and the production of goods and services**.** However, these figures are also subject to more uncertainty than 'source' figures.
- **Fossil fuels**: are hydrocarbons, primarily coal and petroleum (fuel oil or natural gas), formed from the fossilised remains of dead plants and animals by exposure to pressure in the Earth's crust over hundreds of million so years.
- **Greenhouse gases** (GHG): are components of the atmosphere that contribute to the greenhouse effect. Some greenhouse gases occur naturally in the atmosphere while others result from human activities such as the burning of fossil fuels. These include carbon dioxide (CO_2), water vapour (H_20), methane (CH_4) and nitrous oxide (N_20).
- **Lorries:** (heavy goods vehicles) are over 3.5 tonnes maximum gross weight.
- **MtC**: Figures given in MtC (million tonnes of carbon) refer to the mass of the carbon component of the CO_2 molecule multiplied by 44/12 to give the mass of CO_2.
- **Source emissions**: emission figures presented according to the sector from which they are directly emitted (i.e. as opposed to 'end user' classification). This can also be known as 'tailpipe' emissions.
- **Vans:** (including car based vans) or small goods vehicles (including pick-up trucks) which are licensed for Private and Light Goods use (PLG) for vehicles up to 3.5 tonnes maximum gross weight.

References

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