Reducing Carbon Emissions from Transport: What are we doing, and is it enough?

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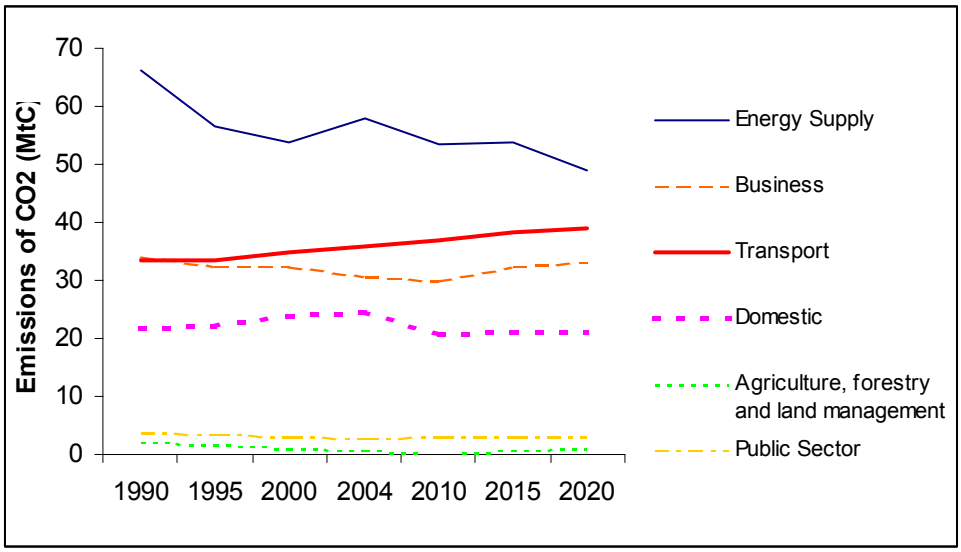
Introduction and context

The gases that make up earth's atmosphere are essential in helping to sustain life on our planet, by maintaining its temperature and creating the effect of a greenhouse. Increasing the concentration of these gases leads to more heat being retained. The consequent warming of the atmosphere and surface is known as global warming, which in turn brings about changes to the climate.

The 'greenhouse effect' is a natural part of the earth's climate system. However recently, concern has arisen owing to the rate of increase in the concentration of these gases and the implications this will have for the stability of global climate. The origin of the rapid increase is now widely agreed to be from anthropogenic sources, through the combustion of fossil fuels such as oil use in transport. Of these gases, carbon dioxide (CO_2) is by far the most prevalent and has therefore attracted the most attention in respect of efforts to curb greenhouse gas emissions. The consideration of CO_2 emissions therefore forms the main focus of this paper.

Considering the five main sectors of the UK economy, transport represents around one quarter of UK CO_2 emissions and is also the sector with the strongest growth in emissions levels (10% increase on 1990 levels on an end use basis). Examining the trends in Figure 1 reveals that it is the only sector to exhibit growth on 1990 levels over the period.

Figure 1 Source emissions of CO_2 by sector

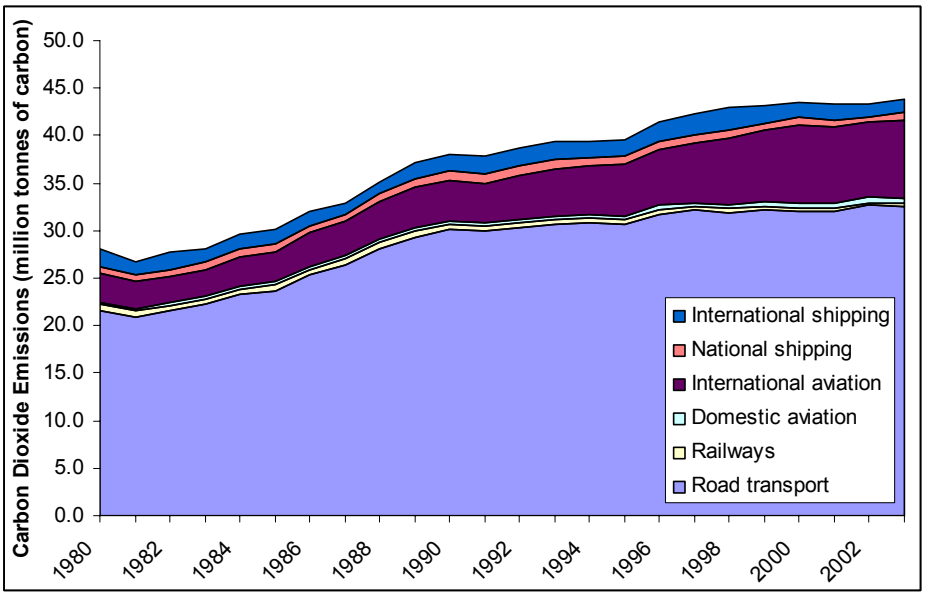


Source: Adapted from HM Government, 2006

Growth in travel, particularly that of motorised modes has been a significant feature in the UK over the last 30 years. Associated with increased motorised transport are growing levels of fossil fuel combustion and consequently, the significant rise in CO_2 emissions (clear from Figure 1 and Figure 2). As already indicated, compared to other sectors of the economy, transport now represents a significant and growing share of total emissions which stood at 36 million tonnes of carbon (MtC) in 2004, excluding international aviation and shipping (44MtC including these modes). This growth is

particularly stark in respect of increased levels of car use (85% of total distance travelled in 2002(DfT, 2004)) and air transport (Figure 2).

Figure 2 CO_2 emissions from transport by mode



Source: Adapted from DfT, 2005

Currently efforts to address greenhouse gas emissions and climate change in the UK are being directed by the UK Climate Change Programme (CCP). It sets out the emissions trends and reduction strategies across economic sectors to form the framework for action to meet the government's emissions reduction commitments. The first Programme was launched in 2000 (DETR, 2000a) and has subsequently been updated by the 2006 Climate Change Programme (HM Government, 2006)[1].

This paper seeks to assess the policy being used to address the climate change impact of the transport sector. Using the context of the government's various emission reduction targets and current emissions trends, current policies and anticipated reductions will be outlined. The effectiveness of the approach is questioned both at the strategic and individual policy level. In concluding, an attempt is then made to suggest the way forward through a redefinition and change of approach to tackling the problem of transport's contribution to climate change.

Reduction targets

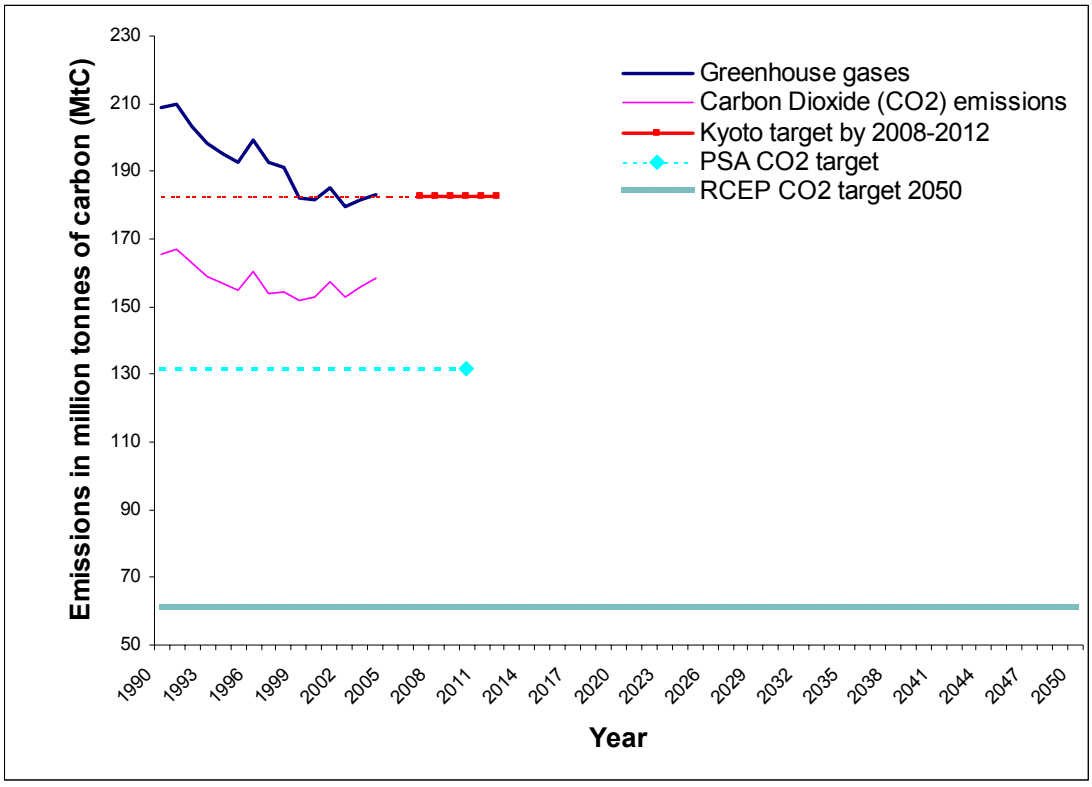
To gain a better understanding of the adequacy of the CCP's transport policies, it is important to examine the context within which the policy has been set. Emissions reduction targets that the UK government has pledged to achieve, and the progress on their attainment, is presented in Figure 3. From the graph, the Kyoto Protocol commitment of a 12.5% reduction in greenhouse gases by 2008 to 2012 appears to be on track, provided that the recent increases in CO_2 emissions, evident by the recent upward trend in the emission trend lines, does not continue. In contrast, the attainment

[1] Unless otherwise indicated, for the remainder of the report, reference to the Climate Change Programme will refer to the 2006 update.

of the Public Service Agreement (PSA) reduction in CO_2 emissions by 20% from 1990 levels by 2010 looks very unlikely to be achieved. The PSA itself is a commitment by three key government departments (Department for the Environment, Food and Rural Affairs, Department for Transport and Department for Trade and Industry), although no allocation of responsibility or timetable for action has been produced as to how much each department is expected to contribute towards meeting this commitment.

Whilst attainment of these targets is important from a short term policy perspective, the most significant commitment made by the government was to the Royal Commission on Environmental Pollution's (RCEP) recommended 60% reduction in CO_2 emissions from 1997 levels by 2050. This target is based on the global atmospheric stabilisation of CO_2 levels at 550 parts per million (ppm), with the aim of limiting the temperature increase to around 2°C. Based on the principle of global contraction and convergence of emissions, it's attainment also implies that the UK would make a full and fair contribution to the global reduction effort. This level of reduction is hoped to be sufficient to prevent catastrophic impacts of climate change. Progress on this target is very difficult to judge, what is clear from Figure 3 however, is the level of reduction required.

Figure 3 Climate Change Reduction Targets and Emissions Trends



Source: Adapted from HM Government, 2006

One difficulty with the reduction targets is that no allocation of emissions reductions across sectors or clear burden sharing of emissions has taken place. This is particularly the case for the 60% reduction target, which arguably as a long-term target needs clearer guidance to act as a driver to put emissions reductions on track. This is not to say that the emission reduction allocation should be shared equally cross

the sectors, but that clarity over the role of each sector needs to be explicit in order that those anticipated to do less, are clearly offset by those envisaged as contributing more. As they currently stand, the role of transport within these emissions reduction targets is unclear, although based on the projections of the CCP; transport emissions are anticipated to continue to rise until 2015. Perhaps the conclusion over the short term should be that transport is therefore not anticipated to contribute to our emissions reduction targets. This in turn would imply that other sectors will need to do more than their ' fair share', and from Figure 1, it is clear that progress in other sectors has also proved difficult thus far.

Coverage of commitments and joined up approach to climate change policy
The emissions reduction targets arguably provide a useful goal around which policies can be designed and against which progress can be measured. The difficulty with assessing progress in transport, particularly in relation to the short-term goals of the Kyoto targets and the emissions covered by the CCP, is that it currently ignores a significant sector of 'total' transport emissions. Both international aviation and shipping are excluded from the emissions inventories, as currently there is no international agreement on the allocation of emissions to individual countries. As is clear from Figure 2, emissions from international aviation (measured here as the simple allocation of UK aviation bunker fuels) have grown very strongly in recent years (increase of 176% between 1980 and 2003 (DfT, 2005)).

The use of these targets, which exclude aviation and shipping emissions, to inform and assess the development of the climate change policy for transport, creates a lack of clarity in respect of the progress achieved thus far. Their continued exclusion from emission inventories also introduces potential conflicts between the compatibility of sectoral policy with the goals of climate change policy, such as in the case of the projected growth of aviation envisaged by the DfT's 2003 aviation white paper and emissions generated by the outcomes of the multi-modal studies, which have been widely criticised (eg. Environmental Audit Select Committee, 2004; Transport Select Committee, 2003). Fragmentation of responsibility and a lack of a clear lead for issues such as climate change has been highlighted particularly in reference to transport policy (e.g. Begg and Gray, 2004).

Policy measures

Taking the government's emission reduction commitments as the overarching objective for climate change policy, examination of the specific transport policies set out in the CCP arguably provide an indication of the contribution that transport is anticipated to make. Greenhouse gas emissions from transport are largely in the form of CO_2 emissions from the combustion of fuel, with most of the sector almost completely dependent on oil based fuels. As indicated previously, CO_2 emissions from transport equated to around 44MtC (including international aviation and shipping) in 2004 and are continuing to grow. For transport, the CCP's defines three key variables that can determine the level of CO_2 emitted:

- Fossil carbon content of fuel;
- Fuel efficiency of vehicles; and
- Distance and means of travel taken

The main measures from the first and updated CCPs are set out in Table 1 and reveal the total anticipated reductions, along with the revision to the expected reduction potential in the intervening period between the two Programmes.

Table 1 Quantified Emissions Reductions in Transport for the 2000 and 2006 Climate Change Programmes

Measure	***2000 Climate Change Programme***	***2006 Climate Change Programme***
EU Manufacturer's Voluntary Agreements, Company car tax reform and reform of VED	4 Million tonnes of Carbon (MtC)	2.3MtC
Wider Transport Measures – 10 Year Plan plus 'built upon' in 2004 Future of Transport White Paper	1.6MtC	0.8MtC
Sustainable distribution (in Scotland)		0.1MtC
Fuel duty escalator	1 to 2.5MtC	1.9MtC
Total Existing Measures	6.6 to 8.1MtC	5.1MtC
Renewable Transport Fuels Obligation (RTFO)		1.6MtC
Future EU Manufacturer's Agreement		0.1MtC
Total New Measures		1.7MtC
Overall Total	**6.6 to 8.1MtC**	**6.8MtC**

It is clear that since 2000, there has been a substantial downward revision to the level of emissions reduction envisaged by the CCP. The total contribution of the transport sector to the updated 2006 CCP is 6.8MtC or 15% of 2004 transport CO_2 emissions. Based on the modelling carried out for the CCP, this level of reduction is not anticipated to contribute to the short-term reduction targets, but only to slow emissions growth.

Long Term Implications

Recent research has examined the possible implications for transport of a more significant emissions reduction target over the longer term. Bristow et al. (2004) calculated that in order to achieve a reduction of 20MtC[2] by 2050, measures such as road pricing, land use change or telecommunications, had to be combined with significant changes in new vehicle technology, improvements to existing technology and changes in vehicle purchasing behaviour. In another study, Banister and Hickman (2005) found that a 60% reduction in transport emissions was achievable by 2030, where the introduction of a combination of radical and integrated transport policies transformed the way we currently travel. The study shows that both technological change and significant behavioural change are both essential to reducing carbon

[2] Where total transport emissions grow to 41% of the total emissions under the RCEP's 60% reduction target and land based transport makes up 60% of this.

emissions in the order of 25MtC. In both cases emissions reductions are over 3 times the level envisaged by the 2006 CCP.

Examining the case of aviation, which as noted above is largely excluded from emissions inventories and current emissions reduction measures, Anderson et al. (2005) indicate that the aviation sector alone could account for between 33%[3] and 50%[4] of the UK's emissions contributions to the 60% target by 2050, without the implementation of policies to reduce this growth.

Clearly, the extent of change required, demonstrated in part by these examples, as measured against the performance to date, illustrates the significant scale of the issue and the difficulty posed by delaying action. Projections by the DfT's 2004 white paper and those undertaken for the CCP predict that both traffic levels and emissions are likely to continue to increase into the future.

In terms of transport, it is often argued that emissions reduction measures are much more expensive than in other sectors of the economy (DfT, 2004) and that efforts on reductions should be concentrated where they are logically the cheapest. This line of argument, however, neglects to contextualise the other issues of sectoral emissions, such as the overall significance of the sector within the whole, the trends of the sector over time and the implications this has for a 'lock-in' of future emissions growth. In the example cited above, Banister and Hickman (2005) indicate that in order to achieve the 60% emissions reduction, action is required in 2005. As transport infrastructure and land use patterns have long lifetimes, the danger of inaction is that we become further 'locked-in' to energy consumption and CO_2 emission trends for decades to come.

As is clear from the growing trend in transport emissions and the necessary revision to the reduction levels between the two CCPs, there appears to be limitations to the effectiveness of design, implementation and outcome of our current policy. The next section considers the main transport policy measures being pursued and identifies some of the limitations of their use in current climate change policy.

Reducing the fossil carbon content of road transport fuels

RTFO

The most important new measure of the 2006 CCP, in terms of quantifiable emissions reductions, the Renewable Transport Fuels Obligation (RTFO) is the main mechanism for the UK to comply with the 2010, 5.75% alternative fuel target set out in the 2003 EU Biofuels Directive. The RTFO's aim is to substitute 5% of all the road vehicle fuel sold in the UK for alternative lower carbon sources; the vast majority of which is likely to be in the form of biofuel. The RTFO mechanism creates an 'obligation' on fuel suppliers to either source alternative fuel at an increasing rate from 2008 in order to achieve a 5% share by 2010 or purchase equivalent credits at a set rate to 'buy-out' of the obligation.

While the introduction of the RTFO is not expected before 2008, a number of issues have already been raised in respect of the legitimacy of the carbon and sustainability

[3] based on the DfT's assumption of emissions stabilisation after 2030
[4] based on historical and maturing passenger growth trends

benefits of biofuel use in transport. Biofuels in themselves are not necessarily carbon neutral, with a number of studies revealing a variation in carbon emissions from neutral or negative to higher levels than even the use of conventional fossil fuels, depending on the feedstock and production method. Clearly this would pose a perverse outcome for a supposed greenhouse gas reduction policy. The only way to ensure greenhouse gas emissions savings from biofuels is through a certification of the production process of a particular fuel path. As part of its work on designing the RTFO measure, the government has recognised the importance of certification and is currently considering how such a scheme should work. However, it appears unlikely that a robust system at the national or EU level will be finalised before the start of the RTFO in 2008. This brings into question the legitimacy of the carbon savings achieved by this measure.

In addition to the attainment of climate change benefits through the use of biofuels, there is also a wider social and environmental sustainability question in relation to where crops for biofuels are grown. Much recent attention by NGOs has been on the planting of palm oil for biofuels at the expense of tropical rainforest (a very effective climate regulator itself, amongst other things). Closer to home, issues have been raised over the cultivation of land for fuel as opposed to food crops, the efficiency and environmental merits of biomass production for transport fuel over its use for heat and power and the full lifecycle greenhouse gas impacts of biofuels produced through energy intensive agriculture.

Clearly, the implications of policy measures in transport go much further than the individual sector and in a global economy are likely to have an impact much further afield. Consideration of wider policy outcomes is essential to avoid a suboptimal outcome, especially in the context of an issue as complex as climate change. Criticism of the design of the RTFO has also been made in terms of its focus on the current fuel providers (large oil companies) that will hamper new entrants to the market and the fact that the buy-out level is too low. The concern is that fuel companies will opt for the purchase of buy-out credits rather than invest in alternative fuels.

Improving fuel efficiency of vehicles

Car maker's Voluntary Agreement

Currently the most significant policy in terms of potential for emissions reductions in the CCP is the EU negotiated voluntary agreements with the European, Japanese and Korean car manufacturer associations (ACEA, JAMA and KAMA). The aim of these agreements is to reduce average new car CO_2 emissions from each association to 140 grams of CO_2 per km (gCO_2/km), which equates to a 25% reduction on 1995 levels by 2008/09. It is anticipated that this target should be met through developments in vehicle technology.

Progress on agreement has been increasingly shown to be off target, with two reports this year suggesting that the target is unlikely to be met and that further, more compelling legislation will be required (European Commission, 2006 and T&E, 2006). This is a significant issue when you consider that it is the most significant policy measure within the CCP for transport. The reasons for the lack of progress are felt to largely relate to the fact as a voluntary measure; there is no real way of ensuring that the policy would be implemented or recourse if it is not. Many argue

that the design of the agreement, focusing on the manufacturers' associations and not the individual carmakers, lacks the real transparency or burden sharing to set out how the commitment would be met.

Vehicle taxation and behavioural change
The second strand of policy concerns the use of economic instruments to encourage the take up of more fuel-efficient vehicles. In 2001, the annual vehicle tax (Vehicle Excise Duty or VED) was restructured into graduated charges based on CO_2 emission levels. Following concerns over the limited impact that this was having, the 2006 budget announced the addition of an extra band and an increase in the differential between the lowest and highest emitters. The revised VED bands are also linked to the new energy efficiency label launched in 2005. The label has to be displayed in car showrooms in a similar way to those of domestic white goods such as fridges.

In addition to VED, taxation on company cars was also reformed to reflect CO_2 emissions from vehicles in 2002. The impact of this measure is widely seen as being more significant in transforming the company car market than that of VED for private cars, average new car emissions have fallen in the sector and are now lower than those of the private car market (Fergusson and Skinner, 2004). Previous research by the DfT identified that the price signal from VED was not a sufficient incentive to induce a significant change in consumer behaviour (DfT, 2003).

Changing behaviour has been identified as a key component of the ambitious carbon reduction strategies in the literature, however it appears that currently there is a difference of expectations between the government and public with respect to the ultimate responsibility for bringing about behavioural change. When questioned on the responsibility for addressing the environmental impact of cars, the public assume that the government will legislate (DfT, 2003). The government's current strategy on CO_2 emissions is to provide information, with the expectation that the public will then make the right choice. Given the bewildering array of information and choices to be made in the short term, attaining a significant degree of behavioural change, within the necessary time frame for long term consequences, perhaps requires greater decisiveness and stronger signals from government.

Encouraging a move towards environmentally friendly means of transport
Wider transport measures
While the two previous components of the CCP for transport focus almost exclusively on road transport, the final section relates more widely to other modes and transport policy undertaken to contribute to wider transport objectives at national, regional and local level. These include looking at the expansion of sustainable distribution programmes, developing the potential of bus quality contracts, use of 'Smarter choices' and intelligent transport systems and demand management through the Transport Innovation Fund.

While the potential emissions reduction and wider benefits of these measures remain largely unquantified in the CCP, examining their use in the reduction strategies put forward in the work by Bristow et al. (2004) and Banister and Hickman (2005) suggest that they do have the potential to play a significant role in our emission reduction efforts. The use of wider transport measures to contribute to achieving reductions in CO_2 emissions have however received criticism, particularly in relation

to the implementation of integrated transport packages including the adoption of demand management measures in the recent multi-modal studies (e.g. Begg and Gray, 2004). Demand management in particular, has been a difficult policy to pursue in transport owing largely to its perceived lack of public and political acceptability. Following the fuel protests in 2000, the government has shied away from the pursuit of ambitious plans for lorry and city congestion charging and work place parking charges, largely leaving the decision to local authorities with very little central policy guidance. The relative success and popularity of the London congestion charge scheme is widely used to advocate its expansion nationally, although the success is also dependent on the parallel implementation of a range of other transport investment.

It is important to remember however, that effective policy design is critical if the identified objectives of the policy are to be achieved. Road pricing is frequently cited as a method to reduce carbon emissions from transport, but arguably unless the scheme is designed with this intention, a significant reduction in emissions is unlikely to be achieved. For example, the most politically acceptable road pricing system is likely to be revenue neutral, with reductions in VED and fuel duty offsetting its introduction. While this system is likely to ease congestion by pricing people out of busy areas and times, this will have only a limited impact on CO_2 emissions if traffic is simply displaced onto other roads or people travel at different times. In fact, a recent study suggests that CO_2 emissions may even increase under these circumstances. The political will to implement a fully national scheme has thus far been lacking, raising doubts over whether there is a real will to introduce charging that will actually reduce CO_2 emissions.

Emissions trading

The inclusion of transport within emissions trading is often seen a future option for 'efficient' emissions reductions. The UK EU presidency during the latter half of 2005, saw the advancement of a proposal for the inclusion of aviation in EU emissions trading scheme by 2008, the DfT is also currently undertaking work on the feasibility of the inclusion of surface transport into the scheme.

Emissions trading and transport has recently become a significant theme in respect of the most cost efficient way for transport to reduce its climate change emissions. As a market mechanism, emissions trading provides a way to reach an emissions reduction level or cap at the lowest cost by creating a market that economically should favour the cheapest reduction options. In the case of the carbon market, an emissions ceiling or cap is defined and companies which emit CO_2 above a minimum threshold are allocated a share of the total emissions relative to their real emission levels. These can then be traded; with the likelihood that those companies able to most cheaply make emissions cuts doing so, selling their excess allowances to companies for whom the cost of emissions reductions is higher. Therefore the level of the cap determines how far emissions will ultimately be reduced. The current key initiative in this area is the inclusion of intra-EU flights into the existing EU emissions trading scheme. While the CCP suggests this should happen during the second phase in 2008, it is unlikely from both a practical and legislative point of view that this will now happen until phase three in 2013. This time lag is likely to prove significant for aviation as the high current growth in air travel and growing 'air dependency' of the UK means we are

likely to lock-in emissions growth unless action to reduce emissions is also taken in the short term.

Irrespective of when aviation or indeed surface transport is introduced to the scheme, there are a number of inherent complexities in emissions trading that are emerging from the existing scheme, illustrating the importance of careful design and effective implementation. For example, earlier in 2006, the price of carbon crashed owing to the realisation that a number of EU Member States had over allocated emissions for the first phase and that too many companies in the scheme had excess allowances to sell. This raises the issue of political influence (subject to external lobbying) over the policy process of cap setting, resulting in undemanding caps and inconsistent burdens between different countries and industries. The set up of the current scheme is also very administratively complex and demanding in terms of the need for monitoring and reporting, verification and inspection procedures, with the interpretation and transposition of the EU Directive varying between individual countries in the scheme. At the present time the scheme only covers industrial installations, so the inclusion of transport in any form will represent a significant change, as transport is likely to be a net buyer of emissions credits and the company responsible for trading credits is much less clear. A recent report adopted by the European Parliament, called for an initial closed scheme solely for aviation alongside a range of other measures to tackle it's climate change impact (European Parliament, 2006).

While emissions trading could provide the potential for another policy measure for reducing carbon emissions in transport, the inherent complexity of a successful implementation on the ground, amongst other issues, means that it should not be seen as the only or best solution.

Conclusions and way forward?

The 2006 CCP has set out a range of measures that are intended to reduce the CO_2 emissions from transport by 6.8MtC over the next decade. Current emissions from transport equate to over 40MtC and are projected to continue growing. The transport sector's CO_2 emissions equate to over one quarter of total emissions and have increased by 10% since 1990. Estimates suggest that if the RCEP's 60% reduction target is to be achieved, total transport emissions must be limited to around 26MtC by 2050, when allowing transport to make up 40% of the 60% target (Bristow et al., 2004). Increasingly, scientific evidence suggests that in order to avoid the catastrophic effects of climate change, the magnitude of reduction required in industrial countries will have to be greater than a 60% cut, with some additional burden for reductions likely to fall upon the transport sector.

However, achievement of the drastic reductions required in the transport sector is attainable but it requires both immediate action and a significant change to both the technologies employed and the way that we use transport. Current emissions inventories do not account for all transport emissions and it is therefore arguable that wider transport policy does not adequately reflect the full climate change impact of transport. Current climate change policy, while having achieved some notable success in the form of fiscal reform of company car taxation to reflect vehicle CO_2 emissions and improvements to consumer information on vehicle emissions, is failing to deliver

the necessary emissions reductions on the ground. Changing behaviour through the provision of the correct incentives is becoming increasingly important. However, lack of political will in implementation of policy has hampered progress with demand management measures and is likely to be a key stumbling block for the successful use of emissions trading. Just as the impact of climate change is not sector specific, the design of policies to reduce the climate change impact of transport cannot by made in isolation and must be integrated into the whole system. The objectives for the policy must also be clear.

So, what is the solution for transport? The current policy for transport relies heavily on the delivery of a few individual policy measures. Focus is much more on treating the symptom i.e. the emissions, than the underlying cause, i.e. unsustainable travel patterns and consumption of natural resources. This downstream focus of policy, while easier to implement and measure, ultimately limits the effectiveness of emissions reductions and simply stores the difficult questions and consequences for future generations. Resource use must be integrated into and underpin all policy areas and not be kept segregated in an individual policy document. Policies must be integrated, combining aspects of economic and market based instruments, demand restraint, the provision of alternatives and education and be fully implemented using a package approach.

Evidence suggests that there is a public expectation for the government to act to tackle climate change. Overcoming the issue of political will to rigorously implement policies to bring about the necessary change, when faced with the dilemma of short term economic growth and political popularity over long term climate stability, is however, likely to prove to be particularly difficult in our current system of consensual democracy.

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