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## The cost-effectiveness of carbon abatement in the transport sector.

### Meeting Report

30th October 2007, 58 Prince's Gate, London, SW7 2PG.  
REF UKERC/MR/MP/2007/007

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### **Background**

The Stern report observed that carbon reductions will be most expensively achieved in the transport sector as compared to other sectors in the economy.

*Transport is one of the more expensive sectors to cut emissions from because the low carbon technologies tend to be expensive and the welfare costs of reducing demand for travel are high. Transport is also expected to be one of the fastest growing sectors in the future. For these two reasons, studies tend to find that transport will be among the last sectors to bring its emissions down below current levels [Annex 7.c]*

The same view has been taken in analysis for the Energy White Paper and cost effectiveness analysis of individual instruments evaluated as part of the Government's Climate Change Programme.

Nevertheless, other sources argue the evidence and analysis upon which such conclusions are based almost exclusively on single technological solutions and neglect both shorter and longer term behavioural instruments and packages of measures. The important question, not addressed in much of this work, is the robustness of the evidence base surrounding the cost effectiveness of behavioural and wider packages of measures.

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# Contents

<b>EXECUTIVE SUMMARY</b> .....	3
<b>INTRODUCTION</b> .....	7
<b>SESSION 1: GOVERNMENT POSITION</b> .....	8
<b>SESSION 2 – COST-EFFECTIVENESS OF NON-TECHNOLOGICAL POLICIES TO ABATE CARBON FROM THE TRANSPORT SECTOR – THE STATE OF THE EVIDENCE</b> .....	13
<b>SESSION 3: IMPLICATIONS FOR APPRAISAL OF TRANSPORT PROGRAMMES</b> .....	16
<b>SUMMING-UP</b> .....	18
<b>APPENDIX 1</b> .....	20
THE STERN AND KING REVIEWS: A BACKGROUND NOTE BY SIMON JACKSON, HM TREASURY .....	20
KING REVIEW.....	21
<b>APPENDIX 2</b> .....	23
IMPLICATIONS FOR THE CLIMATE CHANGE BILL OF THE STERN REVIEW’S POSITION ON TRANSPORT ABATEMENT COSTS: A BACKGROUND NOTE BY CHRIS NICHOLLS, DEFRA.....	23
<b>APPENDIX 3</b> .....	26
THE DFT PERSPECTIVE: BACKGROUND NOTE BY ADRIAN GOULD, DFT.....	26
<b>APPENDIX 4</b> .....	29
THE COST-EFFECTIVENESS OF NON-TECHNOLOGICAL POLICIES TO ABATE CARBON FROM THE TRANSPORT SECTOR – THE STATE OF THE EVIDENCE BY DR JILLIAN ANABLE .....	29
<b>APPENDIX 5</b> .....	33
DOES THE DISCUSSION AROUND COST EFFECTIVENESS OF “HARD” AND “SOFT” MEASURES HAVE IMPLICATIONS FOR PRE-AND POST APPRAISAL OF TRANSPORT SCHEMES AND PROGRAMMES - PHIL GOODWIN.....	33
<b>APPENDIX 6</b> .....	36
DFT “REFRESHMENT” OF TRANSPORT APPRAISAL METHODOLOGIES – GROUP BRAINSTORM FOR IDEAS ON HOW TO IMPROVE TRANSPORT APPRAISAL METHODOLOGIES.....	36
<b>PROGRAMME</b> .....	39
<b>ATTENDEES</b> .....	40

## Executive Summary

This workshop set out to address four key questions, a) to d) below, identified prior to the event. Experts were invited to tackle these questions through means of a pre-workshop briefing paper. These papers were circulated to participants in advance of the workshop. The authors presented a brief summary of their paper during the workshop and participants were invited to discuss the issues raised by the paper and any other related issues. The briefing papers are available in the Appendices of the full report, which can be downloaded from the UKERC website<sup>1</sup>.

**a) What did Stern say about cost of abatement more generally, and about the transport sector more specifically? What was the basis for his findings? How are the Stern and King outputs being fed into policy – what other evidence is being fed in and how?**

*Lead discussant: Simon Jackson, HM Treasury*

The Stern Review conclusion is that emissions reductions from transport, as elsewhere, must be cost effective. If carbon abatement can occur more cost effectively elsewhere in the economy, this should be sought first. As a general principle, to attain emission reduction targets it does not matter where carbon abatement occurs but only that it does. In addition there are the key challenges of overcoming political sensitivities relating to increasing taxation and the barriers to behavioural change (e.g. purchase of cleaner cars).

**b) What is the UK Government's position and implications for the Climate Change Programme/ Bill and transport policy?**

*Lead discussants: Chris Nicholls, Defra and Adrian Gault, DfT.*

The Climate Change Bill reflects the three policy pillars identified by Stern for moving to a low carbon economy: carbon pricing; technology policy; removing barriers to change (eg behavioural change). The Bill is non-discriminatory about the way in which abatement occurs, but carbon budgets will be set in part to reflect the three pillars. Abatement is most likely in sectors other than transport due to its high costs. This does not mean to say that transport will not make a contribution as the current and future mix of policies are aimed at bringing forward this abatement; although once they are part of an emissions trading scheme, this abatement may occur overseas first.

For the DfT, the Stern Review and Eddington Report identify improving the performance of the network - focusing on the most unreliable, congested and crowded sections - as the key challenge for the Department. DfT will need to do this in a way that creates a sustainable transport network and cuts emissions of CO<sub>2</sub> and other greenhouse gases. The DfT response set out in the 2007 Energy White Paper

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<sup>1</sup> <http://www.ukerc.ac.uk/TheMeetingPlace/MeetingPlaceActivities.aspx>

broadly follows Stern's three pillars. DfT is developing appraisal systems to further support the assessment of different types of intervention:

- In appraising transport schemes DfT aims to draw on comprehensive assessment of all impacts – economic, environment and social. Adopted £70/tC in line with Defra recommendation, rising £1 a year. Post-Stern, move to include the higher shadow price of carbon values.
- Choice of measures to reduce carbon should be informed by cost-effectiveness analysis (basis of the analysis in the EWP 2007). Need to further develop Marginal Abatement Curve analysis in transport and to look at the full range of options, and packages of options.
- The Department has announced a refresh of its appraisal tools (NATA refresh) and is launching consultation on this. An aim is to ensure that appraisal tools are more suitable for incorporating assessment of environmental impacts and for the generation and comparison of different options.

**c) What is the state of the evidence as regards non technological/ shorter term/ softer policies and their carbon saving potential and cost effectiveness? How do we develop the evidence base in this area?**

*Lead discussant: Jillian Anable, Robert Gordon University*

In her briefing note, Jillian noted that several key economy-wide and/or global perspectives on the economics of climate change have acknowledged the important role of behaviour change and demand management (Stern, IPCC, King) for the transport sector but each cites limited evidence on the effectiveness of such policies to deliver sustained behaviour change. Her main argument, is that the evidence on the cost-effectiveness of carbon abatement in the transport sector is limited and allows few concrete conclusions to be made. Most importantly, she believes few measures have been thoroughly assessed in this way and evaluation methods are often inconsistent. In summary, she outlines two broad limitations with the state of the evidence in this area:

1. The definition of cost-effectiveness and the methodologies used to assess it;
2. The relative lack of assessment of non-technological options for carbon abatement.

She also lists options to improve the existing evidence base.

**d) Does the discussion around cost effectiveness of 'hard' and 'soft' measures have implications for pre- and post appraisal of transport schemes and programmes?**

*Lead discussant: Phil Goodwin, University of the West of England*

Phil Goodwin contests Stern's proposition that transport is a difficult sector to cut emissions for three main reasons:

- i) Empirical evidence shows that traffic levels can be reduced for reasons other than emissions control. Removal of traffic in towns for non-carbon reasons has reduced traffic by the order of 20-30%.
- i) At disaggregate level, the overwhelming empirical evidence is that travel behaviour does change, notably so over a 5 – 10 year period.

- ii) Appraisal doesn't determine policy but it does give important signals. However, appraisal manuals have a number of features which are extremely unfavourable to traffic reduction. A starting point is the design of a do-minimum future in which traffic has already grown against which all projects are compared. A more suitable methodology for constructing a different future is to start from this year and construct a trajectory year by year for achieving it. Transport projects have to be compared to that trajectory – whether they contribute or undermine it.

Phil raised the following concerns relating to the current appraisal system which should be addressed in the NATA refresh:

- the use of 60-year time-frames essentially presuming a 'business as usual' policy and economic framework and continued ready availability of cheap(ish) fuel;
- no substantial implementation of the policies discussed above, including no road pricing over the whole 60-year period;
- underestimation of the sensitivity of traffic levels (both increases and reductions) to changes in capacity;
- a discomfort about the fair comparison of 'small and cheap' measures with large infrastructure (though when that comparison is made, the small and cheap perform very well);
- a profound inadequacy in treatment of walking and of cycling as modes of transport; and
- rules for the treatment of public and private expenditure and revenue in the appraisal which may fail to give full recognition to the financial and economic advantages of (some) traffic reduction measures, and an illusory advantage of (some) other measures which increase traffic.

Participants were invited to generate ideas for improving DfT's appraisal framework (as part of the NATA refresh) – these are documented in the full report.

### **Discussion: Key points**

The following key points were identified from the workshop discussions:

- Critical importance of decision making processes (that they are transparent, effective and joined-up) and engagement of high-level decision-makers.
- Transport will have to play its part in achievement of carbon reduction targets
- Transport decisions should be consistent with carbon trajectories. Appraisal framework should include an explicit statement whether project increases or reduces carbon. Government officials were wary of saying don't do anything that increases carbon.
- There are several definitions of cost effectiveness methodology in use – we need to be clear about which one is being used. Cost-effectiveness should include social costs and benefits.
- Evidence is available to show that behavioural change has a carbon reduction effect and that fiscal measures are beginning to bite. Evidence on behaviour

change is documented at the local scale, but it is not being reported in academic studies and is not well disseminated. Measures need to be taken to address this and the evidence base needs improving.

- The concept of car dependence is critical.
- It is important that all three of Stern's policy 'pillars' are implemented: carbon pricing; technology policy and behaviour change.
- Carbon price is very important but not the only factor.
- Strategic assessment is necessary and important e.g. taking account of the impact of transport decisions of other sectors on the transport sector and vice versa.

Within the summing-up discussion, a debate took place on the key question as to whether cost-effectiveness is an obstacle to carbon abatement. On the one hand, a strong view was expressed that Stern's conclusion on the high cost of transport abatement had acted as a barrier. On the other hand, government officials gave an assurance that transport was not off the hook as a result of the Stern Review which was in any case a global analysis, but that cost-effectiveness meant that different sectors would make varying contributions. All participants agreed that the transport sector could make a greater contribution to carbon abatement.

#### **Next Steps**

- Jillian Anable invited to make a submission to King setting out behavioural change evidence.
- Gathering of the existing evidence and better dissemination of this evidence at higher level: the UKERC Technology and Policy Assessment function will contribute to this task with its forthcoming transport technology related study; Jillian Anable and Phil Goodwin might also contribute to this task depending on support/time available.

## Introduction

This workshop set out to address four key questions identified prior to the event. Experts were invited to tackle these questions through means of a pre-workshop briefing paper. These papers were circulated to participants in advance of the workshop. The authors presented a brief summary of their paper during the workshop and participants were invited to discuss the issues raised by the paper and any other related issues. The briefing papers are available in the Appendix of this report. This report can be downloaded from the UKERC website<sup>2</sup>.

The four key questions were:

1. What did Stern say about cost of abatement more generally, and about the transport sector more specifically? What was the basis for his findings? How are the Stern and King outputs being fed into policy – what other evidence is being fed in and how?

*Lead discussant: Simon Jackson, HM Treasury*

2. What is the UK Government's position and implications for the Climate Change Programme/ Bill and transport policy?

*Lead discussants: Chris Nicholls, Defra and Adrian Gault, DfT.*

3. What is the state of the evidence as regards non technological/ shorter term/ softer policies and their carbon saving potential and cost effectiveness? How do we develop the evidence base in this area?

*Lead discussant: Jillian Anable, Robert Gordon University*

4. Does the discussion around cost effectiveness of 'hard' and 'soft' measures have implications for pre- and post appraisal of transport schemes and programmes?

*Lead discussant: Phil Goodwin, University of the West of England*

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<sup>2</sup> <http://www.ukerc.ac.uk/TheMeetingPlace/MeetingPlaceActivities.aspx>

## Session 1: Government Position

**Key question 1:** What did Stern say about cost of abatement more generally, and about the transport sector more specifically? What was the basis for his findings? How are the Stern and King outputs being fed into policy – what other evidence is being fed in and how?

*Lead discussant: Simon Jackson, HM Treasury*

**Key question 2:** What is the UK Government's position and implications for the Climate Change Programme/ Bill and transport policy?

This session addressed the first two key questions together with the discussion focussing on the Government's position as regards its interpretation of the Stern Review and other important policy reports and what the findings could mean in reality for the transport sector.

Simon Jackson, HM Treasury.

Stern set out a multi-lateral framework for tackling climate change to minimise the cost of moving to a low carbon economy which is based on three elements: setting a common carbon price across countries; removing barriers to behavioural change; and implementing technology policy. Stern does not require that any particular instrument is used for any particular mitigation policy; rather, that these are cost effective. Stern suggests that each country should use the appropriate mix of taxes, trading, spending and regulation as befits its national circumstances.

Stern said that transport is one of the more expensive sectors to cut emissions from because the low carbon technologies tend to be expensive and the welfare costs of reducing demand for travel are high. Transport is also expected to be one of the fastest growing sectors in the future. For these two reasons, studies tend to find that transport will be among the last sectors to bring its emissions down below current levels.

In the period to 2030, improvements in the fuel efficiency of conventional vehicles using existing technology has the potential to make perhaps the single biggest contribution to carbon savings. However in road transport there are market failures that mean these efficiency gains are not fully realised (such as high discount rate, capital constraint and information failure). Also, technical improvements reduce the cost of travel and encourage more travel in larger vehicles.

Simon also highlighted some key findings of the King Review including:

- At low cost and by 2030, per-kilometre emissions could be reduced by 50 per cent - equivalent to a 30 per cent reduction in the absolute level of emissions. These significant reductions in CO<sub>2</sub> from road transport are achievable in the

short term through progress on fuels, bringing new technologies to market and smart consumer choices such as buying a low-carbon vehicle.

- Almost complete de-carbonisation of road transport is a realistic long-term objective, through electric or hydrogen-powered vehicles. This will require major technological breakthroughs as well as substantial progress towards decarbonising the power sector.
- Fuels must be considered on the basis of their life-cycle CO<sub>2</sub> emissions. Biofuels can occupy a segment of the UK fuel market but care must be taken not to expand demand too quickly, before crop breakthroughs and robust environmental safeguards are in place.

Simon summarised by saying that emissions reductions from transport, as elsewhere, must be cost effective. If carbon abatement can occur more cost effectively elsewhere in the economy, this should be sought first. As a general principle, to attain emission reduction targets it does not matter where carbon abatement occurs but only that it does. In addition there are the key challenges of overcoming political sensitivities relating to increasing taxation and the barriers to behavioural change (e.g. purchase of cleaner cars).

#### Chris Nicholls, Defra

The Climate Change Bill reflects the three policy pillars identified by Stern for moving to a low carbon economy: carbon pricing; technology policy; removing barriers to change (eg behavioural change). The Bill is non-discriminatory about the way in which abatement occurs, but carbon budgets will be set in part to reflect the three pillars. Abatement is most likely in sectors other than transport due to its high costs. This does not mean to say that transport will not make a contribution as the current and future mix of policies are aimed at bringing forward this abatement; although once they are part of an emissions trading scheme, this abatement may occur overseas first. Further, the King Review concluded that an 80% reduction in CO<sub>2</sub> emissions from road transport by 2050 is possible.

#### Adrian Gault, DfT

Adrian's briefing paper drew on the Stern Review and Eddington Report concluding that the identified challenge for DfT is to improve the performance of the network, focusing on the most unreliable, congested and crowded sections. But to do this in a way that creates a sustainable transport network and cuts emissions of CO<sub>2</sub> and other greenhouse gases.

The DfT response set out in the 2007 Energy White Paper broadly follows Stern's three pillars. Adrian also referred to the potential for carbon reduction from the transport sector identified by the King Review and evidence of significant modal shift resulting from Smarter Choices measures.

DfT is developing appraisal systems to further support the assessment of different types of intervention:

- In appraising transport schemes DfT aims to draw on comprehensive assessment of all impacts – economic, environment and social. We have adopted valuation of carbon in line with the £70/tC value recommended by Defra, rising by £1 a year. Post-Stern we are moving to include the higher shadow price of carbon values (on the basis of interim advice recommended by Defra)
- Choice of measures to reduce carbon should be informed by cost-effectiveness analysis, looking across the economy as a whole. This was the basis of the analysis, and contributions to a marginal abatement cost (MAC) curve analysis, in the EWP 2007.
- We need to go further to develop that MAC analysis in transport and to look at the full range of options, and packages of options.
- Eddington makes clear that too often we may have moved too quickly to major capital investments as preferred interventions. He still sees a need for such measures, but cautions that we should start with the transport problem or challenge to be addressed; then move to identification of the full range of options – which may include non-transport interventions; then move to choice of option and prioritisation, based on appraisal.
- The Department has announced a refresh of its appraisal tools (NATA refresh) and is launching consultation on this. Amongst the objectives will be to ensure that appraisal tools are as suitable as we can make them for incorporating assessment of environmental impacts and for the generation and comparison of different options.

Today, the Government issued two consultations on the policy context:

1. Command Paper 7226, Towards a Sustainable Transport System: Supporting Economic Growth in a Low Carbon World, Oct 2007. The report outlines the Government's first steps in responding to the Eddington and Stern Reviews. It notes that work will be taken forward to look at pathways to carbon reduction in transport and what savings might be achieved from different modes and different types of journeys. It will also examine option generation.

2. The NATA Refresh: Reviewing the New Approach to Appraisal. This launches consultation on the Department's appraisal framework.

**NB.** NATA Refresh adopts an approach that incorporates the shadow price of carbon in appraisals and which looks to develop an improved framework and appraisal tools which will help inform choice of the most cost effective measures to reduce GHG emissions.

### **Plenary discussion**

The discussion began with a debate on the definition of "cost effectiveness". It was pointed out that there were three different meanings of the term:

1. Where you seek to achieve a certain benefit at least cost (i.e. 'How much does it cost to save a tonne of carbon?'). Here the benefits or externalities are not costed. This is usually termed cost-effectiveness analysis.
2. Where it is financially profitable to private agents (the definition used in climate change agreements).
3. A net positive social cost benefit analysis where you take into account externalities. (ie compare cost of damage of 1 tonne with the cost of abating it, taking into account externalities). This is social cost-benefit analysis.

There are critical differences between the three meanings and it was important to be clear which we mean.

The main point of confusion is between the damage costs of carbon and the abatement costs. Definitions 1 and 2 only include the abatement costs. Definition 3 includes the damage costs. However, as it is essentially impossible to adequately value the damage costs in monetary terms, social cost-benefit analysis is a difficult way to proceed in the assessment of carbon mitigation options.

Nevertheless, there was some agreement that assessment should encompass costs (or benefits) beyond pure abatement costs and that NATA attempted to do so. However, it was suggested that, in general, cost effectiveness assessment as applied could be too static, because it does not engage with the Stern review argument about technical innovation – cost effectiveness has to build in future innovation. This led to a discussion about whether the cost abatement curve could be used to rank measures, or whether it was too narrow in terms of considering the ancillary benefits. It was suggested that it might in fact be better to start with the narrowest definition of cost-effectiveness, of reducing carbon at least cost (definition 1), and then to identify other impacts (e.g. congestion).

There was discussion of the "rebound effect" and its impact in considering the cost effectiveness of transport measures. This has been a recurrent issue in transport policy generally, where there has been much experience of, for example, the induced traffic arising from road construction or travel cost reductions. Policies which have already been implemented to reduce rebound include the Department for Transport's approach to 'locking-in' the benefits of increased capacity by demand management, and there are related policies to reinforce initiatives for example road pricing which raises revenue and has enhanced effects if this revenue is recycled into improved public transport. Rebounds are complex and differ by sector – it was suggested that large rebounds should not be taken as given<sup>3</sup>.

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<sup>3</sup> A report launched the day after this seminar was mentioned: *The Rebound Effect: an assessment of the evidence for economy-wide energy savings from improved energy efficiency*, A report produced by the Sussex Energy Group for the Technology and Policy Assessment function of the UK Energy Research Centre, Oct 2007  
<http://tinyurl.com/3aafye>

This led to a discussion on the appropriate cost of carbon to be used in transport appraisal. Government speakers said that it was necessary to have a ball-park figure on the damage limitation costs of carbon. The Stern report noted that estimates in the literature range from 0 to £2,000/tonne (*Stern review, page 323*). Modelling for Stern produced a value of around £240/tonne. Latest guidance was to adopt a shadow price of carbon consistent with moving towards stabilisation at 550ppm - for a trajectory towards stabilisation around 550pp, Stern's modelling suggests a value around £85/tonne. This compares to the new shadow cost of carbon used by the Government which is around £70 t/C rising more quickly than the previous estimate. The Government's shadow price is lower than Stern's because Stern assumes a BAU trajectory, whereas the Government assumes a policy trajectory which will successfully meet the target of reducing CO<sub>2</sub> emissions by 60% by 2050. Government speakers argued that the shadow cost of carbon should be consistent with the target: so long as we are on track to that target (and this is argued to be the position with allowance for measures in the 2007 Energy White paper) then the shadow price of carbon consistent with UK effort towards stabilisation at 450-550ppm can be considered appropriate; if not on track the cost should increase.

Some participants claimed that this approach would lead to perverse consequences whereby the more ambitious the carbon reduction target, the lower the social cost of carbon needed to get us there. The lower cost of carbon in the short term would result in weaker policies as abatement is put off into the future. Also, it could lead to large fluctuations in the carbon price and shape of the carbon abatement curves. For instance, the five year budget periods in the Climate Change Bill could see the carbon cost rising at the end of the period as the target is not met. It was suggested that instead the cost of carbon should reflect the total amount of emissions reduction needed and that any delay in action would result in costs going up. Government participants felt that that was what the current approach was suggesting. There seemed to be a broad measure of agreement that the shadow cost of carbon should be that which brings about the target and will work to encourage technological innovation (although other market failures may prevent investment).

In appraisal, the Government approach is to value all the carbon emissions above business as usual. Some argued, but some would not accept, that any increase in emissions attached to a road scheme should require associated carbon reductions within the scheme/package itself. A key question was whether the DEFRA value for carbon and the 60% reduction target are consistent – underpinning this were questions about cost effectiveness and trading to achieve a consistent and efficient outcome across sectors. Maybe prices did not need to be so high to achieve behaviour change.

There was also recognition of the uncertainty of pricing, termed by one participant as the "shifting sands" when the need for measures to keep within 550 ppm (of CO<sub>2</sub>) could be reduced on scientific advice to 450 ppm.

This in turn led to a discussion about the role of pricing: some felt that it was the main policy instrument and that if you get the price right it makes a lot of what else follows easier. Others pointed out that there were market failures that prevented this, and that innovation and investment are not necessarily driven by carbon prices but by other factors. Appraisal could entrench high carbon behaviour and that action was needed rather than a presumption that action will happen somehow. This suggests option generation has an important role.

## **Session 2: Cost-effectiveness of non-technological policies to abate carbon from the transport sector: the state of the evidence**

**Key question 3:** What is the state of the evidence as regards non technological/ shorter term/ softer policies and their carbon saving potential and cost effectiveness? How do we develop the evidence base in this area?

Dr Jillian Anable, Robert Gordon University

In her briefing note (attached in Appendix), Jillian noted that several key economy-wide and/or global perspectives on the economics of climate change have acknowledged the important role of behaviour change and demand management (Stern, IPCC, King) for the transport sector but each cites limited evidence on the effectiveness of such policies to deliver sustained behaviour change. Together with assumptions about future technology and welfare costs, the studies conclude that transport cannot contribute to significant cost-effective carbon reductions in the short term.

Her main argument, however, is that the evidence on the cost-effectiveness of carbon abatement in the transport sector is limited and allows few concrete conclusions to be made. Most importantly, she believes few measures have been thoroughly assessed in this way and evaluation methods are often inconsistent. In summary, she outlines two broad limitations with the state of the evidence in this area:

1. The definition of cost-effectiveness and the methodologies used to assess it;
2. The relative lack of assessment of non-technological options for carbon abatement.

Jillian's paper argues that social cost benefit analysis might not be the most appropriate tool due to the uncertainty and ethical considerations surrounding climate change. In addition she suggests single cost-effectiveness figures may be inadequate due to issues such as timing and scale of implementation and changing costs over time; packages of policies are more important than individual measures; assessment is based almost exclusively on carbon reduction and monetary costs without consideration of other impacts; comparing across studies/sectors is fraught

with difficulty. The paper also argues that the evidence base for non-technological measures has been neglected:

- Some policy options have not been evaluated using a common methodology
- The emphasis is almost exclusively on technological solutions, particularly car passenger technology, at the expense of measures to influence behaviour
- Significant evidence on the potential for behaviour change has been overlooked
- UK Government's own analyses shows technology options to be expensive

She suggested the following options for improving the evidence base in this area:

- Assess and collate the most recent evidence on smarter choices
- More peer reviewed information on the effectiveness of demand management policies
- Incorporation of behavioural elements into models such as Markal
- Appraisal methodology (see Phil Goodwin's note)
- Need to cost programmes, not individual policies (including fiscal instruments).
- Need to assess the impact on the transport sector of measures in other sectors, for example, school choice and centralisation of some health services and the resulting impact on CO2 emissions.

A participant added the following point to the list above:

- Ensure evaluation evidence on smarter choices addresses the longer term – are carbon savings/car use reduction maintained over time? Or, how are they?

### **Plenary discussion**

General agreement was expressed in favour of the arguments set out in Jillian's paper, in particular the idea that cost-effectiveness analysis has not treated behaviour change well and that these appraisals need to consider packages and the way in which measures reinforce one another. There was some acknowledgement that reaching targets would require implementation of most options as opposed to choosing between them. One commentator defined Stern's three policy prescriptions (carbon pricing; technology policy and behaviour change ) as three legs of a stool, and if one is shorter than the others it will fall over. However, as car dependence is built into people's lifestyles, they are less and less able to change, even if the price is increased. A government spokesman pointed to the winds of change and a recognition within the Government of the need to shift direction; the discussion paper published today sets out a raft of changes including smarter choices.

Again, the matter of definition was raised. Behaviour change in response to price changes? Behaviour change in response to technology becoming more efficient? Travel behaviour change can include a number of different actions to influence the amount of travel overall, the mode of travel, vehicle purchase and how it is driven. As discussed in a large number of academic papers, people tend not to become more

efficient, though responsiveness can be varied according to different efficiency-type signals, for example hybrids have started coming through strongly in the car market. Consumer selection of hybrids is an interesting insight into behaviour change, raising the questions how to influence and appraise behaviour change.

It was agreed that what we mean by behaviour change is a grey area, hence the concentration on technical fixes. Some contributors questioned the ability of MARKAL to accommodate packages of behaviour change. Other contributors defended MARKAL, saying that the model is less about appraisal and more about how decisions are made although this in itself means that the model can have undue influence if it is mistaken for a forecasting model when it is clearly not meant for this purpose.

There was some discussion about what happens on the ground. There was support for Jillian's view that carbon reduction might not be the be all and end all. On the other hand, for some local authorities carbon reduction doesn't appear on their agenda which is instead driven by economic maximisation. There must be a fundamental shift in the way we view transport and the policy making process. At local level, appraisal and funding mechanisms hamper optimum solutions. Results from Sustainable Travel Towns show that changes can be made as well as a large body of literature which indicates that 10 – 30% of travel demand reduction can be achieved at the individual level. There is an enormous amount of churn in what people do in their travel diaries. People are relatively responsive to easy wins. However, it was emphasised that this has not yet led to a reduction in traffic figures because there are as many policies around which increase travel demand and there is uncertainty over the longevity of behaviour changes.

Commentators responded that environmental impacts were taken seriously by central Government, for example, VED has become geared towards more fuel efficient cars. Reports by the Department for Transport show positive effects of VED differentials, although the evidence for the effect of VED has not yet been thoroughly examined. Other contributors pointed out that the analysis underpinning economic projections was not always provided, for example, the DfT was unable to produce analysis underpinning air travel growth projections to the level of detail that they would find useful. Aviation projections are based on costs of flying; changing costs would change projections. A team representative said that the King report part 2 would examine consumer preferences on road transport. The DfT has commissioned work on whether people can respond differently.

A participant summed up some of the current limitations surrounding the policy process and the assessment of the potential for behaviour change:

- the policy framework
- models and data used
- formulation of packages and policies
- judgements about what is important (eg choosing a social cost of carbon appraisal is a value judgment)

## Session 3: Implications for Appraisal of Transport Programmes

**Key question 4:** Does the discussion around cost effectiveness of 'hard' and 'soft' measures have implications for pre- and post appraisal of transport schemes and programmes?

Speaker: Phil Goodwin

Contests Stern's proposition that transport is a difficult sector to cut emissions for three main reasons:

- i) Empirical evidence shows that traffic levels can be reduced for reasons other than emissions control. Removal of traffic in towns for non-carbon reasons has reduced traffic by the order of 20-30%.
- ii) At disaggregate level, the overwhelming empirical evidence is that travel behaviour does change, notably so over a 5 – 10 year period.
- iii) Appraisal doesn't determine policy but it does give important signals. However, appraisal manuals have a number of features which are extremely unfavourable to traffic reduction. A starting point is the design of a do-minimum future in which traffic has already grown against which all projects are compared. A more suitable methodology for constructing a different future is to start from this year and construct a trajectory year by year for achieving it. Transport projects have to be compared to that trajectory – whether they contribute or undermine it.

Phil raised the following concerns relating to the current appraisal system which should be addressed in the NATA refresh:

- the use of 60-year time-frames essentially presuming a 'business as usual' policy and economic framework and continued ready availability of cheap(ish) fuel;
- no substantial implementation of the policies discussed above, including no road pricing over the whole 60-year period;
- underestimation of the sensitivity of traffic levels (both increases and reductions) to changes in capacity;
- a discomfort about the fair comparison of 'small and cheap' measures with large infrastructure (though when that comparison is made, the small and cheap perform very well);
- a profound inadequacy in treatment of walking and of cycling as modes of transport; and
- rules for the treatment of public and private expenditure and revenue in the appraisal which may fail to give full recognition to the financial and economic advantages of (some) traffic reduction measures, and an illusory advantage of (some) other measures which increase traffic.

### **NATA refresh ideas brainstorm**

Participants were asked to put forward ideas to address concerns relating to the existing appraisal system. The output of this brainstorm is in the Appendix of this report.

Contributions were categorised under headings that included: testing projects against carbon effect; packages; technical assumptions; social aspects; finance rules. Phil Goodwin made some reflective remarks on the ideas generated and key messages emerging from the exercise:

- equity and distribution not addressed by NATA
- ditto policies and packages
- appraisal frameworks – designed to deal with single projects rather than packages
- trajectory and its significance
- 'Don't forget' points eg freight
- 'Sympathy' messages – acknowledgment that evaluation takes place in the real world

### **Plenary discussion**

Phil's three propositions received some support and the limitations of NATA recognised. There was also defence of NATA and its attempts to reflect costs and uncertainties and efforts are ongoing to make it more mode neutral. As we move towards setting targets, strategic environmental objectives are being fed into other policy objectives, strengthening the linkages across different policies. The view was also expressed that the NATA 'refresh' would not achieve climate change targets since the low carbon price is swamped by other factors. In some quarters, there was reservation about a message that says 'avoid anything that increases carbon'.

Some barriers to and conditions identified for change included:

- In response to recognising the political dimension of decision making above the technical level, develop tools for making the connection between technical appraisal and political aspirations as reflected in themes, strategies and policies. Although we may have to accept that there are parts of the appraisal system that cannot be reached.
- there is a need for rigorous strategic level assessment to avoid wish lists of schemes and to make the linkages between strategic and project level.
- Develop a methodology at an intermediate level above the NATA level of individual projects that can deal with broader goals.
- There is a need for a proper evaluation of alternatives. Transport planning can learn lessons from the staged approach in land use planning where testing of options is embedded in the system.
- Government policy on modal switch is wrongly targeted – focus on modal switch from car to off-peak rail for long distance journeys. Many of the policy instruments under discussion are about changing patterns of urban living eg shift from car to walk. A key factor in getting to where we want to be is lifestyle change – giving people a choice to cut car dependency.
- Appraisal methodology needs to address distributional and equity issues.

- Appraisal methodology needs to address policies and packages especially those containing contradictory aims and measures.
- There is a need for analyses of assumptions underpinning economic benefits in AST
- There is concern that the devolution agenda is pulling local authorities in the opposite direction.

## Summing-up

The following key points were identified from the workshop discussions:

- Critical importance of decision making processes (that they are transparent, effective and joined-up) and engagement of high-level decision-makers.
- Transport will have to play its part in achievement of carbon reduction targets
- Transport decisions should be consistent with carbon trajectories. Appraisal framework should include an explicit statement whether project increases or reduces carbon. Government officials were wary of saying don't do anything that increases carbon.
- There are several definitions of cost effectiveness methodology in use – we need to be clear about which one is being used. Cost-effectiveness should include social costs and benefits.
- Evidence is available to show that behavioural change has a carbon reduction effect and that fiscal measures are beginning to bite. Evidence on behaviour change is documented at the local scale, but it is not being reported in academic studies and is not well disseminated. Measures need to be taken to address this and the evidence base needs improving.
- The concept of car dependence is critical.
- It is important that all three of Stern's policy 'pillars' are implemented: carbon pricing; technology policy and behaviour change.
- Carbon price is very important but not the only factor.
- Strategic assessment is necessary and important e.g. taking account of the impact of transport decisions of other sectors on the transport sector and vice versa.

Within the summing-up discussion, a debate took place on the key question as to whether cost-effectiveness is an obstacle to carbon abatement. On the one hand, a strong view was expressed that Stern's conclusion on the high cost of transport abatement had acted as a barrier. On the other hand, government officials gave an assurance that transport was not off the hook as a result of the Stern Review which was in any case a global analysis, but that cost-effectiveness meant that different

sectors would make varying contributions. All participants agreed that the transport sector could make a greater contribution to carbon abatement.

**Next Steps**

- Jillian Anable invited to make a submission to King setting out behavioural change evidence.
- Gathering of the existing evidence and better dissemination of this evidence at higher level: the UKERC Technology and Policy Assessment function will contribute to this task with its forthcoming transport technology related study; Jillian Anable and Phil Goodwin might also contribute to this task depending on support/time available.

## APPENDIX 1

### The Stern and King Reviews: A background note by Simon Jackson, HM Treasury

What did Stern say about the cost of abatement more generally, and about the transport sector more specifically? What was the basis for his findings?

#### Stern set out a multilateral framework for tackling climate change:

- To minimise the cost of moving to a low-carbon economy, Stern highlighted that policy needs to be credible and flexible, and must have three key elements:
  - **establishing a common carbon price across countries:** correcting the basic market failure to reflect the damage caused by emissions and require everyone to meet the costs they impose on the environment through their actions. To minimise costs, this should be supported by:
    - **Technology policy** to address any additional technology market failures;
    - **removing barriers to behavioural change** especially to encourage energy efficiency.
- Stern also make clear that some climate change is inevitable, and so **adaptation would be essential, particularly for developing countries who may be most vulnerable.** And the Review emphasised the importance of reducing **deforestation**, as this is a major source of greenhouse gas emissions.
- Stern does not require that any particular instrument is used for any particular mitigation policy; rather, that these are cost effective. **Stern suggests that each country should use the appropriate mix of taxes, trading, spending and regulation as befits its national circumstances.**

#### Stern and prospects for cutting emissions from transport

- Stern said that transport is one of the more expensive sectors to cut emissions from because the low carbon technologies tend to be expensive and the welfare costs of reducing demand for travel are high.
- Transport is also expected to be one of the fastest growing sectors in the future. For these two reasons, studies tend to find that transport will be among the last sectors to bring its emissions down below current levels.

- In the period to 2030, improvements in the fuel efficiency of conventional vehicles using existing technology has the potential to make perhaps the single biggest contribution to carbon savings. However in road transport there are market failures that mean these efficiency gains are not fully realised (such as high discount rate, capital constraint and information failure). Also, technical improvements reduce the cost of travel and encourage more travel in larger vehicles.

### **King Review**

The initial findings of the Review are that:

- Urgent progress is needed from road transport to help meet emission cuts for the developed world of 60-80 per cent by 2050 outlined in the Stern Review.
- At low cost and by 2030, per-kilometre emissions could be reduced by 50 per cent - equivalent to a 30 per cent reduction in the absolute level of emissions. These significant reductions in CO<sub>2</sub> from road transport are achievable in the short term through progress on fuels, bringing new technologies to market and smart consumer choices such as buying a low-carbon vehicle.
- Almost complete de-carbonisation of road transport is a realistic long-term objective, through electric or hydrogen-powered vehicles. This will require major technological breakthroughs as well as substantial progress towards decarbonising the power sector.
- Fuels must be considered on the basis of their life-cycle CO<sub>2</sub> emissions. Biofuels can occupy a segment of the UK fuel market but care must be taken not to expand demand too quickly, before crop breakthroughs and robust environmental safeguards are in place.

### **Cost effective emissions reductions**

- Emissions reductions from transport, as elsewhere must be cost effective. If carbon abatement can occur more cost effectively elsewhere in the economy, this should be sought first. As a general principle, to attain emission reduction targets it does not matter where carbon abatement occurs but only that it does.
- There is disparity in analysis of cost effectiveness of technological improvements to vehicles (eg Commission for Integrated Transport report states that TNO suggest £36 per t/C; Ricardo £151 per t/C)

### **What difficulties do we face in reducing transport emissions further in the short term?**

- Political sensitivities over increasing taxation (esp. fuel duty – the cornerstone of Government policy to address carbon emissions from road transport);
- Behavioural change to the purchase of more fuel efficient vehicles. Fuel costs and vehicle excise duty, although a consideration for motorists, unclear as to whether these are key to informing purchase decisions (for example are factors such as safety and reliability more important?).

## APPENDIX 2

### **Implications for the climate change bill of the Stern Review's position on Transport Abatement Costs: A background note by Chris Nicholls, Defra.**

#### **The Climate Change Bill**

The Climate Change Bill sets out in statute targets for the country's carbon emissions over time. The Bill, due to be announced in November, will set targeted reductions in carbon emissions in the UK between 1990 and 2050 of at least 60%.

Targets will be set within 5-yearly carbon budgets (starting 2008-2012, then 2013-2017 etc.), over which the UK's net emissions<sup>4</sup> must not exceed their budgeted level. The Committee on Climate Change will shortly recommend the level for the carbon budgets for the first three budget periods (15 years) to the Secretary of State. This should ensure there is greater certainty for businesses' investment decisions to take place.

#### **UK-Wide Carbon Abatement**

The Stern Review points to carbon abatement being brought about by:

promoting technology;  
adopting an appropriate carbon price; and,  
removing other barriers (e.g. behavioural change, removing other market failures etc.)

The Bill is non-discriminatory about the way in which abatement occurs. Carbon budgets will be set in part to reflect the ways in which these three 'pillars' are being addressed by Government policy, but will also consider a wider range of factors, namely:

- scientific knowledge about climate change;
- economic circumstances;
- Social circumstances;
- fiscal circumstances;
- technology relevant to climate change
- Energy policy;
- Differences between parts of the UK;
- International circumstances.

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<sup>4</sup> Taking into account net purchases/sales of international emissions reduction credits

Carbon budgets are the mechanism by which the Government will target the UK's carbon emissions. Carbon abatement which has taken place in the UK, but also that which has taken place abroad but paid for by the UK (the Clean Development Mechanism, or Joint Implementation schemes), count within the budget. In this way, sectors currently within the EU Emissions Trading Scheme (ETS) can themselves abate or buy carbon abatement from overseas, while those sectors outside a trading scheme do not have this option.

Sectors currently in the EU ETS include major energy users, such as electricity producers, cement manufacturers, steel producers etc. Short term carbon abatement opportunities in this sector are good, especially in the electricity generation sector, where coal can be replaced by gas-fired power stations relatively easily. In the longer term, more abatement is likely to come from nuclear power and greater use of renewable energy sources.

### **Transport's Carbon Abatement**

Transport's CO<sub>2</sub> emissions in 2005 were 41.6Mt of carbon, excluding international aviation and shipping (9.5MtC and 1.6MtC, respectively), against the UK's total emissions of 151.1MtC.

The Stern Review notes that the transport sector's costs of carbon abatement are higher than most other sectors. As transport is currently outside any form of trading scheme, abatement cannot be bought through the CDM/JI process. If carbon abatement is needed in this sector, other non-traded sectors with lower carbon abatement costs are likely to abate their carbon emissions ahead of transport's because of their lower costs.

There are a number of policies, however, that suggest that transport's emissions could start to fall sooner than their high abatement costs would imply.

The successor to the European Union's car manufacturer's voluntary agreement will force this pace of change more rapidly than over recent years. The ambition is to achieve an EU average for new cars of 130gCO<sub>2</sub>/km by 2012, nearly 20% lower than current levels.

Biofuels also have a role to play: these are currently being promoted by fuel duty incentives and the Renewable Transport Fuel Obligation. Their impact on emissions will have an effect on the transport sector's overall carbon abatement.

The King Review states that an 80% reduction in transport's CO<sub>2</sub> emissions by 2050 is possible, and policy recommendations will be announced in next year's final report.

Aviation is expected to join the EU ETS within the next 5-6 years, which would enable it to contribute to abatement elsewhere if its abatement costs are too high.

Surface transport might also join the EU ETS, although details of this are at a much earlier stage than for aviation.

### **Conclusion**

The Climate Change Bill formalises the process of setting a path for the UK to reduce its carbon emissions by at least 60% between 1990 and 2050. Setting a quantity rather than a sectoral target means that carbon abatement should be more efficient, especially for sectors who are part of a trading system, where abatement should occur at the lowest cost level.

The transport sector, without additional measures, would probably abate its emissions later than most other sectors. The current and future mix of policies are aimed at bringing forward this abatement; although once they are part of an emissions trading scheme, this abatement may occur overseas first.

## APPENDIX 3

### The DfT perspective: Background note by Adrian Gould, DfT

Two major reports with substantial implications for transport policy in the UK were published towards the end of 2006. The first, the Stern Review, is broadly summarised in other background notes for this workshop. It makes clear that the climate change challenge is huge and is a significant issue for transport which accounts for around 23% of domestic UK emissions of CO<sub>2</sub> by source and 28% by end user. More if we include the international dimension. Urgent action is necessary to reduce these emissions.

The second, the Eddington Report, sets out the crucial role that transport plays in securing the competitiveness and productivity of the UK economy. It suggests that, in general, the UK transport system provides the right connections in the right places to support the journeys that matter to economic performance. But there are delays and unreliability which increase business costs, and there is growth in travel demand – tending to be concentrated on certain parts of the network at certain times of day.

The challenge, therefore, is to improve the performance of the network, focusing on the most unreliable, congested and crowded sections. But to do this in a way that creates a sustainable transport network and cuts emissions of CO<sub>2</sub> and other greenhouse gases. Energy White Paper response to Stern The broad DfT response to Stern is set out in the 2007 Energy White Paper. These follow the 3 legs of the policy response set out by Stern (not a complete list).

#### **Carbon Pricing**

- Through taxation – road fuel duty
- APD, including moving to a per plane basis (PBR 2007)
- Inclusion of aviation in the EU Emissions Trading Scheme
- Looking at inclusion of surface transport in the EU ETS
- Renewable Transport Fuel Obligation (RTFO).
- *Technology and innovation*
- Successor to EU Voluntary Agreement
- Low Carbon Transport Innovation Strategy (LCTIS)
- King Review

#### **Removing barriers to change**

- Public transport investment
- Smarter Choices
- Act on CO<sub>2</sub> campaign
- Fiscal measures (VED, company car tax etc.)

We need action over each of these 3 legs, and complementary action between the three. What we should, however, bear in mind is the scale of emission savings that may be the prize from some of the pricing measures. For example:

- Sourcing 5% of fuel from renewable sources under the RTFO should save 2-3 MtCO<sub>2</sub> in 2010;
- We are supporting mandatory EU fuel efficiency targets for new cars. This could save 6-15 MtCO<sub>2</sub> a year by 2020 (EWP estimates);
- If we can include aviation in the EU ETS at a cap equivalent to average 2004-06 emissions, this could be worth around 200MtCO<sub>2</sub> savings annually in 2020 across the EU.

The King Review highlights the scale of potential savings from road transport, suggesting CO<sub>2</sub> emissions per vehicle can be cut 30% over the next 10 years and 50% by 2030. At the same time, Smarter Choices measures are suggesting some encouraging results. For example:

- Sustainable travel trials have been supported in Darlington, Peterborough and Worcester. In Worcester, for example, the trial areas show public transport use is up 22% in the past year, cycling up 36%, car trips down 12%. Appraisal systems We are developing our appraisal systems to further support the assessment of different types of intervention:
- In appraising transport schemes DfT aims to draw on comprehensive assessment of all impacts – economic, environment and social. We have adopted valuation of carbon in line with the £70/tC value recommended by Defra, rising by £1 a year. Post-Stern we are moving to include the higher shadow price of carbon values (on the basis of interim advice recommended by Defra)
- Choice of measures to reduce carbon should be informed by cost-effectiveness analysis, looking across the economy as a whole. This was the basis of the analysis, and contributions to a marginal abatement cost (MAC) curve analysis, in the EWP 2007.
- We need to go further to develop that MAC analysis in transport and to look at the full range of options, and packages of options.
- Eddington makes clear that too often we may have moved too quickly to major capital investments as preferred interventions. He still sees a need for such measures, but cautions that we should start with the transport problem or challenge to be addressed; then move to identification of the full range of options – which may include non-transport interventions; then move to choice of option and prioritisation, based on appraisal.
- The Department has announced a refresh of its appraisal tools (NATA refresh) and is launching consultation on this. Amongst the objectives will be to ensure that appraisal tools are as suitable as we can make them for incorporating assessment of environmental impacts and for the generation and comparison of different options. This agenda is particularly important as we move ever further towards binding carbon limits for the entire UK economy either at the national or European level, to which transport will have

to contribute and within which transport will have to operate. Consideration of "better use" options – via pricing, or technology, for example – should sit alongside capital investment. An example of the kind of option to be considered is the potential for use of new traffic management techniques, like hard shoulder running and varying speed limits. Following successful trial in the M42, a feasibility study of the potential for use on other parts of the motorway network is to be conducted. Use of active traffic management on the M42 has seen improvements in journey times and CO2 emissions reduced 4%.

## APPENDIX 4

### ***The cost-effectiveness of non-technological policies to abate carbon from the transport sector – the state of the evidence*** *Dr Jillian Anable, The Robert Gordon University, Aberdeen*

Several key economy-wide and/or global perspectives on the economics of climate change have acknowledged the important role of behaviour change and demand management (Stern, IPCC, King) for the transport sector. However, each cites limited evidence on the effectiveness of such policies to deliver sustained behaviour change. Together with assumptions about future technology and welfare costs, the studies conclude that transport cannot contribute to significant cost-effective carbon reductions in the short term.

Yet, in general, the evidence on the cost-effectiveness of carbon abatement in the transport sector is limited: few measures have been thoroughly assessed in this way and evaluation methods are often inconsistent. There are two broad limitations with the state of the evidence in this area:

The definition of cost-effectiveness and the methodologies used to assess it;  
 The relative lack of assessment of non-technological options for carbon abatement.

#### **1. Is cost-effectiveness an appropriate tool?**

##### ***Climate change is too uncertain to rely on cost-effectiveness***

The emphasis on cost-benefit analysis may be inappropriate as uncertainty around climate change is sufficiently high that it is not possible to identify policy options on a mathematical basis - a long term precautionary approach is sensible<sup>5</sup>.

##### ***Single cost-effectiveness figures may be inadequate***

Carbon reduction is not just a matter of marginal cost to be traded against other items – more important are total emissions in a period and thus it is the timing and rate of reduction which count<sup>6</sup>. (Stern: *The benefits of strong, early action far outweigh the costs.*)

Analysis for the Climate Change Programme (CCP) does not reflect different potential scales of implementation, the total amount of carbon saved, the timing of policies and how soon carbon reductions are made. It may be that changes in these variables are more critical for transport solutions.<sup>7</sup>

<sup>5</sup> Michael Grubb presentation to BIEE/ UKERC *The Energy White Paper: An academic critique*. 25 September 2007

<sup>6</sup> See Buchan, K. (2007) *National project on transport policies to address climate change. Phase One – Perspectives*. MTRU and Transport 2000. March 2007

<sup>7</sup> NAO (2007) *Cost-effectiveness analysis in the 2006 Climate Change Programme Review*. January 2007

By reporting the average cost per unit of carbon reduction over the lifetime of the policy, the single cost-effectiveness figure conceals the fact that costs may change over time (e.g. as technological know-how increases).

***Packages of policies are more important than individual policy instruments***

Cost-effectiveness in transport would be improved by locking-in the benefits of technological gains (reducing the 'take back' or 'rebound effect') – yet, policies are mostly assessed in isolation without necessarily identifying the best *combination* of measures.

***Assessment is based almost exclusively on carbon reduction and monetary costs without consideration of other impacts***

In order to undertake robust cost-effectiveness analysis for climate change policies, ancillary factors must be stripped out to arrive at a pure "cost of carbon". Yet, most transport policies seek to achieve a number of objectives, only one of which is carbon reductions and where the monetised value of additional benefits is often uncertain. (See Phil Goodwin's note)

***Comparing across studies/ sectors is fraught with difficulty***

Any cross study comparisons should be viewed with caution as the methods, assumptions and indicators vary considerably between studies – particularly the range of costs and benefits included; the extent to which demand is assumed to respond to changes and assumptions made on the future prices of new technologies<sup>8</sup>.

**2. The evidence base for non-technological transport solutions has been neglected**

***Some policy options have not been evaluated using a common methodology***

*Fiscal policies* - were not subject to the same quality assurance process as other policies in the CCP<sup>9</sup>. Yet a measure such as fuel duty offers an effective instrument with a negative net cost or positive net benefit. A recent review of hundreds of transport policy options across Europe concluded: *Carbon and fuel taxes are the ideal measures for addressing CO<sub>2</sub> emissions. They send clear signals and distort the economy less than any other approach*<sup>10</sup>. There is, however, no mention of energy taxes in the Energy White Paper.

*Speed enforcement* - in the CCP, speed enforcement has been assessed with different (as yet unpublished) emissions factors and out-dated cost assessments.

*Ecodriving* – evidence of significant savings (5-10% efficiency savings in private vehicles as well as bus and freight operations) but cost-effectiveness not examined.

*Road building* – net effects on traffic generation and carbon not assessed (ex-post)

<sup>8</sup> See Anable, J. and Bristow, A.L (2007) Transport and climate change: supporting document to the CfIT report available from [www.cfit.gov.uk](http://www.cfit.gov.uk).

<sup>9</sup> NAO (2007) Cost-effectiveness analysis in the 2006 Climate Change Programme Review. January 2007

<sup>10</sup> ECMT (2007) Cutting Transport CO<sub>2</sub> Emissions – What progress? OECD Paris.

*Land use planning*  
*Aviation and shipping*

***The emphasis is almost exclusively on technological solutions, particularly car passenger technology, at the expense of measures to influence behaviour***

UK Government analysis has assessed the role that each sector might play in a carbon constrained future using an optimisation model of the entire energy system (MARKAL). The model is focused on technological possibilities and is limited in its consideration of demand-side policy and behaviour change. E.g. the model cannot accommodate key behavioural responses such as mode shift or shifts in purchasing patterns towards smaller vehicles.

***Evidence on the potential for behaviour change has been overlooked***

(see Phil Goodwin's note)

Smarter choices (including Sustainable Travel Towns)

Road Pricing

Ecodriving / speed enforcement

Car purchasing (King has addressed this)

Evidence on car dependency and 'waste' in the system

***UK Government's own analyses shows technology options to be expensive***

Figure 1 shows the cost-effectiveness of various policies assessed at various times for the Climate CCP plotted against the size of emissions reduction expected from each measure<sup>11</sup>. This suggests:

with the exception of the Fuel Duty Escalator, measures expected to deliver significant CO<sub>2</sub> savings (i.e. different versions of the voluntary agreement (VA) and RTFO) appear relatively expensive;

these measures are more expensive than the mid-range social/ shadow cost of carbon (c £90/tC in 2007 prices);

the larger scale, technology based measures are more expensive than the smaller-scale measures – smarter choices and sustainable distribution;

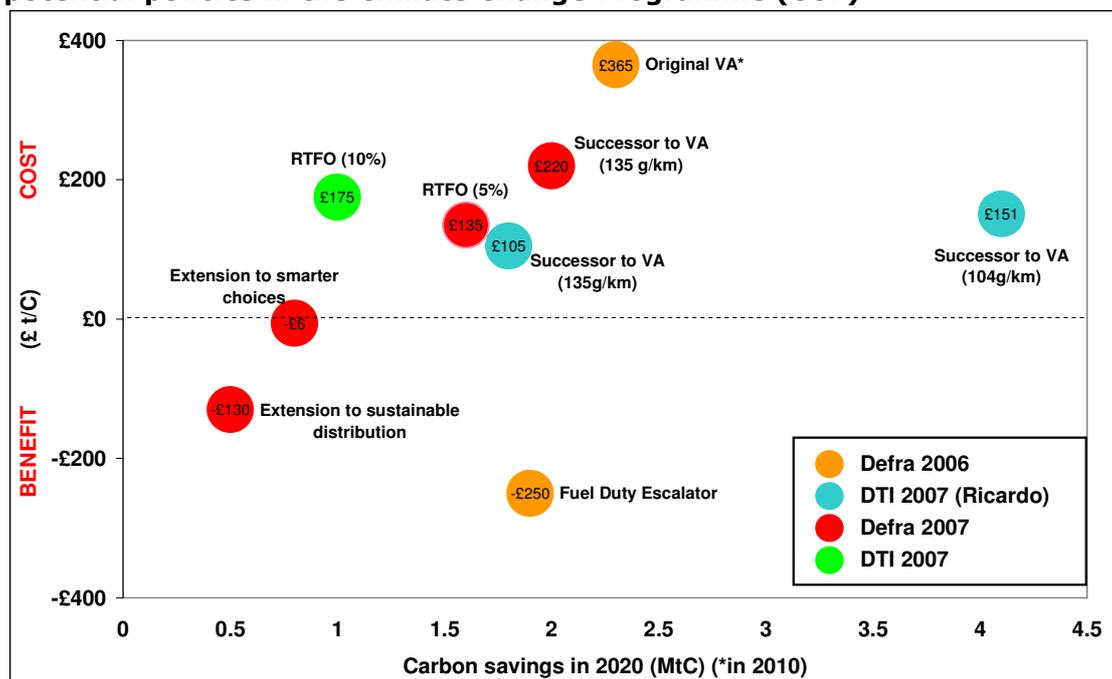
movement towards the higher RTFO target would seem to mean adopting a less cost-effective commitment than the present one. Other studies conclude that biofuels and hydrogen perform best in terms of carbon saving in sectors other than transport;

there may be the opportunity to lower the cost of the original VA by aiming for a tighter carbon target but over a longer period of time.

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<sup>11</sup> CfIT (2007) Transport and Climate Change. The Commission for Integrated Transport, London. (available from [www.cfit.gov.uk](http://www.cfit.gov.uk)).

**Figure 1: Comparative cost data from various studies assessing current or potential policies in the Climate Change Programme (CCP)**



Source: CfIT 2007 (All costs and benefits are brought to present day values using standard discounting techniques. It is important to note that the different cost estimates include different ancillary impacts and are taken from different studies with different base years.)

### 3. How do we develop the evidence base in this area?

Assess most recent evidence on smarter choices

More peer reviewed information on demand management policies

Incorporation of behavioural elements into models such as Markal

Appraisal methodology (see Phil Goodwin's note)

Need to cost programmes, not individual policies (including fiscal instruments). But can this be done?

Need to assess the impact on the transport sector of measures in other sectors, for example, school choice and centralisation of some health services and the resulting impact on CO<sub>2</sub> emissions.

## APPENDIX 5

### ***Does the discussion around cost effectiveness of "hard" and "soft" measures have implications for pre-and post appraisal of transport schemes and programmes - Phil Goodwin, Centre for Transport and Society, UWE Bristol***

The 'Smarter Choices' report calculated a potential for these measures to reduce national traffic levels by around 11%, and peak period urban traffic by over 20%, at a cost per vehicle kilometre removed of 1.5p and a benefit-cost ratio of over 10. I would contest the Stern proposition that transport is a difficult sector to cut emissions because '*...the welfare costs of reducing demand for travel are high*'. This is based on: (i) missing a distinctive feature of transport policies; (ii) a misinterpretation of the empirical evidence; and (iii) a confusion arising from the inappropriateness of standard transport appraisal methods for testing the achievement of targets.

#### **Transport Policies**

The essential feature of transport policy in our time is the robust improvements that can be made by reducing traffic levels for reasons *other* than emission control. These include relief of congestion, greater efficiency of use of transport networks, improved quality of movement and access to activities and opportunities, improved social inclusion, improved commercial success in city centres, reduced accidents, better fitness and health, expenditure savings on expensive infrastructure and maintenance, reduced local environmental damage, more productive use of scarce land and other resources, and reduced nervous tension and stress. This does not discount at all that there are other perceived and/or real countervailing advantages motivating people. Not everybody sees or gives equal importance to these factors. But the point is that there are few sectors where there are so many other good reasons for doing what may be necessary for reducing emissions. There is little plausible argument for telling people they will be healthier or happier if their houses are cooler, for example, comparable to the many benefits of reducing traffic.

#### **Empirical Evidence – 'Soft' (and other) measures**

At the aggregate level it is clear that there are strong pressures for steady continuing growth in traffic, and introspective or qualitative research emphasises the importance of habit and 'car dependence'. But at a disaggregate level there is now an overwhelming (and uncontested) evidence base that travel behaviour does change, that longer term (eg 5-10 year) demand elasticities are of the order of double the small responses seen in the short term, and that habits are broken, changed and re-formed for a very substantial proportion of the population, again over a 5-10 year period. (These time scales are probably connected).

A large amount of case-study and monitoring evidence, and modelling using dynamic forms which are the only ones capable of picking up such effects, indicate that changes in the volume of car travel in the order of 20%-30% can be achieved without great pain or overwhelmingly expensive initiatives. This includes studies of a wide range of 'smart' or 'soft' measures, which typically require few sticks and provide many carrots, which tend to reduce the car use of those people or locations treated by figures of over 10% overall. Studies of road pricing, re-allocation of road capacity (pedestrian areas, bus lanes, cycleways etc) give similar figures. The reasons why this potential has not been delivered at aggregate level is because the instruments themselves are not yet applied intensively or even widely, and because the instruments, though powerful, are very fragile to being undermined or reversed if other, inconsistent, policies are actually providing an increase in traffic. This is still the case.

There is not yet any clear cut evidence of the potential or conditions for reductions of greater than this 20%-30% level. But achieving the first 20% (or even 10%) would transform the nature of the evidence base and political judgements about acceptability.

### **Appraisal Methods**

Achieving a target is all about comparing levels in a base year with levels in a future year. The appraisal methods used for transport schemes never make this comparison, except by accident. They are constructed around the comparison of a future year 'with' and 'without' a specific scheme, often comparing in effect how much worse travel conditions would be with a scheme against how much even worse they would be if nothing is done, the difference being measured as the 'benefit' in the BCR. The 'without' or 'minimum' case, used as the basis for appraisal, virtually always assumes the continuation of traffic growth as inevitable. There is no consideration at all of an alternative trajectory, starting from now.

Such an appraisal is largely useless for carbon reduction strategies. It leads to the proposition that the transport sector is going to get worse, and having got worse will be very expensive to reverse (hence the Stern conclusion). An appraisal methodology suitable for assessing the transport contribution to carbon reduction objectives must start from now, and construct a trajectory year by year for achieving it. For technical reasons, as it happens such an approach would also more clearly reveal the other, non emission-related, advantages of such policies, which would help to secure their acceptance.

The appraisal techniques used in transport are substantial, have been built up over a long period, and are technically very detailed. There are many specific aspects which are widely disputed, by diverse sources such as objectors in public inquiries, a recent transport advisory group of the Conservative Party, and academics and specialists. The DfT have rightly judged that this is time for a 'refreshment' of the methodologies

which would directly address whether they are fit for purpose for present policy objectives.

My own list of points of concern would include the use of 60-year time-frames essentially presuming a 'business as usual' policy and economic framework and continued ready availability of cheap(ish) fuel; no substantial implementation of the policies discussed above, including no road pricing over the whole 60-year period; underestimation of the sensitivity of traffic levels (both increases and reductions) to changes in capacity; a discomfort about the fair comparison of 'small and cheap' measures with large infrastructure (though when that comparison is made, the small and cheap perform very well); a profound inadequacy in treatment of walking and of cycling as modes of transport; and rules for the treatment of public and private expenditure and revenue in the appraisal which may fail to give full recognition to the financial and economic advantages of (some) traffic reduction measures, and an illusory advantage of (some) other measures which increase traffic.

## APPENDIX 6

### DFT "refreshment" of transport appraisal methodologies – GROUP BRAINSTORM for ideas on how to improve transport appraisal methodologies

#### Testing projects against carbon effect

- All projects assessed against "help" or "hinder" / Carbon
- Assess projects for carbon reduction/increase
- Redefine "Do-minimum (=business as usual) & replace by core trajectory
- Check that changing in the baseline from "do=minimum" to desired trajectory works for carbon saving aimed policies as well as the ones likely to increase or not affect carbon
- Assess against Goals/Trajectory not to minimum.
- Values of NO<sub>x</sub>, SO<sub>x</sub> and particulates
- Top-down and bottom-up consistency of carbon value incl. at 30000FT

#### Social aspects

- Build in health impacts (+VE and -VE)
- Have confidence in judgement – resist temptation to monetize everything
- Price is important but cannot do everything
- Holistic include all cost and benefits
- Behaviour change ; assessed with a dynamic 5-10 year profile
- Start from infrastructure: assess (transport)CO<sub>2</sub>impacts of planning etc. **then** made choice **then** vehicle **then** fuel policy
- Consider health benefits of actual travel
- Do not monetise carbon impacts and retain a 7 point scale for other environmental impacts.
- Taking reliability and overcrowding seriously in appraisal
- Regional prioritisation → consistent with national? Should they be?
- Include impacts on quality of life
- Explicit inclusion of distributional consequences gainers and losers.
- Social equity to be included (currently not measured)
- Schemes which do not lead to CO<sub>2</sub> reductions "on target" dropped or charged.
- Look at cross sectoral impacts In v Out
- Address social impacts currently poor

### Technical assumptions

- Small projects/schemes → how to evaluate
- Look at value of journey reliability
- Distribution of costs & benefits needs to be a much bigger issue in final analysis ( eg. Small amounts of time savings to millions of rich motorists vers. Basic existence of poor Bangladeshis whose homes are flooded)
- Reassess the importance of time savings in appraisal - use of time in travel.
- Assessment of cumulative impact of incremental schemes over time
- Equity to active travel
- Should work travel time be valued at less than the average wage
- Assessment of demand created by transport scheme ie. Longer commuting times.
- How are/should investment incentives valued?
- Transport models need to better account for behavioural change policies (integrated not an afterthought)
- Improve data gathering on behaviour change other than choice of car
- Clearer methodology of at he agglomeration benefits from transport schemes
- Understand impact of innovation/creation of lower cost low carbon options
- Danger: self – defeating assumptions.
- Realize that models underestimate innovation and structural changes.
- Understand where the “offset” will be if Co2

### Packages

- Need for integration not trade off stymied by bottom-line focus on NPV and BCR (in which carbon can always be traded off)
- Appraisal needs to consider cumulative impact on emissions of the package of measures against an environmental limit
- Looking at options in combination – packages – mutually supporting
- Look at the right options – allocation of capacity – walking/cycling – traffic control – public transport – “soft” (smart)
- Appraise packages – can it be done?
- Appraise packages – not individual schemes

### Finance rules

- Use a zero or negative (!) Discount rate for environmental impacts
- The dimensions of behaviour change

- Use cost-effectiveness analysis (esp. w.r.t. carbon) and then do sensitivities w.r.t. CBA (private/social )
- The METRIC SCBA cost benefit, cost effective
- Pit Kaldor Hicks and Sugden back in the library and not in NATA
- Consider times scales – effort to reduce C and change behaviour now will reduce abatement cost overall
- Focus on NPV and BCR has major bias against unmonetised impacts. Carbon cannot be adequately incorporated via monetisation due to uncertainty and lack of knowledge – get rid of assumption of 60 years business as usual
- The time scale
- Short medium long term assessment - can it only be a success in long term – 60 years?
- Understand shortcomings of models ( Saturn margin of error on > Co2 +- 100 %)
- Bottom out significance of “welfare costs of reducing carbon from transport”
- Appraise transport /land use planning interaction
- Behaviour changes not = models
- Model policy effects on car ownership levels + demand projections
- Traffic reduction can have a welfare **advantage** and **not** be bad for the economy – Congestion – Commerce – Efficiency – quality of life – healthy – local environment
- Social cost of carbon for CBA’s
- Reflect cost of carbon over time
- Don’t forget goods transport – growth needs to be stopped/reversed to achieve goals.
- Be very explicit about policy objectives and relative importance (weightings) of these.

## Programme

### **The cost-effectiveness of carbon abatement in the transport sector.**

*30<sup>th</sup> October 2007, 58 Prince's Gate, London, SW7 2PG.*

*A half-day workshop to explore the evidence base on the cost effectiveness of carbon abatement from the transport sector.*

*From 13:00 Registration and lunch*

**13:50 Session 1: Welcome and introduction**

**14:00 Session 2: Government position**

*3x 5min introductions from Simon Jackson (HMT), Adrian Gault (DfT) and Chris Nicholls (Defra).*

Plenary discussion on interpretation of Stern/King reports and incorporation into Government policy and any other issues raised by the three briefing papers.

**15:00 Session 3: Cost-effectiveness of non-technological policies**

*5min introduction from Jillian Anable (Robert Gordon University)*

Plenary discussion on key questions and issues raised by Jillian's briefing paper.

*16:00 Refreshment break and brainstorm (during the break participants will be asked to write down their top three recommendations for the DfT 'refreshment' of transport appraisal methodologies consultation).*

**16:30 Session 4: Implications for appraisal of transport programmes**

*5min introduction from Phil Goodwin (Centre for Transport and Society, UWE Bristol)*

Plenary discussion on key questions and issues raised by Phil's briefing paper. Reflections on brainstorm output.

**17:15 Session 5: Wrap up and next steps**

17:30 Close

## Attendees

### The cost-effectiveness of carbon abatement in the transport sector

30<sup>th</sup> October 2007, London.

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