

## **Transport Planning Society**

### ***Transport and Climate Change – facing the carbon emissions challenge***

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**25 April 2007**

#### **Introduction**

1. It is a pleasure to be here speaking to the Transport Planning Society and to see so many old friends. Let me first of all explain that I am not an expert on climate change or on carbon emissions. I come to this debate as an experienced transport professional, seized of the nature and the urgency of the climate change challenge, like many of us, but still on a steep learning curve about the whole subject. I am not in the subject as a transport academic or research professional, but am delighted to see a growing body of work by those who are, and a growing recognition of their work, such as Jillian Anable at RGU, who is the Transport topic leader at the UK energy Research Centre, Abigail Bristow, formerly of Leeds University ITS, now at Loughborough University, and Robin Hickman at Halcrow, along with David Banister, formerly of the Bartlett School and now TSU at Oxford, who have applied 'back-casting' to the climate change challenge. My attention was also drawn in the last few days to Eleanor Mackay's excellent paper for the Transport Planning Society bursary of last November, which covers much of the same ground as I am tackling this evening. In fact since her ability to draw graphs for powerpoint is evidently much better than mind, I have used a couple of her graphs in this presentation.
2. My interest is in trying to bring a greater understanding of what the climate change challenge demands of the transport planning community, and I am particularly pleased to bring this to the TPS (although it is clearly not the first time) and look forward to the debate. My sense is that the UK government has been ahead of the game in a strategic sense - it published the world's first Sustainable Development Strategy in 1994; the government continues to be admirably bold at the level of principles and goals - Climate Change Bill and 2050 commitments - but has been totally failing to get to grips to what you have to do to deliver them, at least in transport. More in a moment.
3. You know as well as I do that within the last 9 months, climate change and carbon emissions have moved to the top of today's public and political agenda. The Stern Report of last September added an economic dimension to what had been till then a

scientific and environmental crisis; the Eddington report in December supported full environmental pricing for all modes including aviation; the UK government has introduced a climate change bill with legally binding obligations to reduce carbon emissions to 2050; and all this has been within the UK, while globally the whole topic got a major boost a few weeks ago with the publication of the second report by the Intergovernmental Panel on Climate Change; this set out very clearly the differential impacts of climate change across the different parts of the world.

4. In this presentation, I will set the scene, lay out what we know about transport and carbon emissions and the challenge, and then identify some of the key issues we have to address in order to make some progress. I will look at both energy efficiency measures and behavioural change measures as responses to the challenge. I will then look at what government is doing and the current framework for UK climate change policy for transport. And consider the issues of public understanding and political attitudes, and what the opportunities are for them changing; and is there a role for the transport planning community in helping those along.

5. This is a fast moving scenario. Here is a list of events and developments in the last 9 months alone.

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### **Setting the Scene**

6. I am not going to argue the basic proposition that climate change is upon us, it is largely man-made, and that on current trends temperatures will rise over the next 50 years and century with a range of catastrophic consequences for life on this planet by the end of the century. If you haven't 'got that', then nothing I am going to say today will persuade you!

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7. The recent IPCC report reminded us that existing divisions between rich and poor nations will be sharply exacerbated by the pattern of climate change impacts: increased drought, crop failure, disease, extreme weather events and sea level rise are all likely to fall much more heavily on the struggling populations in Africa, Asia and South America than on the rich industrial societies of Europe, North America and Australia. And it is these who have done most to cause global warming through greenhouse gas emission, and who are best placed to afford the measures both to mitigate the effects and adapt to its consequences. Interestingly, the intergovernmental panel argues that adaptation strategies should now take precedence over efforts to reduce greenhouse gases, though that will be the subject of their third report in May.

8. The Stern report for the first time authoritatively evaluated the economic consequences of failure to take action now. In a nutshell he said that climate change unchecked could shrink global economies by 20%, and incur costs and losses of over £3.5trillion; it could cost as little as 1% of global GDP to take appropriate actions now to stabilise and reduce carbon emissions. There are those who question his assumptions and economic calculations, but I think we get the general idea, reinforced by the second IPCC report: that serious and decisive action taken in the next ten years may just be able to slow down the rate of increase of carbon concentration..... Indeed, George Monbiot - a well known somewhat apocalyptic commentator - has in the last few days stressed again the urgency of starting now to make serious reductions in emissions, because of the cumulative effect of emissions on carbon concentration in the atmosphere.

9. It is admittedly difficult to comprehend the scale and significance of all this. We go about our daily lives – do our jobs, attend conferences, go shopping, spend time with our families, read the papers, take our holidays – and wonder if it is real. Yet informed public opinion in the UK - and I think increasingly the man in the street - has been running ahead of the UK government’s willingness or capability to get to grips with the subject.

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10. The UK signed the Kyoto Protocol to reduce its greenhouse gas emissions by 12.5% of the internationally agreed base levels by 2008-2012. The base levels are set at 1990. With CO2 accounting for some 85% of greenhouse gas emissions, we will focus on CO2 emissions, as they are the most relevant for transport. Aviation and shipping emissions are not included in Kyoto agreements, although figures from aviation and shipping are included in the Kyoto reporting as memo items.

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11. Alongside Kyoto, the UK has domestically committed to a reduction in CO2 emissions below 1990 levels of 20% by 2010 and of 60% by 2050. The Climate Change Bill published last month and currently going through pre-legislative consultation will make the 60% reduction by 2050 legally binding. This includes UK domestic aviation but excludes EU and international flights. The 1990 reference level is 161.5 MtC – million tonnes of carbon. Even though we talk about CO2, the actual mass we are measuring and forecasting is that of carbon. The target level for 2010 is 129 MtC; and for 2050 it is 65 MtC

**12.** This graph - thank you Eleanor MacKay - shows the overall greenhouse gas emissions, and the Kyoto level, which we look like reaching; and the CO2 emissions (the subject of the UK commitment), the 2010 target of 129 MtC and the very ambitious 2050 target of 65 MtC.

**13.** So what progress is being made? In 2000 the UK emitted 150 MtC greenhouse gases, already a 7% reduction on 1990; but it has got stuck there, and last year rose to 152.9, the highest since 1997. As we will see in a moment, the most important single factor in that was the marginal shift from gas to coal in electricity generation due to pricing and availability reasons; coal produces nearly 2.5 times the amount of CO2 for each GWh as does gas. So let me comment at this stage

- o the targets the UK has set itself are very ambitious
- o as we shall see, the government has willed the ends, but has said little about the means of getting there
- o UK performance can be profoundly affected by a marginal change in another sector

**14.** Before we go on to look at the transport sector, let us ponder why should we in the UK take it all so seriously when we emit less than 3% of global emissions, and the US, China and India are the real problem? For me there are four reasons

- a. There is no silver bullet, no single simple solution: substantial change will only come about as a result of millions of initiatives, measures, decisions and changes all over the world. Every little helps; just as we all vote in elections when any one individual's action has no perceptible effect on the outcome, because we believe in what we are going;
- b. We will have no moral authority to persuade any other nation that action is necessary if we take no action ourselves; the UK played a major role in securing the Kyoto treaty, and continues to be a major voice on the international stage. The Stern report - a British report - has had a significant impact round the world, reinforcing the economic not just the scientific or environmental arguments for adopting radical climate change measures sooner rather than later. The Climate Change Bill is a world first, in binding government to action to reduce greenhouse gas emissions
- c. There are global business opportunities for the UK in products and services related to carbon reduction and

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energy efficiency, and these will be greatly enhanced by a lively home market.

- d. The UK as a low carbon economy will be more competitive and sustainable in a world where oil prices rise and scarcity increases, and geo-political factors dominate oil and gas supply (as we are already seeing).

- 15. Of course the UK should not go it alone. The EU in its ponderous way is already doing a good deal, and for the UK to campaign for EU-wide and global action, such as a global emissions trading system, is crucial to protecting the UK's economic interests and competitive position.

### Transport and Carbon Emissions

- 16. So let us see where transport fits into this picture. While the UK's carbon emissions overall have fallen since 1990 – albeit having plateaued at about 5-7% down - transport carbon emissions have risen by 13% between 1990 and 2006. Transport in 2006 accounts for 29% - and rising - of UK carbon emissions. Road transport accounts for 93% of that; the figures also includes about 1% for domestic aviation, but of course international aviation and international shipping are excluded.

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- 17. Within the road transport sector, emissions from cars have been stable, as the improving fuel efficiency and emissions characteristics of cars has offset the growth in car ownership and use. Emissions from road freight vehicles are rising, and within this the fastest growth is from light goods vehicles – the ubiquitous white van. This reflects growth in numbers, with little mitigating effect of improved fuel efficiency.

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- 18. Of all transport sectors, aviation has been growing the fastest, both international and domestic. If you add international aviation departures from the UK, the transport percentage in 2006 jumps from 29% to 35%. This table shows passenger and aircargo flights - departing international flights and domestic within the UK accounted for less than 3% of the UK total in 1990, but forecast to rise to 10% by 2020 with nearly 15 MtC on the Aviation White Paper estimates; some would put them higher. The effect of radiative forcing - the effect of jet engine emissions at cruising altitudes - means that the total climate change *impact* of aviation CO2 emissions is more than doubled - so for 15MtC read (say) 35 MtC in terms of impact. Clearly we are facing some very big challenges.

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### Issues to be addressed

- 19. I think all this suggests some obvious issues to be addressed

- a. How are the required reductions in CO2 emissions going to be allocated between sectors, and when, and over what period of time?
  - b. Within transport, what are the measures that can be taken, how should they be pursued, and will they be sufficient and sufficiently fast to implement? How will they be prioritised?
  - c. Are the measures which need to be implemented going to be deliverable in a democratic society, and what process of education and learning can help to improve their chances?
20. I don't have a lot to say about the first, except that no sensible targets can be set for transport unless the sector allocations are made. I can understand the analytical and political difficulties involved, and with so much likely to change over the next 10 or 20 years, in energy efficiency, technical innovation, and in public recognition and acceptance, I can see that it may be counterproductive to try and set long term sector targets which all add up to the magic 65 MtC.
21. In any case the target setting process needs to be informed by a careful and comprehensive analysis of the trade-offs, and in particular an assessment of the financial, economic and social costs associated with each of a range of measures within each sector, and a trajectory which is designed for each measure to minimise total financial, economic or social cost.
22. Let us remind ourselves what are the components of anthropogenic - ie man made - CO2 emissions. This chart comes straight from the DTI's regular report on energy trends in March. It shows how power stations have been largely responsible for the dramatic fall since 1990, and the rise since; with transport continuing to creep up, as we have seen, and everything else pretty static - perhaps some slight reduction in industry use, as manufacturing continues to decline in our economy. The change in the power station contribution has been largely because of the substitution of coal by gas in the 1990's, and the rising proportion of coal since, largely because of price, availability and growing concern about the geo-political dimension of gas supply - do I need to mention Gazprom? The differences in the CO2 emissions per GWh - gigawatt-hour - are pretty striking, with gas at 100 tonnes per GWh, oil at 145 tonnes, and coal at 240 tonnes per GWh - nearly two and half times the CO2 emissions of oil.
23. I do not have the proportions to hand of private car for non-business use vs goods vehicles, light vans and cars for business

use, but my guess it that a majority of transport activity is the result of individual decisions directly rather than business decisions, and correspondingly so for CO2 emissions; add that to the domestic energy consumption and corresponding carbon emissions, and you have about 40% of CO2 emissions directly influenced by individuals on a day to day basis. I should explain that the power station emissions do not include those for domestic electricity consumption, which are accounted for at the user end.

24. To me the situation is crying out for some analysis which frames all possible measures to influence CO2 emissions, and then analyses them by their reductions, given the nature and trajectory of their, and puts that against the one off and continuing costs. If I am wrong that the government is doing nothing about this, then forgive me, but I have not heard of it.
25. Just this is being done for transport by CfIT, which neatly takes me into the second issue - what are the opportunities, measures, and reductions for transport and what do we know about their deliverability.

### **Transport - opportunities and benefits**

26. There are two main avenues for CO2 reductions in transport - technical and efficiency measures which reduce emissions without any change in transport output, and changes in transport output as a result of changes in travel behaviour or transport decisions by firms.
27. There is much happening on the transport energy efficiency front, including the reduction of net emissions through the increasing use of renewable fuels.
28. First, surface transport - and cars in particular. New cars sold in the UK in 2004 were on average 10% more fuel efficient than in 1997. The rate of improvement is slowing and does not appear to be in line to deliver the EU targets, which have been to reach [120 g of CO2/km by 2012 at the latest](#). The EU moved to legislate these targets, which as a result of lobbying by the German car manufacturers were finally agreed earlier this year at 130g/km. The new car average is in the 160's currently. Three changes are needed to deliver this change - one, a much higher proportion of diesel cars; second the much increased offer and take up of hybrid engines with regenerative and energy storage capability; third the reduction in the average car size and weight.

29. In the UK the company car taxation arrangements has since 2002 been successfully incentivised the use of lower emission vehicles, by introducing really dramatic differences in the personal tax associated with different car emission levels.
30. Although still much less steep than this, at last government has decided to do something about the general VED structure of charges. I would argue that it is politically the least difficult and a relatively effective way of reducing carbon emissions quickly, and that the newly introduced charges are still modest in relation to the annual depreciation and running costs of a car.
31. I know there is an element of behaviour change in this, but the government is determined to drive down the carbon emissions of cars - through the Low Carbon Vehicle Partnership and other initiatives. HM Treasury - has Gordon finally got it about climate change? - has remitted Professor Julia King of Aston University, with Nicholas Stern, to lead a study of decarbonising cars altogether within 25 years. The first report will come in the late autumn.
32. The fastest rising source of surface transport is roadfreight and light vans - driven by the volume of vehicle mileage rather than worsening fuel efficiency emissions. Once the EURO requirements are met, the current HGV VED regime provides no incentive for fuel efficiency or carbon emissions. The London LEZ proposals, which require progressive adoption of EURO requirements by coaches and HGVs to avoid a penal charge for entering London, will force fleet renewals or retrofitting.
33. Hybrid powertrains can offer a leap in efficiency - based on using a primary source (currently petrol or diesel, possibly fuel cells in the future) coupled with some form of energy capture, storage and release - usually electricity. Current cars deliver 30-50% improvement in fuel efficiency and CO2 emissions - with the Prius rated at 104 g/km and the Honda at 107 g/km.
34. There are two configurations of hybrid - the series and the parallel. Personally I feel the parallel is more elegant and energy efficient; both types are to be procured for London's buses by 2012 under the Mayor's determined climate change policy - in time for the London Olympics! The manufacturers claim in each case fuel savings and carbon emission reductions of about 35%.
35. This is a picture of the Volvo engine, with the ISAM unit the slim black section with cables coming out. This engine is

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designed for truck as well as bus use, and has been on extensive test in the US.

36. The King review of decarbonising cars is significant; no doubt she will be looking at longer term alternatives to hydrocarbon fuels, such as hydrogen and fuel cells. Possibly as early as 2025, and certainly by 2050 and beyond the supply and pricing of oil becomes a really major issue.
37. Rail is a relatively low-carbon mode of transport - at 50g/pass-km on average it is about one-third of the emissions per pass-km by car. But it has been criticised for ignoring energy efficiency and carbon emissions - whether from diesel fuel or from electricity generation back at the power station. Rolling stock renewal in the last decade has seen higher vehicle weights, better performance, more energy hungry kit on board such as air conditioning, mechanised doors, more electronics for everything from lighting to power management. And energy consumption per pass-km has risen.
38. Having been chided and teased by transport ministers steadily over the last few years, it seems the industry - or some of it - is getting the message. At the Railway Forum's seminar last week Eurostar launched its 'tread lightly' campaign to improve its own energy efficiency by 25% by 2012, through a range of engineering and driver training initiatives. This is no doubt a marketing pitch to capture the guilty travellers on shorter cross channel flights - Eurostar already claims 1/10<sup>th</sup> of the emissions of the equivalent air journey.
39. Perhaps more dramatically, Mike Tatton from the Railway Safety and Standards Board identified some general railway practices which if reformed could save over 200,000 tonnes pa - such as disconnecting stabled electric trains, and cutting diesel engine idling (there has been a practice in railfreight of keeping engines on all the time).
40. I am not an aviation expert, but I understand that there have been dramatic improvements in the energy efficiency improvements of aircraft: new aircraft today are 70% more fuel efficient than 40 years ago, and 20% better than 10 years ago. Both the UK aviation industry and independent government sources project further improvements of the order of 20% by 2015 and 40-50% by 2050. Part of this package includes 10% improvement due to air traffic management operational efficiencies.

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41. Interestingly even a short haul flight on a modern aircraft has a similar CO2 emission per passenger km to a large car. But this is misleading - the emissions per hour travelled are of course much higher. It is the emissions per hour that count when looking at people's travel choices, since travel choices are made within a time budget. And the real problem of aviation is the huge prospective growth of air travel over the next 5-10-20 years, which far outstrips any benefits due to efficiency improvements.

### **Transport - behaviour change**

42. While efficiency and operational improvements in transport are useful contributions to reducing the transport CO2 emissions, but they will barely offset the effect of forecast growth in transport.

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43. Fundamental changes in travel behaviour - and in home energy consumption - will be necessary to bring about substantial reductions in CO2 emissions. Some will be achieved by voluntary action by the more environmentally aware section of the population, and we are already seeing a little of this.
44. There is a wide range of measures to influence the modes of travel people use and the amount of travel they make in total. They include:
  - a. Smarter travel - 'soft' measures to influence modal choice, such as workplace, school and residential travel plans, travel demand management including individualised marketing of alternative modes, car sharing and car clubs, travel awareness programmes. They may only have a modest impact on CO2 emissions, but would be seen as necessary complements to harder measures such as taxation changes;
  - b. public transport improvements - bus and rail: while many will be beneficial and help cities to function better, the overall scope for public transport to cut down car use across the country is relatively limited
  - c. Urban form and land-use changes - achieving greater concentration and less transport dependence in towns and cities: these are an important ingredient of a long term strategy, with more limited impacts in a 25 year time horizon.
  - d. ICT developments - have the opportunity to reduce travel, for example commuting and travelling in work time; this is likely to continue to grow in its contribution.

- e. Road fuel taxes - an obvious short term measure, which does cut back the demand for car travel; some political nervousness from September 2000 remains.
  - f. Road pricing - under serious consideration now by government and a number of local authorities to address congestion, based on the successful implementation of the London Congestion Charging scheme. My own view is that whatever road user charging systems are implemented in the UK over the next 15 years, they will be motivated initially by congestion and demand management, but will increasingly be able to serve a carbon-reduction agenda as well - incentivising the use of lower carbon-emitting modes of travel.
  - g. Aviation taxes. Aviation is the elephant in the room which no one is talking about. It cannot be avoided. Demand for air travel continues to grow fast, due to the continuing fall in the cost of flying coupled with the growth in real incomes and the extension of air networks. On grounds of fairness as well as the need to limit the growth of carbon emissions from aviation, some substantial change in the tax regime for aviation is inevitable, whether further changes in the APD, introduction of VAT or some other tax on fuel. Even Eddington - an airline man to his socks - could bring himself to recommend that airlines should pay charges or taxes to reflect their full environmental impacts.
  - h. Aviation in an emissions trading scheme. Aviation is not currently in the EU ETS, but it is being lobbied for hard by the UK government and others. This is probably a necessary step to bring aviation into some form of carbon-rationing system, but I am not sure how effective it will be. Much depends on the starting allowances about which there is much debate within the industry - if your starting allowances are based on your history, BA is going to have more to start with than Ryanair. Ultimately the demand for air travel comes from the market, and the market responds to price signals, so the effect of airlines entering a carbon emissions allowances and trading scheme will depend on how the effect of ETS works through into fares.
45. Now I have just given you a list of familiar initiatives, but no framework for prioritising them, nor for looking at what contribution they can make, or the trajectory they might adopt, or what financial, economic or social costs they might incur.
46. Robin Hickman and David Banister have carried out an interesting exercise for the DfT 2-3 years ago, which they called VIBAT - Vision and Backcasting. It involves the very simple but

powerful idea of going to your target and working backwards, and seeing what packages of actions might be able to deliver those targets. They applied the 60% target to transport, but by 2030 not 2050; and so were looking to save nearly 26m tonnes in the projected 2030 total. They looked at two different images of the future - a 'new market economy' in which the emphasis is on energy efficiency, hybrid technologies, etc and not much behaviour change is envisaged; and a 'smart social policy' scenario in which behaviour change plays a central role. While there will be some reduction in the number of car trips, the principal change is in the length of trips - and reduced carbon emissions is placed at the centre of decision-making. They then analysed and packaged up a range of policy measures consistent with the approach of the each future scenario - including all those I have mentioned above and some more.

47. Time does not permit any further analysis of their really interesting project, but just let me report the conclusions. They conclude that the 60% reduction cannot be delivered under the 'new market economy' model; it can only be delivered under the 'smart social policy' scenario, providing major change in behaviour does occur, and many technological innovations are assumed too.

### **So where is the government in all this?**

48. The 2000 Climate Change Programme put in place the reform of company car taxation and the graduated VED, and the fuel duty escalator (so far as it went). The Renewable Transport Fuel Obligation (RTFO) requires 5% of all UK fuel sales to come from renewable sources by 2010.

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49. The 2006 CCP didn't have a lot more to say, quite honestly - fuel efficiency of new cars through the EU Voluntary agreement; support of new vehicle technologies, further use of taxation to incentivise lower carbon vehicles, and some mention of behaviour change. No wonder the Commons' Environmental Audit Committee in their July report was scathing of their lack of ambition and limited scope.

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50. The autumn saw much discussion of radical measures: bringing back the fuel duty escalator, new taxes on aviation fuel or raising APD, more steeply graded VED rates for cars and light vans according to carbon emissions. What we saw in the mini-budget last November was a modest increase in Air Passenger Duty but nothing else. At the time it seemed truly a missed opportunity politically to steepen the general VED rates, equivalent to what has been done in the taxation of company

cars; however in the main budget in March we did see higher fuel duty and a progressive introduction of steeper VED rates.

51. Last month Douglas Alexander made a wide-ranging speech about transport and climate change and government policy. As already reflected in government policy, the focus is first on technical measures which improve energy efficiency or reduce net carbon emissions without affecting transport output. He mentioned the target of 100 g/km vehicle, and the longer term aim of 'decarbonising' road vehicles altogether over the next 25 years, as I have mentioned. He mentioned the taxation of higher emission vehicles, and the Renewable Transport Fuel Obligation - although the government is sensitive to the environmental, economic and food supply consequences of shifting agricultural production to maize and wheat to produce the ethanol required. The rest of his speech was about a couple of measures to promote behaviour change - smarter travel, and investment in public transport, and a reference to road pricing.

52. I may be critical, but this is a hotch potch approach: there is no overall framework. Nowhere does he take the target on the wall and work back from it, looking at the contribution which transport can make to the reduction target, and what the different measures within transport can achieve towards the transport target - and the gap we are left with. In spite of his department having commissioned what became the Hickman/Banister VIBAT study. Douglas Alexander is a very bright man, and I have to conclude that he is not mentioning much else because - as with road pricing - he judges that the public can only take so much right now.

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53. What we have been reminded about in the recent public debate about road pricing - stimulated by the e-petition on the Downing Street website which collected 1.7m clicks on an inaccurate (though plausible) statement of what road pricing might involve - is that measures to change travel behaviour need popular understanding and consent. Jillian Anable's recent work on public attitudes to climate change and transport - again for the DfT - demonstrated that there is only a weak link between knowledge and awareness of climate change on the one hand and travel behaviour at the individual level on the other. This is similar to the finding of the IPPR on attitudes to road pricing, that while the public accepts congestion is a serious problem and needs radical solutions, the link between pricing the use of the road and the reduction of congestion is not intuitively there!

54. Another of Jillian Anable's findings is that any travel behaviour change strategy will be more effective if it targets change at the community level; again, consistent with the evidence that while national road pricing scares people off, local applications (eg in London, and planned in Manchester, Birmingham and Bristol) are more likely to be acceptable, linked as they are to solving local issues.
55. It is interesting to see that Ken Livingstone, London Mayor, is planning to introduce higher congestion charges for higher emission vehicles (already alternative fuel and hybrid cars pay nothing): a figure of £25 is being spoken of for band G vehicles (over 225 g/km) compared with the standard charge of £8. And the London Borough of Richmond is planning to make the charge for residents' on street parking permits vary according to the vehicle emissions. Because these are local, and their proponents are locally elected, they may well 'stick'.
56. Let me remind you, then, of the VIBAT findings, which are that technical and efficiency measures will never bridge the gap - if the gap is proportionate for transport; and that it will require some pretty major changes in behaviour as well as all the technical stuff to get any where near.
57. As I conclude, I want to share with you my own possible remedy - personal carbon allowances and trading. I have left this till the end. In my view the most effective and fairest way to incentivise low-carbon travel behaviour is a system of personal carbon allowances supported by the ability to trade them.
58. Carbon units - allocated equally to everyone over the age of 16 - would be spent every time fuel is bought or public transport (including flights) are purchased - and for all domestic energy consumption. Unused carbon units can be sold on a simple legitimate market, and those who wish to travel more than their carbon allowances will permit can buy more units. It is a parallel economy to money. It is perhaps complex to comprehend and accept, though it can work perfectly well as an analogue to today's cash and payment systems. Interestingly, recent research at Leeds University suggests that, for choice of car or public transport use, personal carbon allowances are both more effective at changing behaviour and judged much more acceptable than straight fuel taxes. We
59. My conclusions so far are

- a. The UK is committed to an ambitious programme of carbon emissions reduction
- b. The government has not yet introduced the question of how such an emissions reduction would be allocated across sectors
- c. On any reasonable assumption about the reduction transport would need to deliver, technical and energy efficiency measures are essential but not sufficient
- d. Transport behaviour changes are necessary also to bring about substantial reductions and they will bring about major lifestyle changes and economic impacts
- e. Personal carbon allowances and trading may be the only 'fair' way to achieve these ambitious targets.
- f. Transport planners should individually and collectively be supporting the kind of work, investigations, education and promotion of understanding which will enable policy choices to be made in the future in a democratic society.