If, At First, The Idea is Not Absurd, Then There is No Hope For It: Towards 15 MtC in the UK Transport Sector.

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Abstract

This paper examines the possibilities of reducing transport carbon dioxide emissions in the UK by 60% by 2030; a hugely demanding target given current projections of increased traffic levels. The analysis uses a scenario building and backcasting approach to examine a range of policy measures - technological and behavioural - which, in combination, may contribute to a lower carbon future. Potential images of the future are developed to help evaluate whether such an ambitious target is feasible, and to identify the main problems and the decision points over the 30-year time horizon.

1. Introduction

The issues relating to climate change have risen dramatically to the top of the political agenda in recent years, and the importance of transport in contributing to reducing levels of CO_2 is clearly evident: yet the paradox remains that traffic levels continue to rise and all the projections suggest that more emissions rather than less are likely to 2030 and beyond. As urban and transport planners we thus need to think differently in tackling the global emissions problem.

This paper draws on research carried out by in the VIBAT project[1]. This examines the possibilities of reducing transport carbon dioxide emissions in the UK by 60 per cent by 2030 using a modified scenario building and backcasting approach. It examines a range of policy measures (behavioural and technological), assessing how they can be effectively combined to achieve the required level of emissions reduction.

Within this paper, we first give a very brief summary of traffic growth in the UK and an outline of our conceptual approach in the study: that of future studies, forecasting and particularly the backcasting approach. We then derive a CO_2 transport emissions baseline and 60% reduction target in the UK to 2030. Finally – and as the central part of this paper - we develop two alternative images of the future which may achieve the

[1] The Visioning and Backcasting for UK Transport (VIBAT) project is being carried out by the Bartlett School of Planning, University College London and the Halcrow Group for the UK Department for Transport under the New Horizons Research Programme.

suggested emissions reduction target. We conclude by considering the imperative for change.

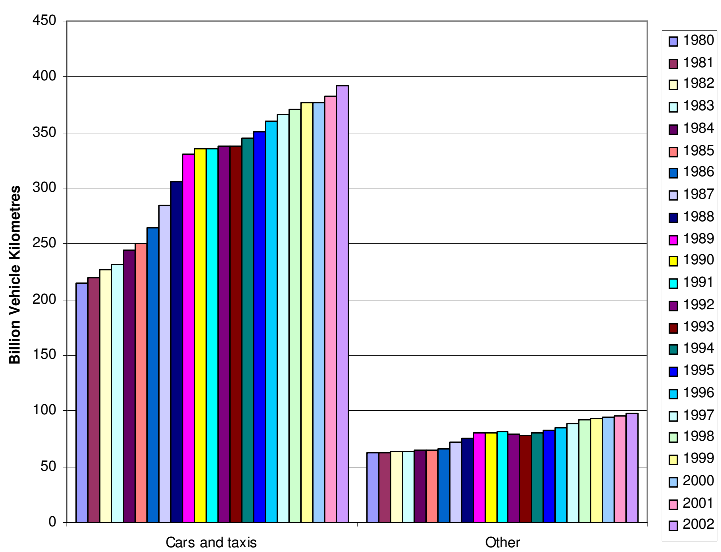
2. Establishing the Context and Baseline

2.1 The Traffic Growth Explosion

At the aggregate level, road traffic in the UK has grown at a rapid rate since the 1980s: by 77% since 1982 to 2002 (from 277 to 490 billion vehicle kilometres). Since 1990 growth has slowed only slightly from that in the previous decade (a growth rate of 18% since 1990).

Travel patterns and trends are becoming ever more complex in the UK: mobility has "stepped up" in recent years, and travel patterns are becoming multi-layered with an increased intricacy in tangential and orbital movements.

Figure 1: *Road Traffic Growth in the UK*



Source: DfT (Travel Trends, 2004)

Key travel behaviour changes are summarised below:

- There has been rapid growth in passenger distance travelled - particular by the private car - since the 1980s, although growth has slowed recently. Education, escort, shopping and business trips are seeing continued growth.

- A recent growth in rail usage, and an increase in bus usage in London (offset by a decline elsewhere in the UK).

- A fall in trips made by non-motorised modes of travel (walking and cycling).

- Freight vehicle kilometres have increased, reacting to business trends such as centralisation and just-in-time deliveries, although greater fuel efficiencies have helped to mitigate environmental impacts.

- Air travel has also grown rapidly, with 'low cost' airlines having a strong recent influence.

Many factors have affected traffic levels, including increasing car ownership and numbers of drivers, falls in car occupancy levels, fuel price changes, varying levels of expenditure on roads and public transport, and land use change (including the increased dispersal of development form). Over a quarter of households now have two or more cars. Males, for example, are still more likely to have a driving licence, but the number of females holding a licence has been increasing at a rapid rate.

2.1 Futures Studies and Backcasting

To help us understand likely future trends and the impact of alternative future scenarios a number of empirical research techniques are available. Futures studies, for example, have been increasingly used in the last few decades to illustrate what might happen to society in adapting to perceived future trends. The most effective studies are used to define a broader conceptual framework for discussing the future and to contribute to policy formulation and the emergence of unforeseen new options.

Futures studies are often not concerned with predicting the future, but instead with creating a choice of futures by outlining alternative possibilities which can form the basis for planning and policy development. Banister and Stead (2004) categorise futures studies as considering one or more of the 'three Ps':

- Possible futures: what might happen?

- Probable futures: what is most likely to happen?

- Preferable futures: what we would prefer to happen?

A variety of related techniques have been employed over the years. These include: trend and mega-trend analyses (both quantitative and qualitative), delphi studies (where information from a panel of experts is gathered about the importance and significance of trends), scenario building, wild card (extraordinary events or possibilities are included), visioning and futures workshops.

The traditional forecasting approach is still frequently used in many research studies. There are however strong concerns as to the usefulness of forecasting in the study of highly complex, long term sustainability problems. Based on 'business as usual' existing trends, forecasting is unlikely to generate sufficiently radical solutions if these are required.

Achieving sustainability, for example, critically requires more than marginal changes at many levels of society. Approaches that focus on the problem to be solved, rather than on present conditions and current trends, are better suited to achieving real solutions that will move us towards sustainability.

There is also a distinction to be made between scenarios and visions or images of the future. Visions or images of the future are often static 'snapshots' in time, whereas scenarios are dynamic, logical sequences of events. Within this, two kinds of scenarios can be distinguished: projective and prospective. A projective scenario's starting point is the current situation; extrapolation of current trends results in future images (and known as forecasting). Forecasting scenario studies are very common in transport studies. Problems are assessed due to current and future transport activity, based on the continuation of current socio-economic trends. A prospective scenario starts with a possible or desirable future situation, usually described by a set of goals or targets established by assumed events between the current and future societal situations. Backcasting is one form of prospective scenario building.

The term backcasting was first introduced by Robinson (1982) to analyse future energy options in terms of how desirable futures could be attained. The major distinguishing characteristic is: "*a concern, not with what futures are likely to happen, but with how desirable futures can be attained. It is thus explicitly normative, involving working backwards from a particular desirable end-point to the present in order to determine the physical suitability of that future and what policy measures would be required to reach that point*." (Robinson, 1990). The major differences between forecasting and backcasting studies are shown in Table 1.

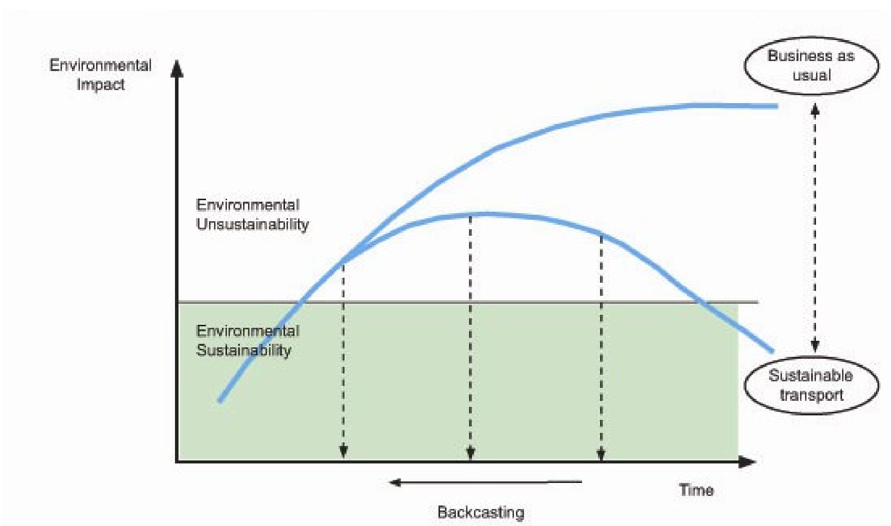
Table 1: *Comparing Forecasting and Backcasting*

Measure	Forecasting	Backcasting
Philosophy	Justification as the context Causality determinism	Discovery as the context Causality and intentions
Perspective	Dominant trends Likely futures Possible marginal adjustments Focus on adapting to trends	Societal problem in need of a solution Desirable futures Scope of human choice Strategic decisions Retain freedom of action
Approach	Extrapolate trends into future Sensitivity analysis	Define interesting futures Analyse consequences and conditions for these futures to materialise
Method and technique	Various econometric models Mathematical algorithms	Partial and conditional extrapolations Normative models, system dynamic models, Delphi methods, expert judgement

(Based on Geurs and Van Wee, 2000, 2004; and adapted from Dreborg, 1996)

Figure 2 shows the main features of the backcasting process. Instead of starting with the present situation and prevailing trends, the backcasting approach designs images of the future representing desirable solutions to societal problems. Possible paths back to the present are then developed. The term 'scenario' covers both the images of the future and the trajectory leading back to the present date.

Figure 2: *The Backcasting Conceptual Framework*



(Based on OECD, 2000)

The OECD project on Environmentally Sustainable Transport (EST) (OECD, 2000; 2001; 2002; see www.oecd.org) is a well known transport study in Europe which has used the backcasting approach. Others have also been carried out - the EU-POSSUM project (Banister et al, 2000) was the first to assess European transport policies as to their consistency and feasibility, using a qualitative scenario-based approach based on backcasting.

3. Reducing Transport Emissions in the UK: A Baseline and Target

In deriving a baseline for CO_2 emissions we have used the published projection made available in Transport Statistics Great Britain (DfT, 2004). Table 2 shows retrospective and prospective data for the years 1985/1990/2000/2015/2030. This is derived from the published data using linear growth between available data. Clearly there is a large increase in expected CO_2 emissions: for example, end user emissions for road transport are projected to increase by 88%, all transport by 73% from 1985-2030, compared to all emissions with an increase of 6%.

As an additional consideration, UK international air transport emissions currently amount to 8 MtC (9MtC including domestic). They are expected to rise to some 14-16 MtC by 2020 (and if extrapolated to 20MtC by 2030). This is despite an improvement in the fuel efficiency of aircraft of around 1.7% p.a. (DTI, 2003). International shipping is also not accounted for in the domestic projections.

Table 2: *Carbon Dioxide Emissions Projection by End User in the UK*

	1985	1990	2000	2015	2030
Road transport	26	33	38	42	49
Railways	1	2	2	1	1
Civil aircraft	1	1	1	1	1
Shipping	2	2	1	1	1
All transport	30	38	41	45	52
All emissions	156	157	148	153	166

Unit: million tonnes of carbon (MtC)

End user emissions for transport include a share of the emissions from combustion of fossil fuels at power stations and other fuel processing industries, but exclude activities emissions. Source categories are also available and relate directly to the vehicle or other piece of equipment producing the emission (source categories data is not available pre-1991)

TSGB 2004 low fuel price scenario used (a high fuel price scenario is also available)

Surprisingly for a topic of such importance, targets for CO_2 transport emissions have not been widely developed, certainly not in a directly comparable form to the TSGB baseline data. Below we show a 60% CO_2 emissions reduction target to 2030 - for the transport sector and for end users - using a baseline of 1990. A number of comparator CO_2 targets are available, for example:

- The UK Kyoto commitment is a 12.5% reduction in six greenhouse gases below 1990 levels over the period 2008-2012
- The UK domestic target is for a 20% reduction in CO_2 emissions below 1990 levels by 2010 (DETR, 2000)
- A path towards a 60% reduction in CO_2 emissions by 2050 has also been adopted (DTI Energy White Paper, 2003) following the recommendation of the Royal Commission on Environmental Pollution (RCEP, 1994)

The business as usual (BAU) projection gives the UK transport sector annual emissions at 52 million tonnes carbon (MtC) of carbon dioxide by 2030.Our 60% reduction target seeks to reduce emissions to 15 MtC, so a reduction of 37 MtC from projected 2030 levels - see Table 3 and Figure 3.

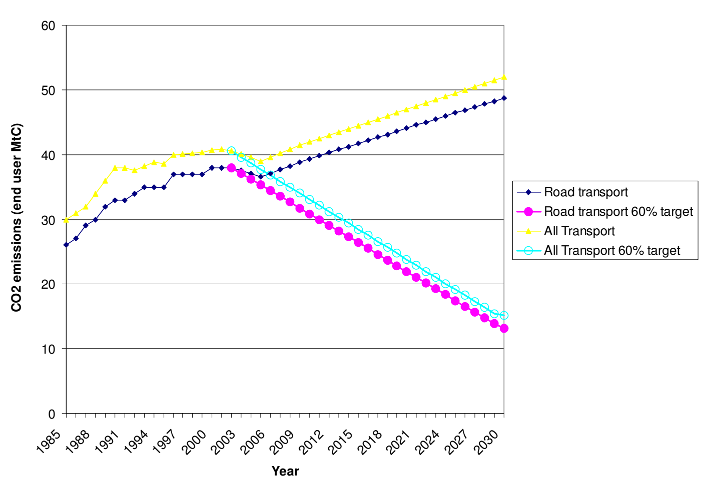
Table 3: *Carbon Dioxide Emissions 60% Target by End User in the UK*

	1985	1990	2000	2015	2030
Road transport	26	33	38	26	13
Railways	1	2	2	-	-
Civil aircraft	1	1	1	-	-
Shipping	2	2	1	-	-
All transport	30	38	41	28	15
All emissions	156	157	148	-	-

Unit: million tonnes of carbon (MtC)

- data not available/not projected

Figure 3: *Carbon Dioxide Emissions Target by End User in the UK*



The striking part of the target is the huge gap between the business as usual projection and the 60% emissions reduction target: achieving this scale of change is not likely to be easy. Further work is ongoing with DfT to ensure consistency of this baseline and target with DfT modelling outputs.

4. Towards Alternative Images of the Future

In this main section of the paper we build on the baseline and suggested target and develop two images of the future: one with a technological change focus, the second with a behavioural change focus. The construction of these images is the second step in the backcasting methodology.

4.1 Broad Socio-Economic and Technological Trends

As part of our images of the future (which are focused on transport and urban planning issues) we need to consider the role of external factors which may influence future travel behaviour, such as political, economic and demographic trends. A number of these are becoming evident:

- The globalisation of the world's economy will continue, with more, longer distance travel required for the movement of goods, services and people (for meetings). But changes in the nature of work (from manufacturing to service and information) and the components of the labour force (more women and part time labour) may reduce travel frequency as work patterns become more flexible, with some substitution (home working) and longer distances (extended commuting areas).

- Globally, production is likely to become ever more dispersed, as firms relocate plants to low labour cost economies, provided that the necessary skills are available. Agglomeration economies and clustering of related businesses will continue, with shorter supply chains to balance the global relocation of manufacturing and services. Trends in longer distance travel will continue, but they will also be mitigated by some compensatory shorter distance travel, more remote working and the need for face to face contact.

- The 24-hour economy will reinforce these trends as continuous activity (through shift working) takes place within countries and as global markets take advantage of the time differences to remain in operation throughout the day and night. New production methods will be required to permit full advantage to be taken of these opportunities, through networking, outsourcing, flexible specialisation, and the customisation of products. These changes reflect the decoupling of space (as opposed to the more common decoupling of the economy), but it still accepts the importance of space as there are arguments for both dispersal and agglomeration.

- Over the thirty year time horizon, it is expected that the UK economy will grow at between 2-3% per annum in line with Treasury projections (DfT, 2005), resulting in a total percentage increase of about 100% (an average of 2.4% p.a. for 2000-2030). The population will also change as the expected total increase amounts by about 9% (2000-2030), and there will be an increase in the median age of the population. Projections suggest that the number of people aged 65 and over will exceed the numbers aged under 16 by 2014 (Social Trends, ONS 2004). These underlying trends mean that income levels will increase substantially over this period, and that leisure time will also increase (at least for the retired), even though the retirement age may also be raised as participation in paid work continues beyond the age of 65.

- Generally, the trend towards individualism, changes in lifestyles and consumer preferences will all continue, as the growing need for instant satisfaction (through consumption and participation) continues. But there is also a heightened concern over the quality of the environment, both in terms of global climate change issues (and CO_2 emissions) and the local environment.

Less certain are the trends in technology. The assumption is made in the VIBAT images of the future that there will be no “new” replacement technology in transport by 2030, only an implementation of current known technologies. Common usage of new technologies is certainly not likely to occur by 2030, due to cost, knowledge and diffusion constraints. This means that the hydrogen solution will not be available within the transport sector by 2030. However, technology will be available to reduce some of the projected CO_2 emissions and advances will contribute substantially to the images through further increases in the efficiency of existing technologies (e.g. the internal combustion engine), the use of electric and hybrid technologies, and the use of alternative fuels (for example gas, biofuels and renewables).

In addition, there is a considerable role that information and communications technologies (ICT) can play in improving the technological performance of vehicles, increasing the capacity and efficiency of the transport system, and in providing alternative means to carry out activities. ICT plays an instrumental role in traffic and transport management systems, travel information and reservation systems, route guidance systems, smartcards, and many other applications. Dematerialisation, eco-efficient technologies and advances in new materials (particularly plastics and polymers), combined with the trend towards miniaturisation (including smartdust technologies), have considerable potential to reduce traffic and freight volumes and weight.

It is also very likely that over the 30 year period (to 2030) mobile services (mainly provided through the phone) will become far more sophisticated and ubiquitous, as real time information will be available on all transport services, smartcard transactions will be used for bookings and through tickets, as well as the increased provision of video links and messaging services. The constraints on use would include costs (which are probably low), and the acceptance, competencies and skills required to use the new ICT. New intuitive interfaces are required. More generally, the role of ICT in society needs to be more rigorously considered, together with its potential to substitute for (or enhance) existing patterns of mobility.

A difficulty remains as to the assumptions to be made on world oil prices. The DTI's long term forecast for 2010 is $23 a barrel (2003 prices) in real terms, increasing to nearly $28 a barrel by 2025. Prices are however already over $60 a barrel, and it seems likely that they will remain high for at least the next few years as demand has grown at a substantially higher rate than supply. World oil prices are likely to be very influential to future lifestyles. High prices reinforce the globalisation process and the switching of production to low cost economies, and also impact on global growth rates (although less than in the past), and on consumption patterns. In the images of the future, we take high oil prices as a reality and explore the implications for demand, as well as the incentive this gives to a move away from oil dependence in the transport sector. Within our images of the future we take $60 a barrel as our oil price in Image 1 and $80 a barrel in Image 2. As prices are likely to vary (most likely higher), we provide sensitivity analysis for $100 a barrel within Image 2 in the more detailed analysis in the VIBAT project.

4.2 Images of the Future

Within these broad likely future trends, we have developed two images of the future, each providing an alternative, qualitatively different future. They reflect a potential move in a certain policy direction: towards a new market economy or a new smart social policy. These are elaborated in Table 4 and in the commentary below.

Importantly we do not make a judgement in terms of the benefits or acceptability of each image of the future. They are developed purely to show a potential future policy pathway and reflect what might happen in the transport sector if current 'knowledge' in technology and behavioural change is delivered as expected.

Table 4: *Images of the Future – External Elements*

	New Market Economy	New Smart Social Policy
Key Drivers	Economic growth	Quality of life
Values	Individualism, economic efficiency	Community and social welfare, environmental quality
Globalisation	Continuous production in low cost locations	Slightly more localised production, with specialisation, clusters and agglomeration
Economic Growth	+2.5% pa = +110% (2000-2030)	+2.2% pa = +92% (2000-2030)
Population Change	+9%	+9%
Role of ICT	High levels of take up and maximum use by individuals	Substantial take up, but concerns over those unable to use the technology (affordability and knowledge)
World Oil Prices	$60 a barrel in 2003 prices	$80/$100 a barrel in 2003 prices
Governance	Central and top down	Multi level and partly bottom up

4.2.1 A New Market Economy

Society at large - this image is driven by the economy making a successful transition to a technology-led new market society[2]. Most manufacturing is carried out overseas and the UK economy depends even more on imports, adding value through its high

[2] The scale of change involved in moving to a new technological society can be viewed in the same context as the transition to agricultural and industrial societies in the past. The late 20th Century and early to mid-21st Century mark this transition towards new patterns of work, leisure and economic activity.

knowledge base and its continued excellence in financial services. There is a ready acceptance of new technology, both in the home and the workplace, but also in transport with a keen desire to overcome the consequences of CO_2 emission increases through clean technology. This concern is not backed up by major lifestyle changes, only marginal changes using ICT to reduce the need to travel for certain activities (e.g. some use of teleconferencing and home shopping).

Global businesses are still powerful players in determining what computer technology is available – but there is a price to pay for the latest technology. The market is oligopolistic[3] where the main manufacturers continue to develop competing proprietary standards to lock in their customers. Often basic hardware is provided at little or no cost, but more sophisticated applications have a high price attached to them. Intervention by government is at a low level, as there is a strong preference for market forces to operate. Increasingly concerns are apparent over the power exerted by some large multi-national companies - with market valuations in excess of many smaller and medium-sized national economies - and in the high levels of world oil prices, carbon dependency and future oil shortages.

Transport policy – the main aim of transport policy is to achieve the required CO_2 emissions target with a minimum of change in terms of behaviour. Car traffic still grows and dominates in terms of modal share, with trip lengths increasing and occupancy levels remaining about the same as in 2000. The main changes are in pushing hard on alternative fuels and hybrid technologies so that the overall average emissions profile of the total car stock reduces to 90 gCO_2/km in 2030 (down from 171 gCO_2/km for the new car fleet in 2004). This is achieved through the phasing in of the hybrid technology over the next 25 years so that by 2030 all new vehicles are hybrid. There is also considerable investment in alternative fuels to reduce the carbon content of existing ICEs and the non-electric parts of hybrids. Niche electric vehicles also have a limited role for low speed vehicles in cities, provided that their source of energy is renewable. The cost of fuels rises overall by 20%, but this increase falls increasingly on those car users that continue to consume fossil fuels. As with all vehicles, lean burn

[3] Economic conditions where there are so few suppliers of a particular product that one supplier's actions can have a significant impact on prices and on its competitors.

ICEs also reduce the fuel needs per km and so the real costs of motoring do not increase by as much as 20%. New materials will be used to make vehicles lighter (-25% from 2000 levels).

To complement these measures, technology is used to ensure maximum efficiency in engine monitoring systems, in route and parking guidance, and in ensuring that vehicles are used efficiently, through measures such as car sharing and demand responsive public transport and taxi services. Freight distance remains constant, but contributions to the CO_2 reduction target are met through load consolidation and the use of smart freight matching services to reduce empty running. Hybrid technology is used for distribution vehicles so that their emissions are halved (LGVs have 2 times the CO_2 emissions of a 1993 pre cat car), and HGV emissions levels are also halved (HGVs have 6 times the CO_2 emissions of a 1993 pre cat car). An issue here for debate is the continued use of diesel in urban areas (and elsewhere) as it has benefits in terms of less CO_2 emissions, but costs more in terms of increased emissions of other pollutants.

Domestic air travel is an increasing producer of CO_2 (in 2000 emissions = 1.38m tonnes of CO_2), and this is expected to increase by 31% to 1.81 m tonnes of CO_2 by 2030. It seems that there are less options for substantial increases in fuel efficiency in the air sector, so savings will be made through the use of larger planes (with less CO_2 emissions per passenger) and higher load factors to reduce the BAU levels to 1.60 m tonnes of CO_2 (+16% from 2000 levels).

The technological measures therefore concentrate on a very heavy promotion of technological alternatives through a restructuring of the car fleet, through the use of new renewable fuels, and the encouragement of more efficient ICEs, coupled with an extensive use of technology in transport to ensure that the system is working at its maximum efficiency. This means that measures to increase load factors and reduce empty running are very important in both the passenger and freight sectors.

Although behavioural change is also acknowledged as being important, the general view is that little change is required, apart from clear pricing signals to encourage less fuel consumption and a switch to cleaner technologies. Public transport use increases, in particular for long distance travel (by High Speed Train) and air, as leisure-based lifestyles increase and as global networks expand. Cities continue to expand at low densities (at 30 dph and below) with continued modest use of planning controls to locate development in public transport accessible locations, and there is only be a token use of soft measures to raise awareness and involve individuals and firms in travel plans. The main changes here again relate to the use of technology to allow greater flexibility in the use of time and location for work, shopping and other activities.

Congestion will increase, as there is a growth in traffic but not a corresponding growth in the provision of road space. A national system of road charging is introduced in the major cities and on the motorway network, mainly to reallocate the current costs of motoring to take account of the amount and time of use of the road system. This is not a revenue raising pricing system. The technology is used to regulate speed within urban areas and on the motorways in a demand responsive way and in accordance with the desired use of road space.

This means that priority is given to particular users at specific times of the day outside schools, in town centres and shopping areas, and in residential locations within cities. On the main roads priority is given to clean (including hybrid) vehicles, those with high load factors (passenger and freight), and other priority users (e.g. public transport). Parking control is privately controlled with charges being made for all forms of parking (including commercial and residential), linked to the number of spaces, their function and location.

The new market economy approach argues for pricing of all space and for the use of that space. This means that the costs of travel (including parking) are substantially raised over this period to help achieve the 60% CO_2 emissions reduction target. The economy also grows and levels of income rise, but the proportion of expendable income allocated to transport (and indirectly to the price of goods in shops) rises to around 25%. This means that pricing is the main mechanism to achieving behavioural change, and if the behavioural measures taken are not sufficient to reach the 33% target, then further price rises are necessary. It should be noted that the price increases are designed to make people and firms create less CO_2, not less travel, so incentives are present to encourage switching to clean technology, and to using the technology in creative ways to reduce levels of CO_2 pollution. In all cases the prices are substantially higher if your vehicle is producing higher levels of CO_2. Table 5 summarises the changes envisaged in the new market economy image of the future.

Table 5: *Characteristics of the Transport Sector in Image 1 (New Market Economy)*

Indicator or Measure	Characteristics of Change
Headline indicators	
Transport CO_2 emissions	▪ 15 MtC for all transport in the UK by 2030
Personal travel	▪ Total mobility is higher than in 2000, higher than the behavioural change image for 2030. People are not willing to dramatically change their travel behaviour, hence all trip type volumes increase (commuting, shopping and leisure travel) ▪ Billion person km by car = + 35% and trip lengths = +10% on 1990 levels ▪ Average distance per person p.a. by car = +35% ▪ More internal air travel ▪ Working hours become more flexible
Car Ownership	▪ Car ownership increases from 2000 levels, car-based lifestyles, saturation of ownership ▪ Car stock = + 70% and cars per person = +50% ▪ Occupancy levels show some improvements on 2000 levels ▪ Lock in to car dependency
Freight travel	▪ Centralized production, long supply chains, companies organised around synergistic constellations of core competencies ▪ High volumes of goods are transported over long distances, freight centres for intermodal distribution at periphery of cities ▪ Freight travel remain road dominated, but with focus on new vehicle technologies and higher load factors ▪ Lock in – oligopolies, proprietary standards; specialisation – key high value markets ▪ Extensive use of IT, logistics planning and new management strategies
Incomes and GDP	▪ Substantially higher incomes = 110% ▪ Similar increase in GDP (+2.5% p.a.)
Technological change	
Vehicle technology	▪ Hybrids market uptake for all new vehicles = 2010 (10%), 2020 (50%), 2030 (100%). Strong shift to hybrids reduces emissions impact of increase in travel ▪ Niche marketing of cars, global production ▪ All purpose cars are dominant, mainly hybrid vehicles or fuel cells ▪ Battery cars become niche market vehicles ▪ Cars are 25% lighter than at present
Vehicle fuels	▪ Efficiency gains in vehicles mean that fuel consumption = -40% ▪ Fuel prices = +20% (real terms) ▪ Average CO_2 emissions for total car fleet = 90 g/km
Use of new technology	▪ Car sharing and mobile technologies are prevalent ▪ Matching for work and social activities ▪ Public transport and taxi is demand responsive

	▪ White vans and distribution of goods, tracking and tracing, alarm systems
Technological sub-total	67% of emissions reduction target achievement by 2030
Behavioural change	
Personal travel behaviour	▪ Limited mode shift to public transport, cycling and walking, increased car dependent lifestyles ▪ Domestic air travel grows in line with global economy, but with larger more fuel efficient planes and higher load factors ▪ Business travel by air and high speed train (HST) is popular, leisure travel by air and car grows rapidly
Land use planning	▪ Little strategic thought behind integration of land use planning and transport, continued urban sprawl ▪ Minimal increase of densities around public transport nodes; urban design and transport planning remain un-coordinated ▪ Some roadspace reallocation, priority to public transport, pedestrianisation, parking supply issues not well resolved
Soft factors	▪ Limited use of green travel plans and safe routes to school; low take up of car clubs and car sharing ▪ Telecottaging, telecentres, flexible working and teleshopping remain fringe activities
Wider traffic demand management measures	▪ Congestion charging in major cities, and a national scheme to cover road pricing on the motorways. Parking controls and market pricing for all uses related to commercial and residential activities
Traffic management	▪ Higher speed limits introduced, but with variable speed technology ▪ Few area-wide traffic calming schemes introduced in the UK
Behavioural sub-total	33% of emissions reduction target achievement by 2030
Grand total for Image 1	Full 60% emissions reduction target achieved by 2030

NB. All % changes refer to the period 1990-2030

4.2.2 Smart Social Policy

Society at large - this image is also market driven, but has a much stronger social and environmental emphasis, is focused on improving quality of life, and the transition to the technological society is moderated by greater social intervention. The UK economy still has some manufacturing capability through its knowledge-based economy, producing specialist products for hi-tech businesses. Its role as a financial centre is still substantial, but it has lost out to the growing importance of the European Centres (Frankfurt, Paris and Milan), which form the Eurocore financial cities. Although there is an acceptance of the importance of the technological revolution that has taken place, there is a strong social and environmental policy imperative as the basis for policy. It is accepted that behavioural change is the essential basis needed to address the required CO_2 emissions targets, however technology can help to a certain extent. The UK takes the lead in moving towards less CO_2 intensive lifestyles, through a combination of strategies including a strong contribution from the transport sector. This includes changes to individual travel patterns and the transport element in the goods and services consumed. Supply chain lengths are, for example, targeted for reduction. Excellence in the social, environmental and quality of life spheres leads to economic competitive advantage in the UK.

Global businesses adapt to the changing environment with more local production. The priorities are still in efficient production, but not necessarily in the lowest cost locations, as consumers are prepared to pay slightly more for goods that are produced locally and that have a lower transport cost associated with them. One key to this change is the use of the "open source" (OS) culture for the provision of public goods and information. One current example here is the use of OS in computing, where the operating system Linux allows users to develop the system through their own software enhancements. Another example is the Ebay or Amazon concept that allows trading between individuals in a bidding system that is based on mutual trust in terms of what is offered and the mechanism for payment and delivery.

Such a system allows OS communities to develop that have supportive policies to encourage a commitment to common goals such as social cohesion, environmental quality and human rights. Intervention by government is at a higher level as social welfare objectives are perceived as important, as are the means to ensure that all members of society are included within the technological society. High oil prices are seen as a benefit and one incentive by which the transport sector can switch from high carbon dependency to a lower carbon dependency.

Transport policy – the expectation in this image is that there will be a slight reduction in the total amount of travel distance by each person in 2030 (-5.5% from 1990 levels), but the overall levels of travel will be higher as population will have increased by 9%. The main reduction has not taken place in the number of trips made, but in the length of trips. The distribution has changed, with some growth in long distance trips, but these are more than compensated for by the increase in shorter more local trips. The desire for less travel (and distance for freight distribution) links in with the greater social awareness of the population, and the importance of community and welfare objectives. The lock-in to car dependency (Image 1) is broken with social priorities pushing for greater use of public transport and other clean modes of transport.

There is less dependence on technological solutions, but cars become cleaner over the period (100 gCO_2/km for new cars and a total fleet level of 130 gCO_2/km in 2030) through new taxation and pricing incentives to use more efficient and cleaner technologies, with tax reductions for not owning a car or for participating in car sharing schemes. Real fuel prices increase by 40% over the period.

Most of the technological innovation is in the monitoring of vehicles according to their emissions profiles, and in implementing a national system of road pricing that is based primarily on environmental charging. The costs of motoring relates to the type of vehicle, emissions and distance travelled, with reductions for more people (or goods) carried – it does not relate to the levels of congestion. If a vehicle is trapped in congested conditions, the levels of pollution are likely to increase, thus leading to a higher charge.

Technology is used to restrict access to certain areas in the city and the countryside to maintain local air quality and tranquillity, and is used to maintain and enforce suitable environmental speeds on all roads. The desire for fast travel is moderated through extensive variable speed limits, so that travel is carried out in an optimal way environmentally – this means that maximum speeds on roads are limited to around 80 km/hr or where the engine is working in the most efficient manner.

Smart technology is used in all forms of public transport to provide full information and interactive services for seamless travel between places using a variety of interconnected transport services. Many forms of public transport are demand responsive with the facility to share trips and routes. This results in a renaissance for all forms of public transport, as their characteristics become more comparable to those of the car. In many cases it is only possible to gain access to the city centre and other facilities by public transport, as car parking is severely limited, and priority is given to public transport. All towns and cities have extensive areas set aside for pedestrians, with comprehensive cycle networks (and appropriate safe storage facilities) to encourage the substantial growth in clean travel (+26% to 2030).

Within towns and cities there is substantial investment in public transport to provide a high quality and dense service network, with competitive prices and higher vehicle occupancy levels. It is as fast to get around the city by public transport, as it is now by the car in 2005, as both the frequency and capacity of services are substantially increased. Complementary actions in planning and development permits higher densities, mixed uses and local facilities, with further encouragement of higher density residential (>40 dph and upwards) and office developments around accessible public transport nodes. Social and leisure activities naturally concentrate at these accessible interchanges, which in turn develop as shopping, leisure and social meeting places. Their functional use is complemented by high quality design and local environmental standards, as they become new city landmarks. Similar design quality issues are important in residential neighbourhoods and elsewhere, where it is made clear through design what the function and use of space is for.

Complementary policies also involve all stakeholders in the debate over priorities, as it is important that people and firms "buy into" the need to reduce CO_2 emissions. Travel plans and travel blending are all part of that process of change, as people move away from the concept of private ownership towards one that involves shared ownership. It is here that technology is not seen as the master or the solution, but something that can be used to help create a better quality transport system for all users. Hence ICT is used to reduce the need to travel through working, shopping and networking from home, but not in the sense of facilitating additional compensatory travel.

Towards 2030 issues relating to personal tradable emissions are discussed - with a view to moving towards a more stringent contraction and convergence global environmental future in the UK - with those that need to travel more buying credits from those that have spare credits from travelling less. Difficulties relating to the costs and administration of such a carbon trading scheme, and whether individuals require (or are entitled to) the same number of credits all need to be resolved in the early years 2005-2010.

There is also potential for less freight traffic through more local sourcing of production, and through companies and individuals purchasing more locally produced goods. Again, greater use is be made of the rail system to transport freight with intermodality actually reducing the total CO_2 profile of journeys. There is extensive use of load matching through internet based freight exchanges and a "spotmarket". This includes both the trunk haul section to the local distribution centres and the final 'white van' delivery to the customer.

With domestic air travel, the expected business as usual growth does not take place as little new capacity is made available, and as long distance travel is made by HST and car hire or by bus. Prices for all forms of transport reflect their full environmental costs, and there are limited subsidies available for social reasons. The basic premise is that users of all forms of transport should pay their full environmental costs of travel.

Overall in the smart social policy image, there is less travel and journey lengths are shorter. Travel time reduction is of less importance, as speeds are related to using less energy. There is a strong shift to public transport and to the greater use of local facilities. Land use planning favours compactness (or polynuclear urban form), public transport orientated development patterns with mixed use and high quality local environments. Traffic demand management is accepted by the public as being necessary to achieve environmental targets, and is perceived as helping to reduce the impact of the car and improve the quality of life in cities. Available road space is allocated to priority users by time of day and urban planning is fully participatory. Table 6 summarises the changes envisaged in the smart social policy image of the future.

Table 6: *Characteristics of the Transport Sector in Image 2 (Smart Social Policy)*

Indicator or Measure	Characteristics of Change
Headline indicators	
Transport CO_2 emissions	▪ 15 MtC for all transport in the UK by 2030
Personal travel	▪ Total mobility is the less than in 1990. People recognise environmental concerns and change their travel behaviour ▪ Billion person km = -5.5% and trip lengths = -10% on 1990 levels ▪ Average distance per person p.a. = small reduction, but increases overall due to population growth ▪ Long distance internal travel mainly by High Speed Train (HST) ▪ Individuals move away from single mobility to multi-mobility use (from one mode to many modes) ▪ Working hours become more flexible
Car Ownership	▪ Car ownership remains stable ▪ Occupancy levels in all forms of transport increase ▪ Increase in rental and shared ownership

	▪ End of lock in to car dependency
Freight travel	▪ Regionalised production, shorter supply chains, glocalisation with regional and local production of goods ▪ Distribution networks more regional and local, public transport bias ▪ Extensive use of IT, logistics planning and new management strategies, load matching and intermodality ▪ Internet-based freight exchanges, spot markets for load matching, load factors increase
Incomes and GDP	▪ Incomes substantially increased = +90% ▪ Some increase in GDP (+2.2% p.a.), but increased focus on improving quality of life
Technological change	
Vehicle technology	▪ Niche marketing of cars remains marginal ▪ Less use of light materials in cars ▪ Low speed city vehicles and use of renewable energy
Vehicle fuels	▪ Efficiency gains in vehicles mean that fuel consumption = -20% ▪ Fuel prices = +40% (in real terms) ▪ Average CO_2 emissions = 130 g/km
Use of new technology	▪ Car sharing and mobile technologies ▪ Matching for work and social activities ▪ Public transport and taxi are demand responsive ▪ Smart public transport – rail, bus, and clean taxis with seamless, smart payment and information systems
Technological sub-total	25% of emissions reduction target achievement by 2030
Behavioural change	
Personal travel behaviour	▪ Mode shift to public transport, cycling and walking ▪ Increased investment in public transport, e.g. new LRT schemes ▪ Public transport is competitive in price ▪ Higher vehicle occupancies ▪ Internal air travel growth is slower ▪ Personal tradable emissions quotas
Land use planning	▪ Smart growth, public transport orientated development, concentration of development in cities and urban areas ▪ Increased densities around public transport nodes, mixed uses. Urban mobility centres (highly accessible meeting places at interchanges) ▪ Development and transport generation profiles matched with accessibility profiles ▪ High quality in urban design ensuring improved quality of life in cities, for all age groups ▪ Less space for cars in cities: roadspace reallocation, priority to public transport,

	pedestrianisation, shared space, traffic calming, limited car parking provision
Soft factors	▪ Social acceptance of demand management ▪ Participatory approaches, information, debate and labelling ▪ Green travel plans and safe routes to school widely used ▪ Niche vehicle usage, car clubs and car sharing ▪ Rail and rental car is a popular combination ▪ Use of telecottaging, telecentres, flexible working and teleshopping, telephone and video conferencing widespread
Wider traffic demand management measures	▪ National system of road pricing, strong public and political support ▪ Bus priority on main roads and motorways
Traffic management	▪ Lower speed limits ▪ Area-wide traffic calming ▪ Eco-driving widespread
Behavioural sub-total	75% of emissions reduction target achievement by 2030
Grand total for Image 1	Full 60% emissions reduction target achieved by 2030

NB. All % changes refer to the period 1990-2030

5. Key Travel Statistics

Our potential images of the future are likely to impact on future travel in differing ways. Table 7 shows what this might mean in terms of an easily identified travel indicator: average kilometres travelled.

Table 7: *Key Travel Statistics – Average Kilometres (Per Person Per Year)*

Mode of Travel	1990		Image 1 2030 New Market Economy		Image 2 2030 Smart Social Policy		2030 Business as Usual	
Car	8,000	76%	11,000	81%	7,000	70%	11,900	82%
Rail	560	5%	560	4%	900	9%	500	3%
Walk and Cycle	380	4%	380	3%	480	5%	360	2%
Bus	880	8%	800	6%	890	9%	680	5%
Air	730	7%	910	7%	730	7%	1,060	7%
Total	10,550	100%	13,650	100%	10,000	100%	14,500	100%

Notes: Estimated travel growth for the Business as Usual is +37%, whilst the level for Image 1 is +29% and for Image 2 is -5%; Account has been taken of the 9% growth in population over this period (1990-2030).

Under Image 1 car km and mode share increase, but not to the same extent as under business as usual. Image 2 provides less car dependency, in terms of car km and mode share, with an increase in rail usage and walking and cycling (Note: further work is being carried out to develop a more detailed travel behaviour profile for each image of the future).

6. Conclusions: Learning to Think Differently

Albert Einstein said "*If, at first, the idea is not absurd, then there is no hope for it*" and also that "*We can't solve problems by using the same kind of thinking we used when we created them*". These thoughts very clearly apply to the difficulty with current rising transport emissions and divergent global environmental targets: firstly the level of change required in the transport sector is huge (and will be perceived by many as unattainable); and secondly to provide a vision of where we would like to be in the future we need to develop different problem-solving techniques to those traditionally used.

On the empirical side, traditional forecasting studies are unlikely to help us in achieving a future that breaks current trends; the backcasting approach is however one that is ideally suited to examining futures that are trend-breaking in nature. Much more research needs to be carried out of this type in the transport field.

In practical terms, what is eminently clear is that a business as usual approach, or limited variations around this, will not deliver the low carbon future we aspire to. Urban and transport planners need to think much more imaginatively about the future if the global emissions problem is to be tackled. Collectively we need to raise our game; we cannot be content with current trends continuing as they are at present. Very significant changes in technology and behaviour are likely to be required in the next 30 years.

We should bear in mind that a 60% CO_2 emissions reduction target is hugely ambitious; there is certainly no guarantee that such a level of change is achievable. However it does signify the likely scale of change required to achieve a more sustainable future. To give an idea as to the scale of the target in relation to global warming stabilisation levels - we perceive our 60% CO_2 emissions reduction target in the transport sector as providing a likely contribution [only] to a 550 ppm CO_2 concentration future by 2030, dependent obviously on what other sectors achieve.

The working is as follows:

- Current total CO_2 emissions in the UK are around 150 MtC (which equates to around 2.5 tC per capita[4]).

- Per capita total annual carbon emissions need to reduce to around 0.3 tC per capita (to meet a global stabilisation level of 450 ppm) or 0.7 tC per capita (for 550 ppm) to meet globally equitable emission shares under a contraction and convergence future.

- Our 60% reduction target seeks to reduce transport emissions to 15 MtC (equating to 0.25 tC per capita): hence 36% of total CO_2 target emissions for a globally equitable 550 ppm future, or 83% of a 450 ppm future.

- With other sectors - such as power stations, domestic, industrial and commercial - still likely to be carbon emitters in 2030, it looks like even a 60% reduction in the transport sector is not likely to be enough to contribute to a 450 ppm contraction and convergence vision.

The UK Government's pathway towards a 60% reduction in emissions is of course a little less demanding. By 2050 we are looking for emissions of around 1 tC per capita. Our 60% target in the transport sector (0.25 tC per capita) would make up a quarter of allowable per capita emissions.

Whatever the target, huge change is required in the future: Houghton (2004) suggests atmospheric concentrations of 450 ppm are more acceptable than 550 ppm, especially when taking into account feedback effect problems. The Global Commons Institute (2001) suggest even lower levels should be sought, down to 350 ppm.

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[4] Using a UK population of 60 million. Hillman and Fawcett (2004) note that, in terms of annual emissions of carbon dioxide per capita, the world average in 2000 was just over one tonne carbon per capita (1tC per capita), but varied dramatically country by country. For the UK emissions were at an average of 2.5tC per capita, in the US they are 5.5tC per capita, developed countries and transitional economy countries an average of around 2.8tC per capita. The developing nations contribute much less: China's emissions average 0.6tC per capita, India 0.3 tC per capita. Afghanistan is currently the bottom of the emissions league at 0.01tC per capita.

Our 60% target - although hugely ambitious - may therefore need to be revised upwards if CO_2 emissions are not radically reduced in other sectors. Global contraction and convergence in particular is a very demanding objective for the UK.

At this stage it might be worth taking a reality check. Remember that traffic growth has risen by 77% from 1982-2002: behavioural change, favoured by many urban planners and environmentalists, is likely to be very difficult to engender. Technological change, favoured by much of the motor industry, is also likely to be difficult to implement on a mass market scale. The much-vaunted hydrogen option is, if at all, only likely to appear post-2030. Hybrid cars are the main alternative.

We should remember however that CO_2 emissions vary hugely between vehicles: the Toyota Prius emits 104 gCO_2/km; the current fleet average in 2004 in the UK is 183.8 gCO_2/km (and the new fleet averages 171.4 gCO_2/km). A Bentley (Arnage R) emits a whopping 495 gCO_2/km, a Porsche (Cayenne S) 380 gCO_2/km, a BMW (3-series E46) 229 gCO_2/km; and even the more utilitarian Skoda (Octavia 1.6) 184 gCO_2/km, Vauxhall (Astra 1.6) 182 gCO_2/km; and Ford (Focus 1.6) 161 gCO_2/km. The supposed sustainable sports utility vehicle the Lexus (RX400h) still emits 192 gCO_2/km. Hence to move all fleet average emissions towards the standards of the Prius will mean that every day car usage in the future ideally is not made in the highly sought after vehicles. Even the supposed technological 'silver bullet' requires change to individual behaviour and individual choice – the Prius in 2004 has sold under 2,000 vehicles (and is priced at over £17,000). The car stock is 20 million. There is a long way to go in terms of cultural change.

Added to this are the fundamental changes occurring to society – in terms of ICT developments, globalisation and the 24-hour economy. How we deal with these trends and how we shape our future will help define whether we get near to achieving sustainable development. The challenge is thus huge: the level of technological and behavioural change required is quite unprecedented. The remaining work on the VIBAT project attempts to relate the likely scale of change involved in our two alternative images of the future to actual carbon emissions and also to define a potential implementation strategy, using likely policy packages and pathways back from the future.

Researchers, urban and transport planners and others are thus provided with a unique opportunity to challenge existing conventional wisdom and to define and develop radical trend-breaking futures. The window of opportunity is however closing – atmospheric concentrations of CO_2 are currently at 370 ppm, and rising by 2 ppm per annum.

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References

Banister, D. (1998) Transport Policy and the Environment. London: Spon.

Banister, D. and Marshall, S. (2000) Encouraging Transport Alternatives: Good Practice in Reducing Travel. London: The Stationary Office.

Banister, D. and Stead, D. (2004) The Impact of ICT on Transport, in Transport Reviews, Vol. 24 (5), pp. 611-632.

Banister, D., Stead, D., Steen, P., Åkerman, J., Dreborg, K., Nijkamp, P. and Schleicher-Tappeser, R. (2000). European Transport Policy and Sustainable Mobility. London: Spon.

Bristow, A., Pridmore, A., Tight, M., May, T., Berkhout, F., Harris, M. (2004) How Can We Reduce Carbon Emissions from Transport? Tyndall Centre. Technical Report 15.

Cairns, S. et al (2004) Smarter Choices: Changing the Way We Travel. London: Stationary Office.

DETR (2000) Climate Change. The UK Programme. London: HMSO.

DfT (2004) Travel Trends. London: Stationary Office.

DfT (2004) Transport Statistics Great Britain. London: Stationary Office.

DfT (2005) Annex to the Transport White Paper

DfT, DTI and DEFRA (2004) Powering Future Vehicles. The Government Strategy, Second Annual Report, London.

DTI (2003) Energy White Paper, Paper 68. London: Stationary Office.

Dreborg, K. H. (1996) Essence of Backcasting, Futures, Vol. 28, No.9, pp. 813-828.

Fergusson, M., Skinner, I., Kroger, K., Kelly, C. and Bristow, A. (2003) Critical Issues in Decarbonising Transport. Tyndall Centre.

Global Commons Institute (2002) The Detailed Ideas and Algorithms Behind Contraction and Convergence. Global Common Institute.

Hickman, R. and Banister, D. (2005) Reducing Travel by Design, in Williams, K. (Ed) Sustainable Planning, Urban Form and Sustainable Transport, Ashgate.

Hillman, M. and Fawcett, T. (2004) How We Can Save the Planet. London: Penguin.

Houghton, J. (2004) Global Warming: The Complete Briefing. Cambridge University Press.

Hughes, P. (1993) Personal Transport and the Greenhouse Effect. London: Earthscan.

Intergovernmental Panel on Climate Change (2001) Climate Change: The Scientific Basis, at www.ipcc.ch

International Energy Agency (2004) Energy Technologies for a Sustainable Future. IEA.

Newman, P.W.G. and Kenworthy, J.R. (1999) Sustainability and Cities: Overcoming Automobile Dependence. California: Island Press.

OECD (2000) EST! Environmentally Sustainable Transport. Futures, Strategies and Best Practice. Synthesis Report. OECD, Paris.

OECD (2002) Policy Instruments for Achieving EST. OECD, Paris.

Office for National Statistics (2004) Social Trends 34. London: Stationary Office.

Robinson (1982) Energy Backcasting: A Proposed Method of Policy Analysis, Energy Policy Vol. 10, No.4, pp. 337-344.

Robinson (1990) Futures Under Glass: A Recipe for People Who Hate to Predict, Futures Vol. 22, No.8, pp. 820-842.

Royal Commission on Environmental Pollution (1994) Transport and the Environment, 18th Report. Cm 2674. London: HMSO.

Royal Commission on Environmental Pollution (1997) Transport and the Environment - Developments since 1994, 20th Report. Cm 3752. London: The Stationery Office.