CARS AND THE ENVIRONMENT

A POLICY PAPER

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CHAIRMAN'S PREFACE

The Scottish Consumer Council (SCC) has been closely involved with transport policy throughout its 21 years. We have covered issues including ferry services, bus deregulation, getting to school by bus and, most recently, travelling on public transport with babies and children. This policy paper continues the SCC's interest in transport issues, and focuses on the impacts of transport on the environment. The particular problems faced by those living in rural areas are addressed in a companion policy paper published by the SCC Sustainable transport policy and people living in rural areas (Farrington, Collins and Coole, 1996).

Although some of us may be able to get around on foot, most of us depend on transport in some form or another to go about our daily lives. Being able to travel to use services or pursue various activities plays an important part in determining our standard of living and quality of life. Many of us rely on our cars to get around and are reluctant to give them up. Even when public transport provides another means of travel the car is usually the preferred option.

In 1994 the Royal Commission on Environmental Pollution published its report Transport and the Environment which examined the impact of all forms of transport on the environment. The Commission's Chairman acknowledged when summarising their findings that the forecast increase in traffic over the next 30 years could not be accommodated in a sustainable transport policy. This paper reviews the RCEP report and looks at alternative fuels and vehicle designs and examines the sustainable transport policy options that have been proposed.

In the light of the RCEP's report and the government's Green Paper Transport: the way forward, SCC is concerned that all the implications for consumers are fully explored. Many of the issues involved are discussed in this paper and I hope that you will find it a valuable contribution to the debate.

Deirdre Hutton
CHAIRMAN
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CHAPTER 1  BACKGROUN D

1.1 Introduction

The Royal Commission on Environmental Pollution (RCEP) published, in October 1994, its eighteenth report for the government, summarising the results of a two year study on the effects of all forms of transport on the environment. The study placed specific emphasis on private cars, public buses and freight transport. The Commission, which is seventeen members strong, includes ten of the nation's leading scientists and is chaired by Sir John Houghton (a member of the Intergovernmental Panel on Climate Change and a leading expert on the problems associated with enhanced global warming). Evidence was given to the Commission by a large number of individuals and bodies associated with or interested in transport. These ranged from epidemiologists and toxicologists to local authorities, government departments and car manufacturers. As a result of the data gathered, the RCEP made 110 recommendations, for government consideration, on how current transport policy and thinking might be changed. Summarising the findings of its study, Sir John said that, although the Commission was neither anti-car nor anti-lorry, the growth in traffic which has been forecast for the next thirty year period in Britain cannot be accommodated in a sustainable transport policy. One of the apparently hardest hitting recommendations made was that petrol prices should be incrementally raised to effect a doubling of its price, relative to other goods, by the year 2005. Concern has been expressed about the potential effects of this recommendation in particular, and about possible measures designed to increase the cost of car use, while recognising the environmental objectives.

This background paper reviews the RCEP report and its recommendations, explores and evaluates the possible alternatives in vehicle design and fuels, and assesses the sustainable transport policy options under consideration. A separate report focuses on issues relating to the effects of increased costs of car ownership and use on rural households in Scotland (Farrington, Collins and Coole, Sustainable transport policy and people living in rural areas, 1996).

Chapter 2 reviews the RCEP report, focusing on the most important recommendations for the average car owner/user, and a range of recent sources on UK transport, in order to provide an up-to-date picture for an understanding of the impact on the environment and on health. A brief discussion of sustainability issues is also included.

Chapter 3 outlines recent trends in relation to transport, and some of their implications, with particular reference to the UK.

Chapter 4 explores and evaluates the possible role of alternative vehicles and fuels for a more sustainable future, including a review of relevant international experience.

Chapter 5 assesses the policy options being considered, especially those designed to affect car use, and examines the potential options for reducing the environmental impact of transport, as well as some safety implications.

Chapter 6 draws brief conclusions relevant to the remit of the policy paper and makes a number of recommendations.
CHAPTER 2  THE RCEP REPORT TRANSPORT AND THE ENVIRONMENT

2.1 The definition of sustainability in the context of transport

The remit of the RCEP in terms of transport was to assess the sustainability of the UK's transport sector. Sustainability or sustainable development are terms which are now increasingly being used as general indications of environmental well being. These were first popularised as concepts after the publication of the 1987 report of the World Commission on Environment and Development (WCED), Our Common Future. The WCED's chairman, Gro Harlem Brundtland, defined the concept of sustainable development as development which meets the needs of the present generation without impacting on the ability of future generations to meet their own needs.

What does sustainability mean in the context of transport? The government's Sustainable Development Strategy (January 1994) stated that a sustainable transport policy would:

- strike the correct balance between the ability of transport to serve economic development and the ability to protect the environment and sustain future quality of life;
- provide for economic and social needs for access while reducing the need for travel;
- take measures to reduce the environmental impact of transport, and influence the rate of traffic growth; and
- ensure that users pay the full social and environmental costs of their transport decisions, so improving the overall efficiency of those decisions for the economy as a whole and bringing environmental benefits.

The RCEP, in addition, defined eight objectives which it felt were necessary to provide the basis for a sustainable transport policy for the UK into the next century.

- To ensure that an effective transport policy at all levels of government is integrated with land use policy and gives priority to minimising the need for transport and increasing the proportion of trips made by environmentally less damaging modes.
- To achieve standards of air quality that will prevent damage to human health and the environment.
- To improve the quality of life, particularly in towns and cities, by reducing the dominance of cars and lorries and providing alternative means of access.
- To increase the proportion of personal travel and freight transport by environmentally less damaging modes and to make the best use of existing infrastructure.
• To halt any loss of land to transport infrastructure in areas of conservation, cultural, scenic or amenity value unless the use of the land for that purpose has been shown to be the best practicable environmental option.

• To reduce carbon dioxide (CO₂) emissions from transport.

• To reduce substantially the demands which transport infrastructure and the vehicle industry place on non-renewable materials; and

• To reduce the noise nuisance from transport.

These are significant aims in the current efforts to move towards sustainability in human activities. However, there are two important points to bear in mind when sustainability is being put forward as a goal.

Firstly, it is not always clear what the thresholds of sustainability are. For example, there is little doubt that oil and gas reserves are finite, although new discoveries continue to advance their exhaustion date. At some time they will be exhausted, so that all mobility based on their use is unsustainable in the long term. In another transport context, traffic congestion itself may be argued to be sustainable; it is a nuisance, wastes time and causes frustration, but it does not give rise to unsustainable environmental impact. It can be viewed as having unsustainable characteristics, however, in terms of the increased exhaust emissions generated in congested conditions, and in terms of the response of new road construction to alleviate congestion. Thresholds present fundamental problems for the determination of what is, or is not, sustainable. On the largest scale, emissions of carbon dioxide (CO₂) are accepted as contributing to global warming. The amount of global warming which is sustainable before significant deleterious effects occur — the threshold of sustainability — is unknown, but the application of the precautionary principle (or common sense) suggests that it would be wise not to find out by pushing global systems to this point. The most useful way of viewing sustainability in many cases is not to think in absolutes, but in degrees — that is, an action or policy may be moving in a more or less sustainable direction.

Secondly, issues of sustainability are obscured by the trade-offs that are constantly made. An urban by-pass will improve the everyday environment of the urban population, but will cause environmental impact where it is built, and may well harm the everyday environment of the people living along its route. It will probably also save lives. Striking the balance of trade-offs in such a situation is notoriously difficult. Every time we use a car we are making, usually unconsciously, a trade-off between its advantages of comfort and convenience against its environmental impact (if we are aware of it), its financial costs (usually on a marginal cost basis) and its risks.

Road vehicle use, and particularly car use, has become the focus of much debate, often couched in terms of sustainability. Declaring car use on its present scale, and in its forecast future scale, to be unsustainable involves making judgements or assumptions. These may be the outcome of a thorough and well-based process, as with the RCEP report and its recommendations, but they can still be subject to valid questioning nevertheless. In particular, the methods proposed for the achievement of greater sustainability need to be analysed and assessed. One of the Commission’s intentions was to make our decision about
car use more conscious by giving strong signals about environmental impacts through pricing mechanisms, in order to affect the trade-off process.

2.2 The key recommendations made by the RCEP report Transport and the Environment

The 110 recommendations made in the RCEP report arose from the fact that the Commission defined an urgent need for the government to adopt a hard-hitting 'sustainable transport policy' to see Britain into the twenty-first century. The most important recommendations for the average road user and traveller were as follows.

- Increased fuel taxes, so that the price of petrol and diesel would be doubled, relative to other goods, by the year 2005.

- Implementation of a comprehensive set of targets to improve air quality, cut transport noise and reduce the levels of CO₂ being emitted by Britain’s road traffic in order to honour the terms of the Climate Change Convention.

- Implementation of a more stringent system of annual MOT tests, with the emissions limits used in the test tightened.

- Graduation of vehicle duty to reflect the polluting potential of vehicles.

- Introduction of a range of measures aimed at cleaning up exhausts from all combustion engine-powered vehicles, making road vehicles more fuel efficient, and the examination of appropriate alternative fuels or vehicle designs.

- Implementation of measures to reduce the level of particulates emissions (particularly PM10) from diesel-powered engines. The possibility of fitting particulate traps or catalysts after manufacture to diesel-powered vehicles to be examined.

- Examination of the effectiveness of lowered and more strictly enforced speed limits.

- Reduction of the government’s road budget by half. Road building work to be restricted to local bypasses and maintenance activities.

- Banning of unleaded super-premium petrol.

- Retention of the standard for benzene levels in air at 5ppm to be lowered to 1ppm at a later date. The case for filtering the airflow back into vehicle interiors to protect the driver and passengers (from benzene etc) should be examined and the levels of benzene allowable in petrol frozen at 1%.

- Encouragement of modes of private transport other than motor-driven — by the introduction of safer and more extensive pedestrian routes and cycleways.
• Implementation of a more comprehensive air quality monitoring programme around the UK, and an increase in the role of local authorities in setting up air quality standards, and taking steps to ensure that these are not then exceeded.

• Changes to company car policies by both the government and the companies involved.

• Use of the proceeds of any potential motorway tolling programme for the maintenance of that motorway, with the remainder being fed back into the costs of a sustainable transport policy, for example by subsidisation of the public transport system etc.

• Implementation of a programme to improve bus usage, frequency and emissions levels — by increasing the number of bus lanes, the policing of these lanes and giving priority to buses over other vehicles and at traffic lights.

• Implementation of measures to effect an increase in the percentage of freight moved by rail and water. These measures would potentially include increased taxes on lorries, restrictions on their movement in urban areas (or unsuitable areas within them), impounding of illegal operators’ vehicles, and tougher enforcement of lorry emissions limits (varying the level of duty according to the level of emissions, for example). More grants for rail and port facilities and for coastal shipping should also be made available.

• Implementation of a 56mph speed limit for all HGVs over 7.5 tonnes from 1996.

• Opposition to European Community (EC) plans to allow 44 tonne lorries on the road.

• A programme of incentives and measures to encourage a switch to natural gas as a fuel for heavy vehicles.

• Discouragement of air travel when rail is competitive. The improvement and extension of rail services (particularly inter-city) to provide cheaper, more frequent and more attractive rail travel.

• Encouragement of light railway and tram systems in towns and cities with passenger flows sufficient to make them cost-effective but which are too small for an underground rail network.

As can be seen from the above overview, many of the recommendations involve non-specific changes like the encouragement of light railways, and very few are given specific achievement targets and dates. It is the recommendations which are more specific and are based on specific targets, however, that seem to have caused most concern amongst the audience of the report. These are summarised below in Table 1.
Table 1  Some of the key targets set by the RCEP report

<table>
<thead>
<tr>
<th>Year by which target must be achieved</th>
<th>Target</th>
</tr>
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| 2000                                 | • Increase the amount of rail freight by 50%  
                                              • Increase the amount of waterborne freight by 20%  
                                              • Reduce the percentage of trips made in London by car from 50% of all trips made to 45%  
                                              • Reduce the percentage of trips made by car in other urban centres from 65% of all trips made to 60% |
| 2005                                 | • Achieve a doubling of petrol prices  
                                              • Bring air quality up to WHO guideline levels  
                                              • Increase the use of public transport to 20% of all passenger-km travelled  
                                              • Quadruple the use of bicycles in urban areas |
| 2010                                 | • Increase the proportion of freight carried by rail to 20% |
| 2020                                 | • Reduce CO₂ emissions arising from the transport sector to 80% of the 1990 level  
                                              • Reduce the percentage of trips made by car in other urban centres from 60% of all trips made there, to 50% |

(Source: RCEP, 1994)

The recommendations made by the RCEP have sparked considerable controversy as they are seen as being too conservative and non-specific by many environmental interest groups on the one hand, and as alarmist by others.
CHAPTER 3 TRANSPORT IN THE UK

In this section recent trends in UK transport, and some of their implications, are reviewed.

3.1 Recent findings in transport research in the UK

The recent report by the Standing Advisory Committee on Trunk Road Assessment (SACTRA, 1994) stated that more road building was not the solution to traffic congestion. On the contrary, it estimated that a new road generates 10% more traffic in the short term and 20% over a longer period. There is evidence, for example, that the M25 orbital road around London created 40% more traffic within the first five years of its completion. Some other relevant information and trends are summarised below.

- Road traffic is forecast to double over the next thirty years.

- The total number of passenger kilometres being travelled in Britain increased by 52% between 1970 and 1987. The number of kilometres travelled by rail increased by 6%, the number of kilometres travelled by bus or coach fell by 23%, and private car travel increased by 71%. In the same period, Britain's main and trunk road network was enlarged by only 2%.

- The level of pollutant emissions from private cars has been significantly reduced over the past few decades. The increased incidence of traffic congestion in urban centres, especially at peak or rush hours, however, has served to reverse the overall benefit, as cars are most polluting during engine idling (less than 10km per hour). Carbon monoxide levels, in particular, are increased by engine idling — 330% more released at 10km/h than at 50km/h; nitrogen oxides are also increased but by a much smaller 119%. In addition, congested conditions also result in more aggressive acceleration for very short periods, an activity which negatively impacts on fuel efficiency and increases carbon monoxide and nitrogen dioxide emissions.

- Optimum fuel efficiency is achieved when cars travel in the speed range 30 — 70km/h.

- Britons are buying cars with increasingly larger engines. In 1983, the most popular engine size was between 1,201 and 1,500cc, with 33.4% of all cars licensed in that year in the UK falling within this range. In 1992, however, the most common engine size was 1,501 to 1,800cc — with 29.3% of all UK licensed vehicles falling into this category. Some of this increase is attributed to the larger proportion of diesel-engined cars being sold with equivalent-sized cars having larger engines.

- Nearly 50% of all of the journeys completed in the UK are less than 3km in length, ie relatively easy for a healthy adult to walk or cycle.

- The trend observed in recent years in the UK of building out-of-town business and shopping centres is increasing the use of private cars.
• The government has plans to increase the duty on petrol by 5% per year above inflation over the next decade, effecting a raising of petrol prices by two thirds by the year 2005. The RCEP recommendation proposes a faster rate of increase, with a doubling by the same year.

• Transport is responsible for the production of more than one fifth of Britain’s carbon dioxide (CO₂) output (90% of which comes from road transport). In view of the predicted future increase in road traffic, this will make it very difficult for the government to achieve the targeted reductions in CO₂ emissions (a reduction to 1990 levels by the year 2000), which it agreed to under the Climate Change Convention. CO₂ is a known greenhouse gas.

• UK air quality is steadily worsening, especially over highly populated areas, for example, London and Birmingham.

• Road traffic is the main source of the pollutants carbon monoxide (CO), nitrogen oxides (NOₓ), ozone, particulates (especially from diesel fuel which emits 80% more particulates than petrol) and benzene emitted in the UK.

• There is increasing evidence linking air pollution (especially particulates and nitrogen dioxide) to increased mortality/morbidity amongst the elderly, the very young, and those with respiratory and/or cardiovascular disorders. The problems are particularly bad in the south of England, with World Health Organisation (WHO) guidelines on ozone and nitrogen dioxide levels being exceeded for three days in a row in a severe pollution episode in December 1991 in London. It is estimated that an extra 160 deaths occurred as a direct result of this episode.

• The hydrocarbons emitted during the combustion of fossil fuels in combustion engines include benzene and other proven carcinogens. It is thought that the amount of benzene in UK urban air has increased since the adoption of unleaded petrol by the majority of UK drivers.

• Drivers of private cars are continually exposed to relatively high levels of benzene and other volatile organic compounds (VOC), many of which are proven or suspected carcinogens.

• The very fine particulate matter released from exhausts, and particularly from diesel engines, has an average diameter of less than ten micrometers. These particles, designated PM₁₀, are especially likely to penetrate deep into the lungs and are also often found in association with other chemicals which are absorbed into the surface of the particles. There is growing medical evidence to indicate that this penetration results in pulmonary inflammation, raises blood coagulability, and makes the affected individual particularly susceptible to infection.

• Cyclists who commute through heavy traffic are exposed to significant levels of carbon monoxide, respirable suspended particulates, benzene, and other hydrocarbons in the course of their ride.
As travel in Britain has become cheaper, and standards of living have risen, the proportion of the average income being spent on transport and travel has increased, reflecting a faster pace of life, longer commuting distances to schools and employment, greater distances travelled for holidays and recreation and decentralisation of cities and towns.

In 1987, proven oil reserves constituted 32.5 years' consumption, in other words sufficient to bring us to 2020 at present consumption rates. In reality, it is very likely that this reserve will be enlarged before then due to oil extraction and detection, technological breakthroughs and fuel conservation programmes.

3.2 The environmental and health impacts of transport

This sub section provides an overview of the concerns about the impact of transport on public health and the environment.

3.2.1 Local impacts

Air pollution and reduced air quality

Exhaust pollutants pose a threat to the health of individuals with respiratory and/or cardiovascular abnormalities, particularly children and the elderly. Increased morbidity and mortality show that British cities are more dangerous places (especially during pollution episodes) for such people to live in. In addition, air pollution has a secondary effect on health due to eating fruit and vegetables grown close to heavy traffic flows. Research has shown that the concentrations of heavy metal ions (HMIs) on such produce can be dangerously high, and that not all of the contaminants are removed by normal washing. This effect, although not large, may be significant when added to exposure from commuting and other activities.

Traffic congestion

The average speed in London city centre is approximately 10mph, with associated longer commuting times, and increased emission levels due to engine idling, with short bursts of acceleration and deceleration. Access to city centres for non car owners may be reduced and the aesthetics of urban areas may be diminished due to noise, pollution and the visual effect of large numbers of cars.

‘Wear and tear’ on roads

Increasing quantities of materials are needed to repair the effects of the constant flow of traffic, especially very heavy vehicles, on the road network. The cost of this maintenance work draws funds away from other areas.
Noise nuisance

The constant flow of traffic in urban centres creates a significant noise disturbance, while less frequent but high-speed through traffic, especially freight vehicles, in rural areas can be particularly disturbing.

Waste management

There are increased waste management problems due to the large quantities of scrap metals from obsolete, burned-out or wrecked cars and lorries. Scrap heaps and yards are visually unattractive but if properly managed can provide an important link in the recycling chain.

Road user casualties

Considerable suffering and financial cost result from injuries to road users and fatalities. There has been a significant achievement in reducing this toll in Britain, in contrast to other European countries.

3.2.2 National impacts

Road building schemes

Past policy has accepted that overall traffic congestion will be eased by widening existing roads and building new roads and by-passes. However, these use up valuable raw materials, necessitate environmentally damaging quarrying, utilise valuable public funds and, ultimately, create greater traffic levels. Carefully selected improvements may be appropriate to remove environmental impacts from built-up areas and to improve safety.

The loss of wilderness and wildlife habitat

The expanding road network is further encroaching on the wildlife habitat of the UK, already diminished by intensive agricultural practice and sprawling residential complexes.

Wildlife roadkill

Many species of British wildlife have been unable to adapt to the expanding network of main roads around the country. The result is significant losses in the numbers of badgers, hedgehogs and many bird species. Cars account, for example, for approximately 60% of the urban foxes killed each year in the UK, while unfenced roads in south-west England alone claim about 1,000 badgers each year.

Increased car ownership

The dependence on the private car in the UK has resulted in a culture which places heavy emphasis on car ownership, giving rise to a multiple-car family society. Car ownership is essential in many rural households (see Farrington, Collins and Coole, 1996).
The running down of the public transport network

The public transport network has been run down due to reduced demand, the convenience of the private car and competition for road space. This has a particular impact on rural communities, elderly people, disabled people and parents with children who have no access to private transport. They are strongly affected by the absence or reduction of public transport systems, diminishing both their economic and social opportunities.

3.2.3 Global impacts

Exploitation of non-renewable resources

The earth’s diminishing supply of non-renewable resources has been systematically exploited — particularly oil and metals (for car manufacture).

The enhanced greenhouse effect and global climate change

Carbon dioxide, methane, nitrogen oxides and water vapour, which are all part of the earth’s atmosphere, are termed greenhouse gases, because they absorb and trap some of the thermal radiation which reaches the earth’s surface from the sun, as it is re-radiated back out into space. This effect is similar to that found in a garden greenhouse, and is thus called the greenhouse effect. It is because of these greenhouse gases that the earth enjoys a habitable temperature of 15° C, and not -6° C. Since the onset of the industrial revolution, however, the proportion of these greenhouse gases in the atmosphere has increased and the result is an effect called the enhanced greenhouse effect, where a smaller proportion of the sun’s radiation is being re-radiated back into space and the earth’s surface is therefore getting warmer.

It is estimated that CO₂ has contributed about 70% of the enhanced greenhouse effect to date; methane, about 23%; and nitrous oxide, about 7%. The problem is exacerbated by the fact that CO₂ (from the combustion of fossil fuels and other sources) is being added to the atmosphere at an estimated 7000 million tons of carbon per year and is likely to remain there for about one hundred years. Other factors, such as the loss of ozone from the atmosphere, also contribute to global climate change, and the mechanisms involved are extremely complicated.

The exact role of CO₂ in the process of climate change is uncertain and no direct cause-effect link has been verified, but the UN’s Intergovernmental Panel on Climate Change has accepted recently that the current warming is unlikely to be entirely natural in origin, and that the balance of evidence suggests a discernible human influence on global climate. The regional implications of global change are not clearly understood (Pearce, 1995).
CHAPTER 4  ALTERNATIVE VEHICLES AND FUELS FOR A SUSTAINABLE FUTURE

As part of any review of alternative policies for the transport sector in the UK, it is necessary to look at the alternatives to the standard petrol or diesel-powered car which may become available in future years, and to assess the possibility of their practical application as a means of reducing environmental impact, in order to weigh these against the price mechanisms proposed by the RCEP.

4.1 Alternative fuels

4.1.1 Compressed natural gas (CNG)

Natural gas, composed primarily of methane, is very well suited for use as a transportation fuel, after conversion to methanol, or after storage on board the vehicle as compressed natural gas or in liquefied form (LNG), followed by combustion in the engine as a gas. A particular point in favour of CNG, which is less expensive and easier to handle than LNG, is that domestic natural gas resources will last longer if used as CNG than if converted to methanol. Internal combustion engines are readily adapted to operate on CNG, with adaption after manufacture costing an estimated £500 per vehicle. It has been estimated that there were 500,000 CNG vehicles operating world-wide by the late 1980s.

The major changes required are the addition of one or more pressurised tanks for CNG storage, additional fuel lines and a gaseous fuel mixer. The main reason for converting to CNG use, apart from lower emissions levels, is the lower cost of the fuel compared to conventional petrol and diesel.

Rapid technological development is currently taking place in this area. In Britain, CNG suppliers and vehicle manufacturers have already initiated joint developments, and British Gas is establishing a national network of gas fuelling stations for motorists. In addition, there are a number of CNG-powered cars, light vans and commercial trucks operating on British roads. A larger scale experiment with CNG is being carried out in Australia. In 1994, Sydney Buses invested over $13 million in the introduction of fifty new CNG-powered buses into their fleet. The number of these buses, designed by the Swedish vehicle manufacturers Scania, will be increased to 250 over the next five years. Other countries, such as Canada, Italy and New Zealand also have sizeable fleets of CNG vehicles. The former Soviet Union announced its intention, in 1988, of converting between 500,000 and one million vehicles — mostly trucks and taxis — to CNG fuel.

CNG is seen as a viable alternative to petrol or diesel because it is a high-octane fuel which can be used at high compression ratios. It is cheaper than petrol or diesel, and world reserves are at least, at a conservative estimate, as large as those of oil. In fact, widespread conversion to CNG engines could create a welcome market for the methane collected from landfill sites, which is at present being fed into the national grid or simply burned off. The creation of a market for methane would, potentially, serve to hasten landfill gas (LFG) collection technology, leading to safer and more environmentally sensitive landfill sites. In addition, CNG has been shown to be safer than standard fuels as it is less flammable.
More importantly, the CNG-powered engine is cleaner burning, producing greatly reduced levels of particulates; it has no lead and very little sulphur; emits 50% less nitrous oxide; has no benzene and runs more quietly than currently available conventional engines.

Finally, CNG produces less CO₂ (by approximately 35%) than either petrol or diesel. When teamed with a catalytic converter the emission levels are cut even further — making it a far cleaner fuel than conventional petroleum-derived fuels. The RCEP report predicts that the net changes in greenhouse gas emissions on conversion from petrol/diesel to CNG engines would be substantial. See Table 2 for estimated changes in air pollution impacts from alternative-fuel vehicles relative to petrol vehicles.

Table 2  
Estimated change (percentages) in air pollution impacts from alternative-fuel vehicles, relative to petrol vehicles

<table>
<thead>
<tr>
<th>Fuel/Vehicle</th>
<th>Hydrocarbon</th>
<th>Carbon Monoxide</th>
<th>Nitrogen Oxide</th>
<th>Ozone</th>
<th>Sulphur Oxides</th>
<th>Particulate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>-50</td>
<td>0</td>
<td>0</td>
<td>-50</td>
<td>Lower</td>
<td>Lower</td>
</tr>
<tr>
<td>CNG, LNG</td>
<td>-60</td>
<td>?</td>
<td>0</td>
<td>-60</td>
<td>Lower</td>
<td>Lower</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>-95</td>
<td>-99</td>
<td>?</td>
<td>-100</td>
<td>Lower</td>
<td>Lower</td>
</tr>
<tr>
<td>Battery</td>
<td>-100</td>
<td>-100</td>
<td>-100</td>
<td>-100</td>
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<tr>
<td>Fuel Cell</td>
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<td>-100</td>
<td>-99</td>
<td>-100</td>
<td>-100</td>
<td>-100</td>
</tr>
</tbody>
</table>

(Source: OECD, 1993)

CNG has its drawbacks, however.

- The weight of the containers required to store the pressurised gas. A CNG fuel tank would weigh approximately two to three times more than a standard one, yet there would be, at the same time, a need to stop more frequently to refuel.

- Major changes would be needed in fuel supply processing, delivery and vehicle refuelling.

- The cost of the necessary compression equipment and the electricity costs of running the compressors.

- The loss in power suffered on conversion of the standard petrol/diesel engine to run on CNG (currently a 10% loss). It is likely, however, that technological advances will overcome this problem.

- Longer refuelling times.

- Environmental considerations. Methane, the major component of CNGs, is a more potent greenhouse gas than CO₂, making the consequences of a major spillage or explosion potentially environmentally serious.
4.1.2 Liquid petroleum gas (LPG)

LPG, consisting mainly of butane and propane, is a by-product from the extraction and refining of crude oil and natural gas processing, produced at levels of 10 to 15% of that of the amount of petroleum produced. As a result of its source, constraints on the supply of crude oil and natural gas will limit the use of LPG as a substitute for conventional fuels. The termination of flaring on oil fields could, however, rapidly increase the availability of LPG. It is currently powering an estimated four million vehicles in the Netherlands, Japan, Italy, Australia, New Zealand, Canada and the USA. When burned, LPG produces very little particulate matter or carbon monoxide, and moderate hydrocarbon emissions. The reduction in emissions associated with the use of LPG is not as great as with CNG because the hydrocarbon emissions which do occur are more photochemically reactive. One further disadvantage is that LPG tends to be less safe and more explosive than other gaseous fuels. In other words, it is very unlikely that LPG will ever replace petrol or diesel in the world's fleet of vehicles, mainly because it is non-renewable and produces emissions upon combustion.

4.1.3 Hydrogen

Clean hydrogen used as a fuel would be virtually pollution free, being the least polluting fuel which could be used in an internal combustion engine (see Table 2). In addition, it is potentially available wherever there is water and a clean source of power. It would, however, require special vehicular storage (as it is a gas), a radically redesigned engine, completely new fuel stations, and a pipeline distribution system. As a result, the technology for cleanly producing, storing and burning hydrogen is far from being commercially viable.

Hydrogen could be produced directly from fossil fuels but this source would have significant environmental implications. Thus, it is accepted that if hydrogen is to be used as a fuel, it must be produced from water. Besides the technical difficulties of this transformation, there are considerable difficulties associated with the actual use of hydrogen as a fuel. These are the result of hydrogen's very low volumetric energy density as a gas at ambient temperature and pressure. The ways of getting around this obstacle include storing it on board as a gas bound with certain metals (hydrides); as a liquid in cryogenic containers; as a highly compressed gas in ultra-high pressure vessels; or as a liquid hydride. The most likely options, however, are hydride and liquid hydrogen storage. Hydride vehicles would be limited by storage weight to a range of about 150 to 320km, whereas liquid hydrogen storage would not be much heavier than conventional petrol, but would be significantly bulkier. One of the main barriers to the use of hydrogen will continue to be its high cost, unless a cheaper method of electricity generation becomes available. It is thus unlikely that it will be cost-effective unless oil prices triple relative to their current cost.

4.1.4 Fuel cells

Many researchers believe that the development of fuel cells may be the next technological breakthrough which will lead to environmental improvements in the transport sector. The fuel cell causes hydrogen and atmospheric oxygen to react to produce electricity, which would drive an electric motor, which would in turn drive the wheels of a vehicle. Such a vehicle would combine the quieter, emission-free, low maintenance operation of electric
vehicles with the longer range and fast refuelling time of hydrogen vehicles. The resulting
fuel-cell vehicle will be lighter than hydride-powered or battery-powered vehicles, will not
suffer the difficulties of cryogenic storage or hydriding, and will not emit nitrogen oxides or
trace hydrocarbons. It is also likely that it would have a lower life-cycle cost than any purely
electric or hydrogen vehicle.

4.1.5 Biofuels

Biological matter (biomass) can be used to produce a range of liquid and gaseous fuels.
Attention was focused on biomass as a transportation fuel in the late 1970s, when, as a result
of the oil crises, Brazil and the US fermented sugar cane and corn, respectively, into ethanol.
About 184,000 barrels of ethanol were produced for use as transport fuel in Brazil’s
Proalcool programme in 1987 and about 50,000 barrels per day were produced in the US. In
the US, the ethanol is mixed in a 10/90 blend with petrol so that it can be burned in
conventional, un-modified vehicles. Smaller scale experiments have been carried out in other
countries.

The major advantages of biomass fuels (or biofuels) are that they are renewable and available
domestically, protecting the transport sector of the country in question from oil shocks which
threaten the economy.

Virtually all current biomass transportation fuel production involves the fermentation of crops
and food wastes containing large amounts of starch and sugar. A more promising option for
the future, however, is the use of ligno-cellulosic material, especially wood pulp. This
material is more abundant and generally less expensive than starch and sugar crops. The
material can be converted into either methanol or ethanol for use as a fuel. Despite this and
all of the other advantages of biomass fuels it is very unlikely that any single biomass-derived
fuel will ever be able to fulfil the needs of a nation’s transport sector. This is due to a lack of
sufficient supply. It has been calculated that the US could only produce up to 1.8 million oil-
equivalent barrels per day of alcohol fuel, using crop residues, forage crops, wood resources,
municipal solid waste and peat, whereas the transportation sector was using 10 million barrels
of fuel per day in the late 1980s. Another disadvantage, besides inadequate supply, is the
problem of cost. With currently relatively low oil prices, biomass fuel is an expensive
commodity. In Brazil, where it is produced in bulk, ethanol fuel is about as costly to
manufacture, on an energy basis, as petrol produced from oil priced at $30 to $35 per barrel.

In Britain, the most commonly-used biomass fuel crop grown is rapeseed, the product of
which, RME (Rapeseed Methyl Esters), is used to make a biodiesel. The two key
environmental advantages associated with biodiesel are:

• Reduced emissions have been associated with biodiesel although there are no
definitive figures on the emission levels from this fuel as test data has proved
notoriously difficult to replicate. It is thought that sulphur emissions would be
eliminated altogether, the level of particulates halved and the hydrocarbons released
reduced by a smaller amount. Unfortunately, it is also thought that nitrogen oxide
levels would rise by about 4 to 5%.
Increased biodegradability levels on spillage. Between 78 and 90% will biodegrade within three weeks for biodiesel, compared with only 50% for mineral diesel.

There are many problems associated with the production of biodiesel, however. It is known for example — as a result of the experience of other countries — that a large processing plant is required to make any biodiesel production project economic, in the same way that a suitable bioethanol-manufacturing plant must be huge to succeed. A minimum of 30,000 tonnes of rapeseed is needed to produce biodiesel, requiring about 12,000 hectares (ha) of rapeseed to be grown and harvested. Due to a number of considerations, the only economically competitive way in which biofuel crops can be grown in this country is to grow them on set-aside land. Unfortunately, there is not enough set-aside currently assigned in the UK to meet the needs of any large-scale, commercial biodiesel producing operation. For example, in Scotland, there is, at the moment, about 16,000 ha of set-aside available. Every single hectare of this land would have to be sown with rapeseed in order that the smallest-possible processing plant could be supplied. This is because a system of crop rotation would have to be implemented, as rapeseed cannot be grown in the same field year after year. It is very unlikely that all Scottish farmers would like to diversify into the growing of rapeseed for a variety of reasons: experience, farm-size, land type, other crops grown etc... It is therefore equally unlikely that Scotland will ever be in a position to open a biodiesel plant as it will probably never have enough RME to supply one.

As a result of this, fuels such as biodiesel are not seen as being potential commercial alternatives to petrol and diesel in the UK although they may meet the needs of a specialised group of vehicles and situations. The markets for biodiesel are seen as being niche-markets such as for diesel engines used in tunnels, mines, warehouses, other underground works, anywhere air-flow is restricted, for example in factories, and in city-centres. Places where the use of biodiesel run engines would be especially appropriate include waterways, lochs, the Norfolk Broads and golf courses (Cook et al, 1994).

Biodiesel can, however, also be produced from palm oil, sunflower oil, soya and peanut oil. Unfortunately, it is likely that, in addition to inadequate supply, high production cost will further prevent any large-scale biodiesel use. It currently costs between 20 and 25p per litre to produce biodiesel from RME, whereas it costs less than 10p to produce mineral diesel.

4.1.6 Compressed air

Pneumacom, a team from Missouri, are working on a prototype car which is totally non-polluting and runs on compressed air. The fuel tank of a conventional car is replaced with three air cylinders which store air compressed at twenty megapascals. The conventional engine is replaced by two small engines, each driving one of the front wheels. Two double-acting cylinders drive each wheel via the passage of the highly compressed air through them.

The exhausted air itself is then vented to the outside at only 25% above atmospheric pressure. The top speed of the car is 60mph, but 90mph is thought to be possible with further research. Each air charge lasts only 2.5 hours but it takes a mere four minutes to recharge the storage cylinders. The compressed air necessary is currently available from fire stations and under-water diving equipment outlets. It would not be difficult to fit filling stations with the necessary equipment. It is estimated that a production vehicle will cost only $10,000.
Of the alternative fuels reviewed above, the one which at present appears to offer the best combination of practicality and reduced emissions in the UK context is compressed natural gas. Fuel cells offer the prospect of the virtual elimination of emissions and are claimed to be close to practicality, but CNG is practicable now. The RCEP recommended that heavy vehicles in urban fleets should be switched to CNG, with substantial benefits for air quality. A particular problem with the more widespread adoption of CNG as a vehicle fuel would be the conversion costs for filling stations, especially economically marginal sites in rural areas.

4.2 Alternative engine designs

4.2.1 Electric cars

In 1990, General Motors produced an electric car suitable for motorway use, called the Impact, which can travel at 55mph for 120 miles on one battery charge. Its maximum speed is 100mph, and it can accelerate from zero to 60mph in eight seconds. The car, however, used a lead-acid battery (weighing 400kg) which lasts only two years and cost $1,500.

Interest in the development of electricity-driven, battery-powered, vehicles continues to increase as they are, currently, the only options available commercially for vehicles which produce no emissions known as zero emissions vehicles. Electric cars use a battery pack which generates enough electricity to power the wheels of a vehicle for short distances before requiring recharging from an electricity supply source. Electric vehicles produce no emissions during operation, but this does not mean that they have no environmental impact. Their environmental impact has simply been transferred from the car’s exhaust pipe to a power station. Despite the fact that power stations still have to burn fuel of some type to generate the electricity required to charge the batteries and that emissions are associated with this combustion, the environmental effects of electric cars versus conventional cars will still be greatly reduced, more localised and less complex to control. This is because emissions are released from a finite number of large stationary point sources instead of an enormous number of smaller mobile points. Another added benefit of electric cars is their significantly quieter operation, meaning reduced noise disturbance in urban areas if widespread adoption of electric vehicles was to occur. The RCEP, however, did not see electric vehicles as the way forward for the UK transport industry due to the acknowledged problems of battery-operated vehicles, namely:

- cost (electric vehicles would involve a cost increase of between $3,000 and $5,000);
- weight;
- short life span (two years for conventional batteries);
- recharging times (several hours on average);
- short range (approximately 100km);
- low storage capacity of conventional batteries;
The batteries most commonly used currently are conventional lead-acid batteries, but due to their weight and bulk, research is ongoing for alternatives which will be small enough to fit into a family car, be capable of powering a vehicle for relatively long distances as well as being easy and fast to recharge. Suitable nickel metal hydride batteries are expected to have been developed, with much greater storage capacities than present lead-acid batteries, soon after the year 2000, according to the California Air Resources Board. However, that authority in December 1995 dropped its recommendations requiring a quota of electric car sales for major car manufacturers, recognising that electric cars are not ready for the main market. Instead, voluntary targets will be set, (Gwynne, 1996).

Table 3 contains a synopsis of the different batteries seen as the way forward for electric car development.

Table 3

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
<th>Electrodes</th>
<th>Electrolyte</th>
<th>Distance between recharges</th>
<th>Cycle life</th>
<th>Power</th>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>Lead-acid</td>
<td>1) Lead 2) Lead Dioxide</td>
<td>Sulphuric acid</td>
<td>100 km</td>
<td>400</td>
<td>125 km 100 km/hr</td>
<td>$10,000 cost</td>
</tr>
<tr>
<td>Advanced lead-acid</td>
<td>Nickel-cadmium</td>
<td>1)Nickel Hydroxide 2)Cadmium</td>
<td>Aqueous potassium hydroxide</td>
<td>125 km</td>
<td>900</td>
<td>100 km/hr</td>
<td>Scarcity and toxicity of cadmium</td>
</tr>
<tr>
<td>Sodium sulphur</td>
<td>1) Sodium 2) Sulphur</td>
<td>Solid ceramic, beta-alumina vanadium sulphate and sulphuric acid</td>
<td>150 km</td>
<td>800</td>
<td>110 km/hr</td>
<td>Weight -300kg Cost- $46,000 Battery needs 2 x 280 ltr storage tanks</td>
<td></td>
</tr>
<tr>
<td>Vanadium redox flow</td>
<td>Intercalating/ 'shuttlecock'</td>
<td>1)Nickel Hydroxide 2)Complex alloy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel-metal-hydride</td>
<td>Lithium</td>
<td>1)Graphite with lithium 2)Manganese dioxide</td>
<td>Solid polymer electrolyte</td>
<td>1,000</td>
<td>60kW</td>
<td>Battery discharges when not in use Low peak power reactivity of lithium</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Glanz, 1994)

4.2.2 Hybrid electric/gas turbine cars

The accepted restrictions which apply to current electric cars (low range and top speed, and added weight) make it unlikely that purely electrically driven cars will replace conventional
models in the short to medium term. One way of by-passing these shortcomings, whilst retaining many of the benefits in emission reduction, is the development of hybrid engines. The USA is now making the electrical hybrid driveline one of the principal focal points in the government-supported partnership for a new generation of vehicles, President Clinton's Super Car Project.

The hybrid route has been adopted by the car manufacturers, Volvo, whose Environmental Concept Car (ECC) has reached the prototype production stage, with low-volume production of these vehicles planned for 1998.

The ECC has a hybrid engine which can be run totally from nickel-cadmium batteries for use on short journeys and in urban areas, but which can also run via a gas turbine using conventional fuel for long-distance driving. The batteries can be recharged by normal methods or during the driving period by the turbine itself. A gas turbine engine is used which burns diesel (but could be adapted to most other gaseous or liquid fuel types) at a high combustion efficiency, and produces low emissions in the process. The power output of the turbine is 40kW and has the added attraction of being very quiet during operation. The turbine is integrated with a high-speed generator in a powertrain system named High Speed Generation (HSG). The power generated by the HSG can be stored in the batteries or used directly to drive electric motors which in turn drive the wheels. The system is linked to a two-speed gearbox, and the car frame itself is made of light-weight aluminium, reducing the mass of the car by 12%, in a design which reduces drag coefficient by 30%. The use of specially designed tyres leads to a reduction in rolling resistance of 50%. As a result of all these changes it is estimated that fuel efficiency for the ECC has been improved by between twenty and thirty per cent. The fact that the batteries are not the sole power source for the car means that they can be made much smaller than in a purely electric car, saving both weight and space. Recharging the batteries takes one and a half hours if carried out while driving, or between six and fifteen hours if charged from a wall outlet at home.

When running on batteries alone, emissions are reduced to zero, and when powered by the HSG the resultant emissions are low enough to meet the standards of future Californian legislation. The nickel-cadmium batteries currently being used in the prototype are a short-term solution only, however, according to Volvo. The next generation will be nickel-metal hydride, with lithium-based alternatives as the long-term battery of choice. The car itself will be the size of a normal family car and will be sold not just on its superior environmental characteristics but on the fact that it offers similar levels of safety, comfort, performance, reliability, effectiveness and value for money as the conventional car.

The ECC will cost considerably more than a conventional car due to its increased complexity and the cost of the batteries. This problem has been recognised in California, where a sum of $5,000 is being cited as an appropriate incentive to the users of similar alternative cars.

4.2.3 Miscellaneous designs and modifications

Further increases in fuel efficiency could dramatically reduce the amount of fuel required to run the world's cars, resulting in significant environmental benefits. Prototype high-efficiency cars that get about 100mpg at motorway speeds and over 65mpg at normal city traffic speeds have already been road-tested. In addition to standard diesel fuel, these
automobiles can burn methanol, corn oil, kerosene and a variety of other non-traditional fuels. Their acceleration, safety and driving characteristics have been found to be very similar to conventional cars. Amory B. Lovins of the Rocky Mountain Institute in Colorado has estimated that raising the average fuel efficiency of the US car and light truck fleet by one mile per gallon would cut oil consumption by about 295,000 barrels per day. In one year, this would equal the total amount of oil the Interior Department hopes to extract from the Arctic National Refuge in Alaska (Webb, 1995).

Fuel efficiency may also be increased in conventional vehicles by the development and use of tyres specially designed to reduce rolling resistance (RR) during travel. Michelin has developed a tyre which reduces RR by 20%, resulting in an average saving in fuel of 5% for the vehicles using these tyres. Rolling resistance occurs because tyres deform when they roll along the road and energy is wasted in making this deformation. This wasted energy has been accepted up to now because decreasing it has often meant a compromise in road grip. The new Michelin tyres give rise to no such compromise.

The use of specially designed exhaust gas filters to cut the volume of particulates being released from diesel-burning vehicles is currently proving very effective in reducing pollution. Several types of particle traps are being tested. The first uses the nitrogen dioxide produced by the combustion of the diesel to carbon dioxide. The exhaust gas passes over a platinum catalyst where the reaction takes place at a temperature of about 275°C, the heat coming from the exhaust. At the same time carbon monoxide and hydrocarbons are converted to carbon dioxide, while the nitrogen dioxide itself is reduced to nitrogen. The process cuts nitrogen oxide emissions by about 10%. The only problem is that the sulphur in the diesel itself inhibits the platinum catalyst so the device can only be used with low-sulphur diesel fuel with less than 5% sulphur, the EU’s target for sulphur levels in diesel from October 1996. The other method involves the use of a cerium catalyst which is, in this case, added directly to the fuel itself at about 50g per tonne. The effect is to lower the temperature at which the carbon in the fuel burns off (to 200°C), resulting in lower carbon emissions. The two methods are being tested in buses in London, Lyons and Dresden, and it has been estimated that the level of PM10 emissions from vehicles fitted with these particle traps may be reduced by up to 90%.

Reducing the size of the average UK family car engine by 200cc could reduce the level of CO₂ emissions from the transport sector by a small amount, but not enough to allow the UK to reach 1990 CO₂ levels by the year 2000, according to a recent report from the UK Transport Research Laboratory (Wootton and Poulton, 1993). This report estimates that, if no changes are made to private cars in the UK over the next few decades, CO₂ emissions will increase by between 20 and 33% on 1990 levels (depending on whether traffic growth is assumed to be very high, or slightly lower) by the year 2000, and between 138 and 170% by 2020 (see Table 4). These increases would not be as high if engine size came down by 200cc but would still be significantly higher than 1990 levels.

The other likely scenario for the UK is 'higher-tech' cars which will incorporate much lighter body parts, improved engine management systems, direct fuel injection, better lubrication and continuously variable transmissions. Such changes would result in UK CO₂ emissions levels falling closer to 1990 levels over the next two decades but would still be insufficient to meet the set target. It is only by a combination of smaller engine size and rapid technological
developments that the target might be realistically met, according to the Transport Research Laboratory report.

Table 4 The effects of emissions-curbing policies on CO\textsubscript{2} emissions

Carbon Dioxide Emissions as a Percentage of 1990 Levels

<table>
<thead>
<tr>
<th>Year</th>
<th>No Change scenario</th>
<th>Engine Downsize by 200cc</th>
<th>Rapid technology introduction</th>
<th>Both downsizing and technology improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>133 (120)*</td>
<td>127 (114)</td>
<td>121 (110)</td>
<td>116 (105)</td>
</tr>
<tr>
<td>2020</td>
<td>170 (138)</td>
<td>155 (127)</td>
<td>120 (98)</td>
<td>110 (90)</td>
</tr>
</tbody>
</table>

(Source: Wooton and Poulton, 1993)

* The figures shown in non-bold type reflect the worst case scenario of traffic growth in the UK over the next two decades (36% increase in vehicle km travelled by the year 2000 and a 99% increase by 2020). Those shown in brackets and in bold type reflect the more optimistic forecasts which have been made for future traffic growth (21% increase in vehicle km travelled by the year 2000 and a 61% increase by 2020).

4.3 Summary

Although alternative fuels, especially CNG, and changes in vehicle and petrol/diesel engine design; offer the prospect of significant reductions in emissions, the RCEP felt that these would not be sufficient to offset forecast traffic growth, the consequences of which would be unacceptable (RCEP, p233). The next chapter considers other approaches proposed by the Commission, particularly fiscal measures.
CHAPTER 5  ALTERNATIVE POLICY OPTIONS AND THEIR POTENTIAL EFFECTS ON THE UK MOTORIST

This chapter looks at some of the major alternative, pollution-reducing policy options and analyses their effectiveness and relevance.

5.1 Fuel price increase

The first option to be discussed is the fuel price option proposed by RCEP. The RCEP’s argument for the doubling of fuel prices in real terms by the year 2005 was based on the Commission’s Objective F, to reduce CO₂ emissions from transport, so that by the year 2020 they would be not more than 80% of the 1990 level. An intermediate target for transport for the year 2000 was then set, in line with the economy as a whole, so that CO₂ emissions from surface transport in the year 2000 should not exceed the 1990 level. In order to achieve this in the context of forecast growth in road vehicle use, the Commission set a target for improvements in vehicle fuel efficiency between 1990 and 2005, requiring the average fuel efficiency of new cars sold in the UK to increase by 40% with a target of 20% for new light goods vehicles and 10% for new heavy vehicles (RCEP, p239).

The technical potential for achieving a 40% increase in car fuel efficiency exists, but RCEP believe that a doubling in fuel prices by 2005 is needed in order to ensure that this technology is applied, because manufacturers and car buyers expect a substantial and permanent increase in the relative price of fuel (RCEP, p240). The other main effect that the Commission expects this fuel price increase to have is in reducing the demand for fuel, by 30% in the short term and 70% in the period to 2020. It admits that sustained rises on the scale now under consideration are a new phenomenon, and that there is considerable uncertainty about the size of the effect which such increases would have (RCEP, p112). In particular, there is uncertainty about the extent to which the reduced demand for fuel would be made up of reduced car use, switching to more fuel-efficient cars of the same size, or down-sizing (switching to smaller cars). It is also probable that improvements in vehicle fuel efficiency, and/or down-sizing, would be used by consumers to offset at least partly the increase in fuel price. Overall, the RCEP believes that both technological improvements and a decrease in fuel demand are required in order to meet the CO₂ targets, and that the doubling of fuel prices is the main method of achieving them (RECP, p307-8). In addition, there would be health benefits in respect of lower exhaust emissions, other than CO₂.

There are concerns, however, about the potential financial impact on car-dependent rural and low-income consumers, and the potential safety implications of down-sizing for all car users. Discussion of the former issue is explored elsewhere in the paper on Sustainable transport policy and people living in rural areas (Farrington, Collins and Coole, 1996).

5.1.1 Safety implications

These arise because the risk of serious or fatal injury is greater in small cars than in larger cars. This is only partly due to the effects of accidents between smaller and larger cars. In a review of international literature on the safety implications of down-sizing, Sleightholme-Albanis concluded that the overwhelming consensus is that no down-sizing is possible without causing increased road casualties. It is not simply a question of the size differential of the
UK car fleet, which may eventually be reduced: no amount of engineering or changes to the fleet size composition can make small cars safer than large cars (Sleighholme-Albanis, 1993).

A basic way of demonstrating the safety differential is to consider official statistics of the risk of injury to drivers involved in two-car accidents by size of car in 1993, the most recent data available at the time of writing. The average figure for drivers seriously or fatally injured in small cars is 8%, while the corresponding figure for large cars is 4%, half the rate for small cars.

Estimates of the increased number of fatalities resulting from the downsizing of half of all large cars (1.5 million in 1993) suggest that there will be approximately 37 per year in Great Britain. Sleighholme-Albanis, using a different approach, estimated that for an overall improvement of 8% in average car fuel consumption in Great Britain, an additional 35 to 47 fatalities per year would result (Sleighholme-Albanis, 1993). In fact, this amount of fuel consumption improvement could only be achieved, in terms of down-sizing large cars, by down-sizing almost three times as many large cars as there are in the fleet, so that the two estimates differ by a factor of about five. Nevertheless, the safety implications of down-sizing are widely accepted, and should be a significant factor in the debate about fuel price increases.

Other ways of achieving greater fuel efficiency include:

- reducing the weight of cars without reducing their size by the careful use of alternative materials such as aluminium and some plastics, in such a way that safety is not compromised;

- using smaller engines without reducing weight. This implies some reduction in performance, and also in the effectiveness of reductions in fuel consumption, since a small engine under greater load in a large car will tend to consume more fuel than the same engine in a small car.

There is clear evidence from the United States that reducing car weight on its own is an inadvisable approach to fuel economy goals. The RCEP report appears to make uncritical reference to the US Corporate Average Fuel Economy (CAFE) scheme, introduced in the 1975 Energy Policy and Conservation Act, remarking that there was a 25% improvement between 1970 and 1990 in fuel consumption by US cars, albeit from a very high starting point and that this appeared to be the result of the CAFE standards (RCEP, p135).

However, Sleighholme-Albanis (1993) reports Curry, head of US National Highway Traffic Safety Administration, as saying that in single-car crashes alone, the average weight reduction of 1000 pounds in new cars result in 1340 additional deaths, plus thousands of injuries annually.

"Unintentionally, from 1972 to 1983, we traded off lives for fuel economy gains". (Curry, in Sleighholme-Albanis, 1993).
Therefore, when the RCEP argues that the most important principle in vehicle design to achieve fuel economy is to reduce size and weight, and makes a recommendation on these lines it can be questioned whether the safety implications have been adequately addressed in the Commission’s report. The key factor from research appears to be to reduce weight without reducing size or compromising safety. The same can be said for the safety implications of the proposals for steeply graduated annual excise duty on cars, based on the certified fuel efficiency of a car when new. This point is taken up in the next sub-section.

5.2 Fuel efficiency and emissions taxing

5.2.1 Fuel efficiency taxing

The RCEP recommended that the annual excise duty on cars be steeply graduated, and based on the certified fuel efficiency of a car when new. The Commission wished to penalise the ownership of large cars compared with that of small cars since the latter use less fuel. However, this would tend to encourage down-sizing, which in the previous sub-section was shown to be an inadvisable policy on its own. The Commission is really referring to fuel consumption rather than fuel efficiency for a given engine size. More attractive is the German proposal to the EC for setting fuel efficiency standards for three size classes, and levying fines on manufacturers selling non-compliant models (RCEP). The RCEP preferred to recommend economic instruments (taxation and fuel price increases), but the US Insurance Institute for Highway Safety has proposed different fuel consumption standards for different sizes of vehicles as a way to reduce the pressure for downsizing. This appears to be a more positive way of encouraging or enforcing fuel efficiency for cars of a given body or engine size: taxation bands could penalise poor fuel efficiency within specified body or engine size bands.

5.2.2 Emissions taxing

It is widely believed that the most likely emissions taxing policy for implementation in the UK would be one linked to the annual MOT inspection. Strict emissions limits for each of the key environmental and health pollutants from car exhausts would be set by the government in line with those recommended by the EU, the WHO and/or by Californian legislation. During the MOT, the levels of each of these emissions would be calculated for the car or vehicle being tested using the average emissions released over a pre-set distance travelled. The number of miles travelled over the past year would be read from the odometer, which would have to be modified in UK cars to prevent tampering and false readings. A charge for each of the emissions being released by the car would then be calculated on the basis of the distance travelled during the year, and the more environmental and health-damaging pollutants would be more severely weighted in these calculations. An emissions bill would then be presented to the car owner soon after the MOT examination. This charge would be paid directly to the Inland Revenue by the car owner, or the charges could be added to the next year’s car tax, or perhaps by a number of other possible payment options.

Irrespective of the method of payment used, the positive attributes of an emissions tax are that:

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• It encourages more frequent servicing and tuning of car engines to keep emissions levels as low as possible.

• It might stimulate a move to alternative fuels or vehicles, as the initial high capital costs of converting a car to the use of CNG or buying an electric car could be offset by government financial incentives for such purchases, as well as the absence of or significant reduction in annual emissions taxes.

• It does not penalise those individuals who use their vehicles for infrequent trips but does penalise those who travel for long distances, long-distance commuters, for example. In other words, those people who own a car but choose to use another transportation mode to reach their place of employment, entertainment etc, would be rewarded by lower annual tax bills.

• The costs of the tax for long-distance or frequent drivers on company business would have to be paid by the company, which might stimulate thought about ways of reducing the amount of travel carried out by company employees.

• It might encourage people to move away from diesel vehicles or to use cleaner diesels as diesel engines could be potentially quite heavily taxed due to the close links between PM10 and deaths from respiratory and heart disease, which would impose a heavy weighting on particulate emissions levels.

• It would reward pollution-cutting devices such as catalytic converters and particle traps, making people think more carefully about the pollution being produced by their own individual cars.

• It would discourage the continued use of very old cars with no emission-reducing technologies, with low fuel-efficiencies and which use leaded fuel. This might have knock-on effects, especially for the elderly, first-time buyers or poorer individuals who could not afford to buy a new or relatively new vehicle. The government could help such people by contributing a certain proportion of the cost of the new vehicle, with the level of support given dependent on the difference between the emissions levels of the old and the replacement vehicle.

Unfortunately, such a system does not take into consideration those individuals who drive at lower speeds, and thus produce less pollution. Nor does it distinguish between urban driving which is more environmentally damaging due to congestion, and motorway or rural journeys. In particular, it does not take account of situations in which there is an absence of alternative travel modes, for example in rural areas.

Emissions taxes may be administered in other ways, and there appears to be scope for smart card technology to monitor car emissions, but these have technical or practical difficulties at present which make it unlikely that they could be easily administered in the near future. However, greater weighting for urban driving and reduced weighting for rural driving excluding certain trunk corridors should be feasible, and would recognise the need for car use in areas such as rural Scotland.
It might be said that congestion pricing is another form of emissions taxing. This method penalises users of inner-city or urban areas where congestion is most widespread and most damaging, or perhaps at those times of the day when certain areas experience higher than average pollution.

5.3 Road taxing

Road taxing schemes can vary in the way in which taxes are administered. A likely option would be adding the extra cost of the tax onto the yearly road tax which every car owner has to pay. Alternatively, an annual registration fee might be used to collect the tax, or a system of toll booths could be set up to collect taxes for the most heavily used (and thus most expensive to maintain) routes. What is more difficult is the level at which the tax should be set if a toll system is not implemented. Should the tax be raised to further penalise those people who use roads a great deal or should it be a standard tax irrespective of road usage levels? It would seem to be most logical to apply the tax on a graded scale, based on the number of miles travelled per year by the car, calculated from the annual MOT test, and/or the nature of the roads being used. Unfortunately, such a system is likely to specifically penalise rural motorists as, by definition, the distances this group travels are frequently far greater than those travelled by their urban or suburban counterparts — to reach schools, places of work, shops etc.

5.4 Road pricing

The principle behind road pricing is that drivers pay for the specific uses they are making of roads, and for all of the costs incurred by other users (Balchin et al, 1988). The specific ways in which road pricing can be used to bring benefits to the environment will be discussed later in this section. Firstly, road pricing as a policy will be considered more generally.

5.4.1 Case studies

A toll ring scheme was set up in Oslo in the late 1980s with the intention of alleviating congestion. The decision was made to set up the scheme in order to raise revenue to use for road and public transport improvements. Drivers are charged for entering the city. Some pay at toll booths but others (65% of drivers) pay via electronic charging systems which take readings from tags on the cars' windscreen. Technically, the scheme has been extremely successful, with few problems of queues. About £60 million is being raised each year from the scheme. The money is funding a package of road improvements for the city, and the proportion of toll revenue going into public transport has been raised from 10 to 20%. The road improvements have already been seen to help speed up buses in the city.

The scheme has now much greater public support than it had initially, when it was quite a contentious issue. Now, 40% of residents, compared to 29% in 1989, accept the tolling scheme. This is believed to be because of the clear link between the toll and transport improvements in the city.

A similar toll ring scheme to that carried out in Oslo has been set up in Trondheim in central Norway. Even greater use is made of electronic tags by the Trondheim scheme. Ten out of twelve toll booths are fully automated, and tag equipment was distributed to motorists free of
charge. The capital investment for the scheme was paid for in six months. Operating costs are only about 1% of the revenue raised. As a result of the scheme:

- traffic queues are disappearing;
- the traffic peak has been reduced by 10%; and
- accident incidents and pollution levels are lower.

(House of Commons, 1995).

These two examples from existing schemes in Norway show that road pricing schemes can be effective as a source of revenue for traffic or environmental improvements, and for reducing congestion in urban areas.

5.4.2 The economic principles behind road pricing

Direct road pricing involves road users paying more directly for using road space. It aims to take into account the social costs of motoring. In effect, drivers pay the equivalent of marginal social costs.

Road pricing schemes can vary for specific localities according to:

1. Who should pay. Different user groups may not all pay, or they may pay at different rates. Exemptions may exist, for example, for the disabled, or reduced rates for elderly drivers. Public transport may also be exempt. This may apply particularly where environmental improvements are the aim of the scheme, in which case public transport will need to be enhanced at the expense of the private car.

2. When charges are made. Some charges may only apply during specific hours or days of the week. This will generally be at times of peak traffic levels. This is the case for the Trondheim toll ring. However, the scheme in Oslo charges 24 hours a day. This is because in Oslo the intention of the scheme is to raise as much revenue as possible from as wide a range of drivers as possible.

3. Where charges are made. The locations where charges are imposed will depend on the objectives of the scheme and the geography of specific localities. Charges may be made:
   - for entering the city centre only;
   - over the inner city area;
   - along certain congested corridors;
   - across entire built-up areas (eg Oslo); or
• at a regional level (such as Dutch proposals).

Charging zones could also be established with different charging levels.

4. How charges are made. There are various methods for charging: electronic methods for charging, whereby cars are tagged, and so trigger electronic charging devices as the cars pass them, are used predominantly for road pricing, having the fewest implications for holding-up through traffic. There are several options for making charges:

• point-based, coinciding with links or nodes in the network;
• cordon/boundary-based, going in or out of sections;
• area-based, to gain right-of-access within an area;
• length-based, according to time or distance travelled; or
• externality-based, for example, according to prevailing network conditions.

The level at which charges will be set is also an aspect of setting up an effective road pricing scheme, which needs careful consideration. The level of charge adopted will be influenced by technical costs which need to be met, and political feasibility or public acceptance. The purpose of the scheme will also influence the level of charging, whether it be primarily to raise revenue, or to have a specific role in changing driving behaviour.

Road pricing can be used as a policy to bring about environmental benefits, where it is effective in changing driver behaviour in terms of:

• reducing overall traffic levels, especially through traffic, and discouraging shorter distance trips;
• enabling the creation of smoother network driving conditions; and
• encouraging a switch to less polluting/more fuel-efficient vehicles (Jones, 1994).

To achieve environmental benefits, Jones (1994) argues that a scheme must:

• cover a wide temporal/geographical range;
• be charge-based on trip length, with a fixed initial charge to discourage short trips by car; and
• differentiate charges according to the vehicle and its energy efficiency, and the traveller.
Revenue raised could go into a green fund to invest into research into emissions, fuels, engines, to insulate people from the effects of the scheme and to compensate people for damage, for example to health.

In terms of how feasible the introduction of road pricing in the UK is, the Department of Transport thinks it unlikely that road pricing policy will be a reality until after the year 2000. They argue that the technical feasibility of road pricing schemes still needs to be proved: that the technology works and the most effective price levels are set. Tests or pilot schemes would ideally need to be carried out to prove feasibility. However, legislation is needed to allow for pilot schemes. The government is unlikely to go ahead with putting legislation in place without more evidence of the worth of the system (House of Commons, 1995). There are other issues to consider before the introduction of a road pricing policy.

- There may be enforcement issues to solve. Would this be done best by an independent agency, by cameras or electronic checks, or perhaps through random checks?

- There are problems in accurately calculating the benefits to the traveller and costs to society.

- Alternatives to using cars must be provided. This would be of fundamental importance to car-dependent consumers, and particularly those in rural areas and on restricted incomes. There might be a need for rural and off-peak public transport services to be subsidised. Improvements in public transport service provision would be essential. In addition, other schemes should be considered for serving the particular needs of people living in rural areas, such as dial-a-bus, school bus and taxi services, community transport (such as special services to doctors’ surgeries), mobile services, and supporting transport.

- The use that will be made of the revenues collected. Initial suggestions from the government have been that funds raised from road pricing schemes would go straight into the Treasury. However, it is probable that the public acceptability of road pricing schemes would be greatly increased if the public were aware that revenues collected would go straight into transport improvements for their local area. For a road pricing scheme as part of a package to bring environmental benefits, the funds could be directed into a green fund and towards improved public transport provision. In addition, it has also been suggested that there is political misperception of public attitudes towards reduced car use. It has been indicated that people are more prepared than has been previously anticipated to reduce their use of private cars, especially where they understand the reasons behind the need to use alternatives and can see the environmental and congestion-saving benefits which will follow (Jones, 1992). However, these are mainly urban-based studies.

- Road pricing schemes may have an impact on local economies, though this is difficult to predict. If people reduce their visits to a location because of a road pricing scheme, in the long run this may lead to people and businesses relocating. In addition to this, control would be needed over possible increased pressure for decentralisation
of shopping and other facilities, which would bring local environmental impacts from land-use changes.

From the discussion above, it is possible to make a comparison between the various points for, and against, the introduction of road pricing schemes.

5.4.3 Points in favour of road pricing policies

The following are some of the benefits of road pricing policies.

• Less congestion, free-flowing traffic, less delay.

• Greater productivity and reliability from buses.

• Road tax revenue for local authorities.

• A change in driver behaviour. People might adjust their behaviour to make better use of their cars, for example, by making better use of passenger capacity, travelling by the cheapest routes and at the cheapest times, and by making fewer, larger shopping trips.

• Users of roads would pay for ensuing costs.

• It would better reflect the true cost of travel (ie marginal, social costs).

• Give priority to journeys of most value.

• Cars and public transport would be on a level playing field for price. This would accord with EU principles on competition.

• There would be greater potential benefit from revenue than the loss of benefit to those paying the charge.

• Road pricing as part of a mix of transport policies does more to reduce traffic levels than a package without it.

5.4.4 Points against road pricing policies

• Doubts exist over the effectiveness of such schemes.

• Possible detrimental effect on local economies, and pressure for decentralisation.

• Different effects on different people, related to their ability to pay or to access alternatives.

• Motoring could become a privilege of the wealthy.
• Low and middle-income users at peak times with no alternative to car use would be worst affected. Motoring is the third largest item of expenditure, after housing and food for middle income households (Scottish Office, 1992).

• A large swing to public transport could overload the service and, therefore, timing of investment needs to be planned.

• Cars diverting onto other roads and alternative routes would spread impacts on the environment.

• It may be difficult to persuade people to leave their cars at home.

• It may not necessarily change driver behaviour in terms of travel needs. Evidence from surveys carried out by the RAC has shown that many people drive because they do not have other options that are either accessible, convenient, or affordable (House of Commons, 1995).

• The needs of elderly, disadvantaged and disabled people would need to be accounted for through the provision of transport alternatives.

5.4.5 Summary

There is a fair balance of opinion for and against the idea of incorporating a road pricing policy into an overall transport policy to combat environmental pollution and congestion.

The following conclusions can be made on road pricing.

• Road pricing can help reduce congestion in urban areas (as shown in Norway) and raise considerable revenue.

• Revenue raised should be put back into transport improvements in the charge area, ie public transport improvements.

• Provision must be made for alternative modes of travel. This could be achieved if revenue is redirected back into public transport on a carefully timed basis.

• There is a need to set up pilot studies to test the reliability, accuracy, and enforceability of road pricing schemes.

• Certain priority groups probably need to have exemption from charges.

• Road pricing cannot be used alone. It should be set up within a mix of transport policies.

5.5 Direct measures aimed at reducing congestion levels in urban areas

A range of measures to reduce inner city congestion includes the following.
5.5.1 Investment in telecommunications

Investment in telecommunications systems in the UK could potentially result in an increased incidence of tele-working and tele-commuting. Improved telecommunications have demonstrated their ability to supplant physical transportation. Obviously, however, this would be a long-term approach to easing traffic congestion as the effects would take an appreciable amount of time to become noticeable.

5.5.2 Land-use controls

Another long-term policy option is to use planning measures to ensure that future conurbations and developments will have less need for private transport, and ample room and optimum convenience for public transport. There is currently debate about the effectiveness of the compact city in reducing travel demand, and about the ability of the planning system to achieve greater urban density. Indeed, Breheny and Gordon (1996) argue that large fuel price increases would be more effective than planning controls in achieving this type of urban form, but are uncertain about the environmental impacts of greater urban densities.

5.5.3 Vehicle bans

Although seen as a relatively drastic measure, the banning of particular types of vehicles (or all non-public transport vehicles) from a key area or areas can have a marked effect on congestion levels, inner city speeds and associated air pollution within the areas in question. Bans can be imposed at certain times of the year (when weather conditions are likely to result in photochemical smog, for example) or of the day (peak traffic flow periods; in a limited area or even in one or two streets; or only on certain vehicle types (e.g. diesel-engines, HGVs) to realise the greatest reduction in congestion. In practice, many such restrictions already apply to delivery vehicles in city centres.

In the summer of 1995 the city of Athens began a trial period to assess the air quality changes which would occur in this heavily car-dependent and polluted city if all private transport was banned from the city centre. Summers in Athens have increasingly been subject to dense smogs and other potentially health-damaging pollution incidents. Although the results have not yet been analysed, initial reports over the summer indicate that, despite severe initial reluctance on the part of the residents, it would appear to have been very successful in improving air quality. The full results of this trial, once available, could have important pointers for the UK and should be analysed in detail.

5.5.4 Bus and taxi traffic priorities

The bus/taxi lane has already been used in several parts of the UK for some time, with varied levels of success and popularity. For bus/taxi lanes to work most efficiently, they should be intensively policed to prevent the parking of cars (even for very short periods) and other obstructions. In general this measure is seen as a useful way of improving public transport reliability, but it normally needs to be part of a wider package including park and ride schemes (see 5.7.3).
Electronic technology improvements in recent years have led to the design of electronic signalling priority systems for buses at urban intersections. Buses fitted with transponders or other electronic labels can ensure their own rapid passage through intersections by manipulation of the signals. Such Selective Vehicle Detection (SVD) priorities have been successfully tested in London where they were shown to reduce both travel times and their variability. These measures may have more than the direct benefit of reducing congestion: the indirect benefits of faster bus journey times may, in addition, serve to entice people away from their cars.

5.5.5 Traffic signal controls

The use of modern responsive traffic signals, as opposed to fixed time systems, has been shown to help reduce traffic delays in urban areas. Traffic delays in busy dense road networks can be reduced by approximately 20% below those of traditional junction signals.

5.5.6 Speed limits

As described earlier in this paper, the speed at which a vehicle travels has a vital effect on the level of emissions produced. This effect is enhanced when speed limits lead to smoother traffic flow. The implementation of stricter speed limits in specifically chosen areas might thus lead to reductions in the fuel consumption of the cars travelling through the restricted speed area, and, therefore, reduced pollution.

5.5.7 Electronic vehicle location

Technology improvements may at some point in the near future be able to guide traffic to the best route through a city or area. The benefits of such advances are obvious — it has been estimated that as much as 15% of traffic could be eliminated with perfect routing. The systems now being developed can identify the location of vehicles and guide the driver to a pre-selected destination.

5.6 Direct measures aimed at restraining traffic in urban areas

5.6.1 Area bans

As seen above, this measure is quite effective at reducing localised congestion problems, but does not necessarily reduce overall pollution — it may move it to other areas. Similarly, area bans do not restrain traffic: they merely divert it. The same can be said for traffic calming measures, although they can provide local benefits.

5.6.2 Restricted road building

As discussed earlier, more roads do not ultimately mean less pollution and traffic congestion. The building of more roads on its own is not a solution for the UK. In 1994, 22% of the motorway network, representing 696 km, was operating above the level it was originally designed for. It is estimated that by the year 2000 up to 37% of the network could be operating above its design capacity (Worsford, 1995). It would, therefore, be preferable that the capacity of UK roads be increased, rather than that more be built. Car sharing lanes.
speed limits, more intensive policing and other measures may prove useful here. The safety benefits associated with road improvements could be given greater weighting in determining resource allocation.

5.6.3 Zones and collars

This involves defining certain areas in which traffic restriction measures are put in place as opposed to broad-based use of these measures across the whole city (which might be very unpopular in areas where traffic levels are low or negligible). Special traffic signal prioritisation, for example, might only be implemented within the zone which collars the environmentally vulnerable or highly congested area (usually inner city centres).

5.6.4 Permit and rationing systems

Similar to banning vehicles from certain key areas, this measure involves the identification of those people for whom access to a restricted-traffic area is vital, and allowing them unlimited or restricted access to that area by issuing permits or passes.

5.6.5 Priced permits

To restrict access to key areas for non-essential traffic, a limited number of permits could be sold (simultaneously raising revenue). In Milan, this system was implemented to prevent non-city centre residents from accessing certain parts of the city and to give priority to local traders. The scheme reduced traffic into Milan city centre by over a quarter during the morning peak period and only a small proportion of this reappeared during the rest of the day.

5.7 Direct measures aimed at reducing traffic flow into city centres

5.7.1 On-street control

Reducing the amount, or attractiveness of on-street parking has proved very successful in many cities as a means of reducing levels of traffic entering the inner city area, reducing congestion, and increasing a shift to public transport or other alternatives such as walking and cycling. In a test study recently carried out by the Transport Research Laboratory (Dasgupta et al, 1994), halving the number of parking places on-street had the effect of decreasing the share of the trips made by cars in the city centre by over a third, and total car use by between 5 and 8% (over five study areas — Leeds, Bristol, Sheffield, Derby and Reading). Speeds in the central area were seen to increase by up to 35% and CO₂ emissions were reduced by 3.5 to 5.5%. Doubling the parking charges in the same areas, as opposed to reducing total numbers of spaces, had a similar but much lower effect. The regressive nature of this approach is a problem for low-income car users.

5.7.2 Residential parking controls

Parking permits issued to residents only can have a significant effect on residential area parking by preventing non-residents of an area using streets as a cheap alternative to paid parking spaces.
5.7.3 Park-and-Ride schemes

This concept has been adopted in several UK cities, providing parking facilities (either free or very cheap) at key bus or rail stations for public transport users. This can convince commuters to drive their own cars from the outskirts, suburbs or surrounding rural areas to points relatively close to their city centre destination, where they leave their cars and complete the remainder of their journey by public transport. Measures must, however, be implemented to ensure that local residents do not use the parking facilities as free or cheap residential parking. Linking the parking fee to public transport tickets can help to avoid this complication. Park-and-Ride is seen as having a significant role to play in reducing car use in urban centres, but recent research suggests that the road space released by reducing congestion tends to fill up with cars again. Park-and-Ride must therefore be developed as part of a wider package (Parkhurst, 1995).

5.8 Other measures aimed at reducing private car use

5.8.1 Car-pooling or ride-sharing schemes

Such schemes have been used for a long time with some success in the US and in Germany. People travelling to and from similar points can informally arrange to share their cars (each of the passengers driving their own car on different days). This reduces the total number of cars on the road at any one time, as well as reducing the commuting costs for the passengers involved. More formal lift-share agencies also exist to link people who want to make similar journeys but who do not know each other.

Countries where lift-sharing is popular increase its attractiveness by designating motorway lanes as car-pool lanes, resulting in faster travel times (although they are difficult to police and quite unpopular), waive motorway tolls for cars containing more than two persons and so on. Lift-share companies are being formed in the UK and the success of these ventures has yet to be seen.

5.8.2 Mobility planning

This approach often focuses on major employers, and encourages schemes which reward travel to work by foot, cycle, or public transport by providing allowances, financed by charges (such as parking fees) based on employees who travel to work by car. Car allowances and mileage payments may be curtailed. While clearly of benefit in encouraging people to think about the environmental consequences of their travel behaviour, such schemes presuppose adequate alternatives for car users, particularly rural dwellers, and may also be resisted by employees who, rightly or wrongly, perceive car allowances as part of their remuneration package.
CHAPTER 6  CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The RCEP has made a clear case for the need to consider, as a matter of urgency, how to limit, and if possible reverse, the growth in atmospheric pollution arising from increased road traffic and particularly from car use. More equivocal is the choice of methods for achieving this goal. The problems addressed by the Commission are more urban than rural in nature. The rural use of cars is a much less significant component of the problem. Policies designed to tackle these issues should recognise this distinction.

The RCEP report, and an extensive literature, shows that there are many possible approaches to the goal of limiting the environmental impact of road traffic. These include alternative fuels, improved vehicle design, traffic restraint, improved public transport, higher levels of walking and cycling, and a range of taxation measures designed to affect peoples' behaviour in terms of car purchase and use. The Commission made 110 recommendations in these areas. There is an urgent need for a comprehensive and systematic environmental, social and economic appraisal of the probable effects of these recommendations in a variety of combinations.

The Commission rejected the idea of legislation requiring manufacturers to comply with more stringent fuel efficiency standards, and of fuel efficiency-based vehicle excise duty in car size bands. Both of these approaches offer potential ways of achieving significant reductions in fuel consumption which should be explored more closely, and large-scale fuel price increases appear to be an unnecessarily indirect way of achieving these ends.

It is essential that the development of transport and environmental policy (together with other related areas such as land use and energy) is based on a thorough evaluation of options, leading to cohesive and integrated policies capable of identifying and implementing measures appropriate for a variety of contexts. The most obvious contexts for Scotland are probably central urban areas, urban-based journey-to-work areas and deep rural areas. Inter-urban flows might be treated separately. Each type of area could receive the package of measures best tuned to its needs. Policies for central urban areas, for example, could focus on air quality management (see Appendix), with selected measures applied as appropriate, such as park and ride, bus lanes, rail or Light Rapid Transit investment, road traffic restraint (parking pricing, road pricing) land use planning and traffic management. Policies for journey-to-work areas could focus on strengthening public transport provision relating to commuting, and on intercepting car commuters at peripheral park and ride schemes.

National policies would provide the enabling framework, with legislation regulating fuel pricing, emission taxing, MOT testing, and fuel efficiency requirements. We favour fuel efficiency targets for manufacturers, over large-scale fuel price increases and emission taxing.

It is beyond the scope of this report to explore the capacity of reorganised Scottish local government to deal with these policy issues. It does, however, appear that to achieve the policy overview necessary for the integrated action needed, it will be necessary for policy to
be developed at least one level above the new unitary authorities, that is, by regional transport authorities, or even at a Scottish level. The challenge for such authorities — or, in their absence, for consortia of new unitary authorities — will be to achieve a progressive degree of intervention in the operation of privatised and deregulated operators so that attractive, reliable, affordable, integrated and safe public transport services can build up into a system providing a viable alternative to car use in Scotland.

6.2 Recommendations

Recommendation 1

The doubling of fuel prices as proposed by the RCEP, the taxing of emissions based on annual car mileage, and steeply graded fuel consumption-based vehicle excise duty, should be opposed on the following grounds.

a) They would be regressive, causing hardship to those on low incomes and rural dwellers heavily dependent on car use. Public transport is often not a viable alternative (Farrington, Collins and Coole, 1996).

b) They would cause car down-sizing and consequently probable higher casualty rates among car users.

c) Alternative ways of securing fuel economy improvements are available, for example, fuel efficiency taxing based on car or engine size bands, and legislation governing fuel efficiency, applied to manufacturers.

Recommendation 2

There is an urgent need for a comprehensive and systematic research programme to identify the social, economic, and environmental impacts of the RCEP's recommendations in a range of combinations.

The RCEP report, and an extensive literature, shows that there are many possible approaches to the goal of limiting the environmental impact of road traffic. These include alternative fuels, improved vehicle design, traffic restraint, improved public transport, higher levels of walking and cycling, and a range of taxation measures designed to affect peoples' behaviour in term of car purchase and use. The Commission made 110 recommendations in these areas and there is an urgent need for a comprehensive appraisal of the probable effects of these recommendations in a variety of combinations.

Recommendation 3

Detailed work is needed to evaluate the possibility of setting up regional transport authorities or a Scottish transport authority.
The challenge of providing viable alternative public transport, as part of the approach to the reduction of car use, will require intervention in the privatised, deregulated passenger transport industry by bodies able to take a broad view of policy-making and implementation. These may be consortia of unitary authorities, or perhaps more appropriately regional transport authorities or a Scottish transport authority, with powers broadly similar to Passenger Transport Authorities. More detailed work is needed to evaluate these alternatives, and the financial basis on which they would operate.

Recommendation 4

Policies should focus on air quality management in urban centres.

Focusing policies on air quality management in urban centres would be useful in achieving the best mix of measures such as park and ride, bus lanes, car parking charges and traffic restraint, for each urban centre (see Appendix). This would tackle the problems of congestion and the concentration of harmful emissions. The wider problem of CO$_2$ emissions would also be tackled by these measures, and in addition by the measures outlined in 6.2.1c.

Recommendation 5

Revenue raised should, at least in part, be allocated to measures which promote a sustainable transport system.

The matter of tax hypothecation is beyond the scope of this report, but it is worth noting that a conservative estimate of several billion pounds will be raised by the fuel tax increases to which the government is already committed. If a view were taken that a portion of this revenue should be allocated to measures such as those proposed in this section of the report, it would be an appropriate use of the revenue.

The RCEP produced a detailed report with an overall goal of the rapid reduction in energy use by the transport sector, on the basis that current and forecast use of energy in this sector is unsustainable. Yet, as the Commission said,

*The present system of transport is the consequence of policy choices over a period of a century or more. Their cumulative effect has been to transform almost beyond recognition the ways in which land is settled, the ways in which people work and travel to work, and the ways in which families live* (RCEP, p.253).

They point out that:

"there is now an opportunity to take the difficult policy decisions which will lead, in the course of the coming decades, to a sustainable system of transport, mobility and access .... these policies will amount, in effect, to a decision by the present generation to take on the burden of resolving problems which were created in part by earlier generations" (RCEP, pp 253-4).
A strategic point to consider is whether the burden of this decision is unreasonably great and abrupt for some groups in particular to bear. This report has concluded that alternative methods of achieving the Commission’s goals do exist. It is a matter of judgement as to whether the timescale is as urgent as the Commission proposes, but the balance of view taken here suggests that appropriate progress towards the Commission’s goals can be achieved without the disproportionate burden which the Commission’s particular proposals on fuel price increases would cause.
APPENDIX

The Implementation of an Air Quality Management Area (AQMA) System

The proposed Air Quality Management Area (AQMA) system recently proposed by the government for use by local authorities (LAs) could be expanded and used as a way of classifying all of the UK in terms of its air quality. This system has been proposed as a way in which LAs whose areas suffer from environmental pollution might be identified and measures taken to reduce pollution. This system would create a framework by which each LA could identify the standard of air quality in the areas falling within its remit and take the necessary measures to raise that standard. The classes identified would be based on a number of factors: the absolute levels of transport pollutants in the air; the levels of the specific emissions known to have health effects; congestion levels in the cities; the number of residents in the area in question; the presence of schools and hospitals in the area; average traffic speeds; presence of danger black spots and so on. Each of these parameters would be weighted according to the risk which they represent. The parameters themselves and the pollutant levels would be defined and set. Each LA would then have to choose the best policy tools to meet the specific needs of their own area. The benefit of such a system would be that people living in very rural areas or areas of very high air quality would not have to pay directly for the necessary improvements in poorer AQMAs within their LA zone — except when they entered those AQMAs in their cars. Each LA would have the responsibility of informing their local inhabitants of the air quality situation, the steps being taken to improve it and the steps which each individual could take to contribute towards that improvement.
REFERENCES


Standing Advisory Committee on Trunk Road Assessment Report, Department of Transport, May 1994.


