

Chapter 5 Clean Low Carbon Transport

Transport will contribute to carbon reductions...

- 5.1 The transport sector, including aviation, produces about one quarter of the UK's total carbon emissions. Road transport contributes 85% of this, with passenger cars accounting for around half of all carbon emitted by the transport sector.
- 5.2 The movement of people and goods will remain essential for economic success. Rising demand for transport reflects the priority which people attach to mobility. Transport is and will continue to be a highly-valued, high demand commodity.
- 5.3 But we can reduce the impact of transport on the environment through better, cleaner vehicles and fuels and by our action to reduce the negative impacts of traffic growth.
- 5.4 Measures for promoting a shift to low-carbon vehicles and fuels are brought together in our *Powering Future Vehicles*¹ strategy, published in July 2002. **That strategy is complementary to this white paper.** In the foreword to the strategy, the Prime Minister spelled out his objective that the UK should lead the global shift to the low-carbon economy, building competitive advantage for the UK's automotive industries as well as providing cleaner and better transport. We have set targets that within the next decade one in ten new cars sold in the UK will be low-carbon vehicles with emissions of 100 grammes per kilometre (g/km) CO₂ or less, and that one in five new buses will also be low-carbon. We have made the UK the first country to set itself targets for shifting its mainstream transport fleet to low-carbon technologies.

The *Powering Future Vehicles* (PFV) strategy

The PFV strategy provides a framework for decisions and action, aimed at promoting the development, introduction and take-up of low-carbon vehicles and fuels; and at ensuring the full involvement of the UK automotive industries in the new technologies.

The key components of the strategy are :

- to promote research, development and demonstration of new vehicles, fuels and fuelling infrastructure;
- to ensure that environmental, health and safety issues are dealt with;
- to ensure that new technical standards and testing procedures are promptly developed and put in place;
- to work proactively with EU and other partners on international issues and standards;
- to facilitate the quick and smooth development of new fuel distribution infrastructures;
- to ensure the continued development of appropriate taxation of low-carbon transport;
- in this and other ways, to encourage consumers' take-up of low-carbon vehicles and fuels, including financial measures and consumer information and awareness;
- to make maximum use of new vehicles and fuels in the Government and other public sector fleets;
- to work closely with all stakeholders in establishing the Low Carbon Vehicle Partnership; and
- to set challenging targets for making the UK a world leader in the move to low-carbon transport.

¹ *Powering Future Vehicles: The Government Strategy*. DfT, DTI, Defra and HMT, July 2002

5.5 Action at both UK and European level has already promoted significant technical progress and innovation in the automotive industries. We expect this progress to continue. Since 1990, the average carbon efficiency of new cars entering the fleet - the distance travelled for a given amount of carbon emitted - has improved by 10%. Cars have also become safer and cleaner, with air quality emissions down to one twentieth of what they were 20 years ago. These are important achievements. At the same time, strong economic growth and the high priority which people attach to mobility has led to increasing car mileage. The net effect is that total carbon emissions from car transport have been roughly flat.

5.6 The Transport Ten Year Plan² sets out a comprehensive programme of investment and innovation. The strategy focuses on addressing the negative impacts of congestion. It promotes increased use of public transport and a shift of goods traffic from road to rail, as well as sustainable patterns of land use. All help to reduce the need to travel and consequent environmental impacts. By 2005, we expect to see progress as a result of schemes to tackle traffic bottlenecks; a growing programme of new bypasses and other major road improvement schemes; better traffic management, helping to limit congestion on both motorways and in towns and cities; and increased use of public transport.

5.7 The Plan will be reviewed in 2004. The review will roll forward the Plan, setting out proposals for transport up to 2015 and will continue to take full account of our objective to reduce the environmental impact of transport.

Innovation will continue to improve vehicle efficiencies...

5.8 The EU voluntary agreements on new car fuel efficiency with the European, Japanese and Korean manufacturers have proved a highly effective mechanism for improving cars' fuel efficiency and reducing carbon emissions. They have provided manufacturers with a stable long term framework within which to plan, research and introduce fuel-saving innovations. This approach, which focuses on the levels of carbon emitted rather than on dictating particular technologies, gives manufacturers the flexibility to develop the best and most cost-effective solutions. The agreements are on course to reduce emissions from the average new car from 190g/km in 1995, the base year for the agreements, to 140 g/km by 2008 - a reduction of around 25%³.

5.9 **We strongly support this approach. We will work with the Commission in developing further voluntary agreements to continue the reduction in average new car emissions or other arrangements with the same objective.** We will draw on the expertise of the Low Carbon Vehicle Partnership in doing so.

5.10 In the UK we have backed the voluntary agreements with a supportive fiscal framework. We have moved to graduated Vehicle Excise Duty and Company Car Tax, both now linked to the car's CO₂ performance. This is encouraging car buyers to consider buying the lower-carbon vehicles coming into car showrooms. **We will keep transport taxes under review to ensure that they**

2 *Transport 2010 - the Ten Year Plan*, Department of the Environment, Transport and the Regions, July 2000.

3 All figures relating to the voluntary agreements are for 'tank to wheel' emissions.

continue to provide incentives to encourage the early development and take-up of low carbon vehicles and fuels.

it has attracted international attention. A further call for projects is in progress, to deal with identified Roadmap priorities.

Vehicle taxation - supporting low-carbon choices

Before 1999, **Vehicle Excise Duty (VED)** was the same flat rate for all cars. VED for new cars is now graduated, linked to a car's CO₂ emissions. VED now ranges from £60 to £160, with zero duty for electric vehicles.

Company Car Taxation (the personal tax on private use of company cars) also shifted to a graduated, CO₂-linked basis last year. Tax is payable on a proportion of car list price, ranging from 15% to 35% for higher emission cars.

We are monitoring the impact of the shift to CO₂-related taxation on car buyers' choices. Diesel car registrations in 2002 - with their lower CO₂ emissions - were 38% up on the previous year, taking diesel's share of total new car registrations to 23.5%, compared with less than 5% in 1990⁴.

5.11 We are also supporting strategic automotive research and development through the *Foresight Vehicle* programme. Over 400 companies and organisations are involved in projects valued at £100m. Around one third of these projects relate to low-carbon vehicle technologies, including new powertrains, advanced electronics and advanced materials and structures. The Foresight Vehicle Technology Roadmap⁵ was developed in collaboration with industry, and identifies priority issues. Published in November 2002,

⁴ Society of Motor Manufacturers and Traders Analysis of 2002 car sales.

⁵ www.foresightvehicle.org.uk/initiatives/init01.asp

Foresight Vehicle Programme - Project Examples

HEART4EV

This project seeks to increase the efficiency of the gas turbines used to power hybrid vehicles. The current limitation of this technology is a reliable, low cost, highly effective air-to-air heat exchanger (known as a “recuperator”), used to recover energy from the turbine’s high temperature exhaust gases and pre-heat the incoming air.

The project will result in the UK having a world leading, low-cost, durable and highly effective recuperator, for marketing worldwide. It will also open the way for future drivetrain programmes aimed at establishing the recuperated microturbine as an alternative to reciprocating internal combustion engines, with significantly lower fuel consumption and carbon emissions.

HERO

This project is investigating the application of parallel hybrid drivetrain technology in an off-road 4x4 vehicle. HERO demonstrates that the application of hybrid technology in the form of a “mild hybrid” can enhance both the performance and functionality of an off-road vehicle and reduce its environmental impact. This could significantly reduce exhaust emissions and allow the use of regenerative braking to make significant gains in efficiency.

LAMTRAK

This project is supporting another innovation - an infinitely variable ratio transmission device for use in vehicles - known as the Torotrak rolling traction variator - to increase fuel efficiency and reduce pollution.

LAMTRAK will assist Torotrak in meeting its target of 80% penetration of the world’s automatic transmission market. The project will improve understanding of the elasto-hydrodynamics of friction reduction in thin lubricating films. This in turn will lead to increased application in vehicles, leading to greater fuel efficiency.

RHOLAB

The RHOLAB project aims to develop a novel lead acid battery incorporating thermal management, fault tolerance and safety features as a traction battery for hybrid vehicles. A battery pack must meet a specification that includes sensing, switching and thermal and electrical control devices in a way that does not jeopardise its manufacturability. As part of the project, the consortium will build a prototype pack that will allow the operation to be assessed while powering a hybrid vehicle.

CHOICE

This project will design, build and evaluate a diesel series hybrid city bus incorporating vehicle and passenger information systems.

The vehicle performance will be optimised in terms of exhaust emissions and fuel efficiency based upon a wide range of input information including current and predicted operational duty, actual measured performance and current and immediate route location. The platform for the project is the Dennis Dart SLF single deck 50-passenger bus, with latest access features for disabled passengers. The series hybrid powertrain will employ an engine from the passenger car sector, giving lower cost, better emissions performance and fuel economy, compared to conventional bus powertrain systems.

5.12 The creation of the Low Carbon Vehicle Partnership is an important component in the Powering Future Vehicles Strategy.

The Low Carbon Vehicle Partnership - (LowCVP)

LowCVP - an action and advisory group - will promote the UK's shift to low-carbon transport, help industry, consumers, environmental and other stakeholders to participate in the shift, and maximise the competitive advantage for UK businesses.

Launched in January 2003, the Partnership Board is made up of top-level executives of UK auto manufacturers, transport operators, consumer and environmental groups and the research and technology sectors.

Early projects will include:

- a collaborative programme involving bus manufacturers, operators and users in shifting the UK to low-carbon buses;
- a programme to build the UK component industry's capability in the design and manufacture of key components for new technology vehicles;
- advice to Government on the role and remit of the Centre of Excellence for Low Carbon and Fuel Cell Technologies, an initiative proposed by the Automotive Innovation and Growth Team (AIGT) now being taken forward by the Government;
- advice to Government on the setting of 2020 targets for ultra-low-carbon vehicles, including zero-emission vehicles, and on the priorities for government R&D programmes; and
- helping Government co-ordinate its low-carbon research development and demonstration activities and providing a 'single portal' for potential participants.

5.13 Work⁶ commissioned by the Department for Transport and the DTI indicates the scope for further reducing average new vehicle carbon emissions. It suggests that full-specification family cars with carbon emissions of 100g/km (equivalent to about 75 miles per gallon of diesel) or less may be achievable within the next two decades, in particular through hybrid and related vehicle technologies. As the Foresight Vehicle Programme projects show, (see box, page 66) this is an area of technology where the UK has a strong research, development and design presence.

6 *Carbon to Hydrogen Roadmap for Passenger Cars : A Study for DfT and DTI, Ricardo Consulting Engineering Ltd, November 2002.*

Hybrid vehicles

Hybrid vehicles use internal combustion engines in conjunction with electric battery power, to give increased efficiency, lower fuel consumption and lower CO₂ emissions. Hybrids usually incorporate energy recovery from braking systems, and eliminate engine idling in static traffic. This also reduces noise and urban pollution. Hybrid vehicles will increasingly have the capability to switch to electric-only driving for extended distances, giving zero tailpipe emissions for example when driving through Low Emission Zones.

We support take-up of hybrid cars with £1,000 purchase grants under the *TransportEnergy* programme, administered by the Energy Saving Trust. Hybrids also benefit from lower Vehicle Excise Duty and Company Car Tax.

Two hybrid cars are currently available in the UK - the Toyota Prius, a family saloon with CO₂ emissions of 120g/km⁷ and the Honda Insight, a two-seater car at 80g/km. A four-door Honda Civic hybrid will become available in early 2003, at 116g/km.

UK-based Ricardo Engineering Consultants have produced the *i-MoGen* - a demonstration hybrid diesel car, delivering full 1.8 litre diesel

performance with a 1.2 litre diesel engine.

A number of global vehicle manufacturers and component suppliers are now applying *i-MoGen* technology in their future programmes.

We are supporting development and road demonstration trials of hybrid and other innovations through the Government's New Vehicle Technology Fund. Projects include a micro-turbine-engined bus developed by the Wright Group of Northern Ireland; two other hybrid bus projects being carried through by EA Technology and Environmental Transportation Systems; and an LPG-fuelled hybrid urban delivery van being developed by ENECO Ltd. Projects in the pipeline include several demonstration pilot diesel hybrid taxis.

Hybrid technologies provide direct and immediate benefits in reducing cars' fuel consumption, driving costs and carbon emissions. They also provide a stepping stone to the development of mass-market hydrogen powered fuel cell vehicles, since the electric traction and control systems used in hybrid vehicles will also be key components in fuel cell vehicles.



We can also reduce emissions through lower-carbon fuels...

- 5.14 Better cars will significantly reduce fuel use and carbon emissions. But we can also reduce the carbon intensity of transport by adopting fossil fuels that have a lower-carbon content. We already support the increased use of the well-established road fuel gases - LPG (Liquefied Petroleum Gas) and natural gas.

⁷ A car which has a fuel economy of 55mpg will emit 120g/km of CO₂

LPG and Natural Gas

We promote the wider use of these gases through lower rates of fuel duty, and through our *TransportEnergy* Programme, run by the Energy Saving Trust. This provides grants for the purchase and conversion of gas vehicles, and works together with the fuel industry on the fuels' availability on the road, and with vehicle manufacturers.

Starting from scratch in the late 1990s, **LPG** is now available nationwide from over 1,100 filling stations. The positive experience of LPG shows that, with industry and Government working together, major innovations in fuel technologies and distribution can be quickly and successfully carried through.

There are currently (February 2003) around 75,000 LPG cars in the UK. We have particularly encouraged manufacturers to develop off-the-shelf LPG car models, to make this fuel a mainstream showroom option for car buyers. Models are now available from eight manufacturers.

Natural gas is mainly used in heavy vehicles. Apart from lower emissions, the noise from gas fuelled engines is up to two-thirds lower than diesel engines, a useful environmental benefit in busy urban areas. *TransportEnergy* grants support the conversion or purchase of lorries, buses and utility vehicles. A major supermarket chain is in the process of converting its delivery fleet. Work with industry - vehicle manufacturers, users and fuel suppliers - continues with a view to encouraging wider take-up.

Our objectives for natural gas reflects the EU Commission's analysis of the future pattern of transport energy use, which identified natural gas - alongside biofuels and hydrogen - as an important component in widening fuel diversity and energy security in the transport sector.

- 5.15 And we are promoting the wider use of other alternative fuels - in particular biofuels - which have significantly lower lifetime carbon emissions. With the low duty rates being introduced, we estimate that biodiesel and bioethanol could account for up to 5% of total fuel use by 2020.

Biofuels for transport

Alongside renewably-produced hydrogen, fuels made from biomass represent an important potential route for achieving the goal of zero-carbon transport, creating new opportunities for agriculture in the UK as well as globally.

We have reduced the duty on **biodiesel** to 20 pence/litre below the standard (ultra low sulphur) diesel rate, and this fuel is now coming on to the retail market in increasing volumes in a 5% blend with conventional diesel. Some lorry fleets are also converting to 100% biodiesel fuelling.

As announced in the Pre-Budget Report in November 2002, we propose to introduce the same 20 pence/litre incentive for **bioethanol**, subject to EU agreement. This can also be used in blends for existing cars, potentially also as an 85% pure biofuel in adapted cars.

Biofuels are currently made from food crops. We are also interested in supporting the development of bioethanol and biodiesel production from biomass such as farm wastes, forestry residues, coppice crops and possibly also domestic waste. These can potentially deliver bigger carbon savings and wider environmental, farming and rural employment benefits.

A significant contribution to carbon reductions...

- 5.16 Taken together, the proposed continuation of voluntary agreements on vehicle carbon dioxide performance, increased use of biofuels and other initiatives could improve the carbon efficiency of transport by up to 10% by 2020. The carbon savings will increase further beyond 2020 as more fuel-efficient cars spread progressively into the fleet.

Ultimately taking us beyond fossil fuels, to a very low-carbon transport economy...

- 5.17 Although vehicle technologies seem capable of becoming twice as fuel-efficient as today's vehicles, deeper carbon reductions will need low-carbon fuels - either hydrogen (generated from non-fossil sources) or biomass-based liquid fuels.
- 5.18 The auto industry generally expects hydrogen powered fuel cell cars to move towards mass-marketing around 2020. This timetable ties in with the findings of a recent investigation⁸ carried out for us by environment and energy experts from three leading UK environmental organisations, the Energy Saving Trust, the Institute for European Environmental Policy and the National Society for Clean Air. This study indicates that the greatest carbon savings from early non-carbon electricity will come from its use to displace more carbon intensive electricity generation rather than from its use for transport energy. This suggests that the major environmental benefits from a shift to

the large-scale use of hydrogen-fuelled vehicles will come at the point when surplus low-carbon energy becomes available.

- 5.19 But on a longer-term time scale, hydrogen use in transport has major potential for decoupling transport and carbon, if current technological and cost barriers can be overcome. **We are is therefore supporting research, development and demonstration programmes (including vehicles and fuelling infrastructure) to overcome the initial market barriers to the development of this technology.** The Chief Scientific Adviser's Energy Research Review Group recognised that hydrogen production and storage was a key research area.

⁸ *Fuelling Road Transport - Implications for Energy Policy*, by Nick Eyre, Malcolm Fergusson and Richard Mills, November 2002.

Hydrogen, transport and future energy systems

Hydrogen looks likely to play a key role in future low-carbon energy systems, as an 'energy carrier' through which non-fossil energy can replace fossil fuels in stationary power units such as domestic fuel cell based CHP units and in vehicles. Hence the very wide interest in the prospective shift to a future 'hydrogen energy economy'.

Hydrogen fuelled vehicles have zero tailpipe emissions - they emit only water vapour at the point of use, improving local air quality. They will also be low-noise. Industry experts agree that buses, utility vehicles and similar depot-based fleets are likely to be candidates for the early trialling and introduction of hydrogen fuel cell technology, since larger vehicles can handle hydrogen fuel tanks more easily and need only depot supply of the fuel.

There is considerable international interest in developing hydrogen for transport. In the USA, increased funding for research and development into hydrogen-powered vehicles was announced in the 2003 State of the Union address. The aim is to take hydrogen powered vehicles from the laboratory to the showroom within a generation, and to develop hydrogen production, storage and distribution technology. This is expected to create further opportunities for US-UK collaboration.

Hydrogen can be produced from a wide range of sources, including hydrocarbons, biomass and wastes, or the electrolysis of water. But these sources must themselves be non-fossil for hydrogen vehicles to deliver their full lifecycle carbon benefits.

Hydrogen seems likely to play a key role in future transport technologies. We are supporting the shift by:

- exempting hydrogen from road fuel duty for a period to encourage its early development and take-up;
- granting Enhanced Capital Allowances with a 100% first-year write-down for investment in hydrogen fuel infrastructure;
- supporting fuel cell research (see paragraphs 4.59-4.60);
- giving hydrogen projects a high priority in the Carbon Trust's Low Carbon Innovation Programme;
- funding the trialling of fuel cell buses by Transport for London in 2003 and the supporting hydrogen fuelling station being installed by BP;
- supporting the trialling of fuel cell cars as these come out of car-makers' design laboratories; and
- working with London and other local and regional organisations on a wider network of demonstration trials, including linkages with existing local hydrogen distribution networks such as that on Teesside. We will encourage projects that can demonstrate hydrogen production in combination with other carbon abatement technologies.

A low-carbon economy needs to be planned for...

- 5.20 We expect both hydrogen and biomass fuels to play major roles in a very low-carbon transport economy, with benefits also in terms of improved energy diversity and security. But significant use of hydrogen for transport has profound implications for the long-term demand for non-fossil electricity as well as for future energy infrastructures, including electricity and gas. Equally, significant use of biofuels for transport has major implications for biomass production, fuel production, and fuel distribution - as well as for the rural economy and agriculture.
- 5.21 We need to adopt a strategic approach to both these important new technologies, bringing together the prospective uses of hydrogen and biofuels in transport with other aspects of the energy system. We need to understand more about the options and technologies for hydrogen and biofuel production. And we need a clear vision of the way in which infrastructures can evolve in good time. With industry, we also need to reach a common understanding of the likely trajectory to the availability of affordable hydrogen vehicles. **Drawing on the Low Carbon Vehicle Partnership and other expert knowledge, we will over the next year produce an assessment of the overall energy implications of both a hydrogen economy, and of large-scale use of biomass-based fuels, and develop roadmaps of the possible transition to these new fuels and vehicles.**

We need to reduce the emissions from aviation...

- 5.22 Demand is rising in the aviation sector internationally at about 4% a year. We all benefit from the growth in business, services and our ability to travel. International aviation emissions currently do not count in the national inventories of greenhouse gas emissions. There is no international agreement yet on ways of allocating such emissions. The UK's international emissions currently amount⁹ to some 8MtC (9MtC including domestic). They are expected to rise to some 14-16MtC by 2020.
- 5.23 **We are committed to ensuring that the long-term development of aviation is sustainable and that it meets its external environmental costs. We are discussing with stakeholders the most economic instruments for ensuring that the industry is encouraged to take account of, and where appropriate reduce, its contribution to global warming. We will set out our plans in an Air Transport white paper.** Potential instruments to address CO₂ emissions from international aviation being considered internationally include an en route emissions charge and participation in an open emission permit trading system. For domestic flights British Airways has joined the UK emissions trading scheme. These may be opportunities for future participation in this scheme for other carriers who operate UK-based routes.

⁹ UK aircraft CO₂ forecasts for 2030 are reported in Annex E of : *The Future Development of Air Transport in the United Kingdom: South East*. Department for Transport, July 2002 and February 2003.

Reduced emissions from the other transport modes, such as shipping...

- 5.24 Other transport modes account for much smaller amounts of energy and carbon but can contribute useful reductions. Like aviation, shipping is international in nature and in its oversight. The UK supports the work of the International Maritime Organisation (IMO) to put in place a global strategy for reducing greenhouse gas emissions from ships. An IMO Working Group is working on both technical improvements to engines, onboard machinery, hull and propeller design, and also working on operational and market-based measures such as environmental indexing of ships, voluntary agreements, emission standards and emission trading. The Working Group will put forward a draft resolution on the strategy at the IMO Assembly this year.
- 5.25 On the domestic shipping front the we are working to reduce carbon emissions from domestic freight transport by encouraging a switch from road to other modes. Freight Facility Grants support freight owners and carriers in switching traffic from road to inland waterways and this programme has now been extended to coastal freight and short sea shipping.

And rail...

- 5.26 Rail transport carbon emissions, accounting for less than 1% of total UK emissions, are typically about half those for road-based modes per passenger or tonne per kilometre. Investment in rail infrastructure will help to reduce overall carbon emissions by supporting the shift in passenger and freight transport from roads and domestic aviation. New rolling stock on the network is also more energy efficient, further helping to improve carbon performance.