

Powering future vehicles strategy

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Prime Ministers Foreword



Road transport is central to the UK's economic success and is a source of great personal freedom. But although road transport is so important for Britain, its use and growth inevitably carry other consequences. There are environmental impacts ranging from the global effects on climate change, to local impacts of air pollution and noise.

New technologies starting to come on stream offer us the chance of a different future vision for road transport: quiet and unpolluted city centres, with new vehicles run on clean and sustainable fuels.

Last year the Government published a draft strategy on *Powering Future Vehicles* for consultation. It set out our objective that the UK should lead the global shift to the low carbon economy, building competitive advantage for our automotive industries, and it invited comment on how we proposed to support the shift to low-carbon vehicles and fuels.

After this consultation, today's strategy sets out the policy we are going to implement. It includes two very important commitments. A target that within the next decade one in ten new cars sold in the UK will be low-carbon vehicles. And a target to increase the number of low carbon buses. Beyond 2010, we will accelerate the shift towards technologies such as hydrogen fuel cells, with zero tailpipe emissions.

These commitments make the UK the first country to set itself a target for shifting its mainstream motoring over to low-carbon technology, helping the environment, improving motoring, and helping build competitive advantage for the UK's auto industries, as the global market demands increasingly cleaner vehicles.

Delivering these objectives involves more than one part of Government, and I have set up a joint Ministerial Low Carbon Group to oversee the delivery of the low-carbon agenda, and to report annually to Parliament. But Government is only part of the story. Successful change depends also on the UK vehicle and fuel industries, consumer, environmental and other stakeholders. So I attach particular importance to the Low Carbon Vehicles Partnership announced in this document. I wish them every success in their work as we move towards a low carbon transport system.

Britain needs a modern transport system. But we also need to embrace fully our environmental responsibilities. It is the job of us all to get that balance right.

Tony Blair

Rt Hon Tony Blair, MP

Section 1

Introduction

1.1 New vehicle technologies and fuels offer opportunities for radically reducing the impact of road transport on the environment both globally in terms of climate change, and locally in terms of quality of life.

1.2 The Government's objective for the UK is clear that this country should lead the global shift to clean, low-carbon transport. The framework for decision-making put in place by this *Powering Future Vehicles* strategy, and the targets and decisions announced in this document, will support the UK's shift.

1.3 New vehicles and fuels will benefit the consumer, through a better quality of life and more fuel-efficient motoring. Setting out the right framework for the future will build competitive advantage for UK industry in the global shift to a low carbon transport economy.

1.4 The objectives of the *Powering Future Vehicles* strategy are:

- to promote the development, introduction and take-up of new vehicle technologies and fuels;
- and to ensure the full involvement of the UK automotive industry in the new technologies.

1.5 The strategy is not a technology master plan, because this is neither possible nor sensible, with many technologies and fuels being actively worked on. Although the ultimate low carbon destination looks likely to be fuel cells using renewably-produced hydrogen, the detailed route to that destination will depend on how the many technical issues are resolved. **Annex A** to this document, describing the range of prospective new technologies and fuels, in particular covers hydrogen fuel cell technology, and also hybrid (internal combustion and electric) technology, which most auto companies now see as a stepping stone technology to fuel cell transportation, offering substantial carbon reductions, as well as bringing forward, commercialising and building the component supply chain for the electric vehicle technology needed also for fuel cell vehicles.

1.6 Against this background, the Government's strategy is founded on focussing on the bottom-line low-carbon objective; on facilitating developments and fuels which support this; and on ensuring that Government takes the many necessary actions promptly and speedily.

1.7 The *Powering Future Vehicles* strategy therefore puts in place the framework for present decisions and actions, and further actions as new fuels and vehicle technologies come forward.

1.8 The Government is also taking two immediate actions to drive the UK forward to low carbon transport. It is setting itself the target that within the decade, one in ten new cars will emit 100 grams of carbon dioxide per kilometre or less the first targets which any major country has set for shifting its main-market vehicle fleet to low-carbon technology. It is also setting a demanding target for low-carbon buses. Second, the Government has initiated action with industry and other stakeholders, to launch the Low Carbon Vehicle Partnership by the end of the year.

1.9 In addition to delivering lower carbon dioxide emissions, low carbon vehicles will have an important role to play in delivering air quality improvements, especially in urban areas. This will have significant benefits for human health and the environment. Road transport is currently responsible for a significant proportion of emissions of some of the air pollutants of most concern, including particulate matter and oxides of nitrogen. Reducing emissions of these pollutants from

road transport will have a key role to play in helping the UK to meet its Air Quality Strategy objectives as well as to comply with legally binding EU limit values for these pollutants.

1.10 The strategy follows from the consultation draft, published in December 2001, which set out in some detail the background to the strategy and the challenges it will help overcome. Views of stakeholders were invited on the Government's proposed approach and in particular on the use of and level of targets. The proposals were strongly welcomed, and this final strategy document builds on the many substantial and detailed responses.

Section 2 The Strategy

2.1 Targets

The Government will set challenging targets for making the UK a world leader in the move to a low-carbon transport system, looking to the next decade and beyond.

2.1.1 Targets help promote progress toward shared goals. The targets set out below which Government sets for the delivery of the UKs shift to low-carbon transport, and its contribution to its achievement, rather than being Government targets for industry will send strong signals to the market about the Governments priorities; will indicate the objectives on which incentives such as fiscal measures and Government programmes will be focussed; and will help drive forward the change to a low carbon transport economy.

2.1.2 The Government, having considered responses to the draft *Powering Future Vehicles* Strategy, has now set the following targets, that:

By 2012, 10% of all new car sales will be cars emitting 100g/km CO₂ or less at the tailpipe

New cars sold today emit an average of 178 grams of carbon dioxide per kilometre, and the European Voluntary Agreement aims for this figure to reach 140g/km CO₂ by 2008. The Governments target for 2012 will demand significant improvements beyond this. In motoring terms these target vehicles will deliver around 70 miles per gallon, compared to a new car average today of 40 mpg.

By 2012, 600 or more buses coming into operation per year will be low carbon, defined as 30% below current average carbon emissions

The move to hybrid vehicle technology will be important here and this will deliver environmental benefits in terms of quieter, cleaner running in busy streets

2.1.3 The Government also plans to develop further targets, as follows:

Sales of ultra-low carbon cars by 2020

2.1.4 The Government wants to put in place a longer-term target that will help maintain the momentum of innovation and roll-out of new technologies. The Government envisages developing a 2020 target for the proportion of ultra-low carbon vehicles of the same magnitude as the 10% target for new car sales by 2012, with the expectation that a significant proportion of the 2020 cars will offer zero tailpipe emissions. The precise target, including the definition of ultra-low carbon will be quantified within one year.

Manufacturing and supply chains

2.1.5 The Government believes such targets will encourage UK involvement in the new low carbon vehicles, and it will be seeking advice, particularly from the Low Carbon Vehicles Partnership, on what would be realistic and achievable. This will form part of the Partnerships first years work.

Other targets

2.1.6 The Government aims to develop targets for **light goods vehicles**, as better data on the carbon performance of these vehicles becomes available. In the meantime the positive action under this

strategy should encourage the development of low carbon light goods vehicles in particular, with their closer similarity to cars. The Government will ask the Low Carbon Vehicle Partnership to support this work, keep progress under review and advise on possible targets as soon as practicable.

2.1.7 The Government is also committed to continuing to press for carbon savings from the **heavy goods vehicle** sector. Data is not currently available on heavy goods vehicle emissions. However, fuel cost is already significant to vehicle operators in this sector, and is a powerful driver for more efficient and therefore lower-carbon vehicles.

Keeping targets up-to-date

2.1.8 These targets reflect two common threads of the consultation responses that targets should provide a clear definition of low carbon, and should be achievable. They are based on today's information on the pace of technical development, but they need to be kept up-to-date. All target levels will be reviewed in 2005 to ensure that they remain challenging but deliverable, responding to developments in this rapidly changing field.

2.1.9 Government action to help meet the targets will be subject to Regulatory Impact Assessment and cost-benefit analysis of the action, and subject to review.

2.2 The Low Carbon Vehicles Partnership

The Government will work closely with all stakeholders from the automotive, energy and other sectors, establishing a forum to maximise the potential for UK business to gain competitive advantage from the Powering Future Vehicles strategy.

2.2.1 The Government in particular invited comment in the draft strategy on the setting up of a Low Carbon Vehicle Partnership. Consultation responses welcomed the concept. And the Automotive Innovation and Growth Team (AIGT) study published in April also viewed the Partnership as playing a key role in the shift to low-carbon transport. The Government welcomes these responses, and wants to see the Low Carbon Vehicles Partnership start as soon as possible.

2.2.2 The Partnership needs to belong to its members rather than to the Government. And Ministers have invited Professor Jim Skea, Head of the Policy Studies Institute, who also chaired the AIGT sub-group on environmental issues, to take on the job of Partnership Launch Director, to work with leaders from all the stakeholder groups, with the aim of getting the Partnership up and running by the end of the year.

2.2.3 The Partnership will bring together and involve all the constituencies with a stake in the shift to low-carbon vehicles and fuels, including:

- the automotive industries, including component suppliers, technology providers, and the vehicle sales and after-sales support sectors;
- the fuel and energy industries;
- motoring and consumer interest groups;
- transport operators;
- environmental interest groups;
- the finance and investment community;

- local government;
- the R&D and academic communities;
- the Energy Saving Trust and the Carbon Trust.

2.2.4 The Partnership will;

- encourage industries and other stakeholders to engage proactively in the move to low carbon vehicles and fuels, building on informed and shared knowledge of prospective technology developments, and the supply chain demands and opportunities which the new technologies will generate;
- provide a forum in which stakeholders can work together in overcoming market barrier issues affecting the shift to new vehicles and fuels;
- provide a forum for Government, industry and other partners to liaise on upcoming policy developments and regulatory issues national, EU and other. This will ensure that Government and partners keep closely in touch, and also assist Government in taking a proactive role in international developments, initiating action where necessary;
- and provide Government with independent input and feedback, particularly on problems and obstacles hindering the move to new vehicles and fuels, ways of dealing with them, and on the progress and effectiveness of Government programmes.

2.2.5 As an early task, the Government will seek the Partnerships advice on the setting of the targets for the introduction of ultra low carbon cars by 2020, and for the manufacturing and supply chain. The Government will also want the Partnerships views on the setting up of the Centre of Automotive Excellence and Development, to take forward work on low carbon and fuel cell technology one of the key recommendations of the Automotive Innovation and Growth Team. This Centre will complement the existing Government programmes, working closely with the Partnership.

2.2.6 The steps being taken to ensure that the Governments research, development and demonstration pilot programmes work effectively together are set out in Section 3 below, and include a key role for the Low Carbon Vehicles Partnership.

2.2.7 Finally, the Partnership will monitor and advise Government on progress towards the 2012 and other targets, and advise on the review of targets programmed for 2005.

2.3 Research, Development And Demonstration

Government will use its grant programmes to fund research development and demonstration projects and will review them regularly to ensure that they are properly focused and working effectively together.

2.3.1 **Annex B** summarises the main Government research, development and demonstration programmes supporting the shift to low-carbon vehicles and fuels.

2.3.2 In particular, *Foresight Vehicle* is the government's main automotive research and development programme. Over 100 projects have been started in areas such as electronic, telematics, materials and structures, power-train and design and manufacturing processes. The programme is carrying out a technology road mapping exercise to identify technology and research priorities for the next generation of vehicles.

2.3.3 Alongside *Foresight Vehicle*, the Government is sponsoring the *New Vehicle Technology Fund* to support the pilot demonstration and introduction of low carbon vehicle technologies. The Fund is administered by the Energy Saving Trust as part of its *TransportAction* initiative. Projects initiated and supported by the Fund include:

- The trial deployment of three **Daimler Chrysler hydrogen fuel cell buses** in London involving Transport for London, First Group Buses and BP, programmed for 2003;
- The **Wright Electrocitiy hybrid bus** which uses a microturbine that can run on either diesel, LPG or natural gas. This low-floor bus will be trialled in a number of cities later this year and is expected to deliver a 30-50% reduction in fuel use and carbon emissions, and improvements to local air quality.

2.3.4 Other important pilot demonstration projects in the pipeline include **hybrid diesel taxis**, further **hybrid bus** designs, and **hybrid diesel vans**. These are all sectors of the of the automotive industry in which UK companies have a strong presence as well as being types of vehicles for which hybrid technology offers particularly significant low-carbon benefits potentially up to 50% reduction in fuel use and carbon emissions.

2.3.5 The Chief Scientific Advisors Review of Energy Research considered that a dedicated hydrogen research programme should now be established to complement the work currently being undertaken in the Fuel Cells Programme. The Government intends to establish a hydrogen and low carbon fuels programme which will also allow work on intermediate fuels such as methanol to be undertaken.

2.4 Encouraging Consumer Take-Up Of Low-Carbon vehicles

The Government will encourage consumer take-up of low-carbon vehicles and fuels, through appropriate financial measures, and overcoming market barriers.

2.4.1 The Government will work to ensure that consumers in the UK feel able to take early and full advantage of new vehicles and fuels, building on the experience gained from promoting the present generation of new vehicles and fuels LPG, CNG, electric and hybrid vehicles through the *PowerShift* and *CleanUp* programmes among other measures.

2.4.2 In particular, the Government will:

- continue *PowerShift* type grants including grants for hybrid vehicles to support the move to low-carbon vehicles, and help offset the higher costs while the market for these vehicles is small;
- consider grants for other new vehicles as they reach the market, taking into account short and long term benefits, in terms of reducing carbon emissions, reducing air quality emissions and noise particularly in urban areas, and other factors. The Government will look to the Low Carbon Vehicles Partnership for advice on future grants and the operation of existing schemes;
- provide consumers with authoritative information on the availability, performance and safety of new vehicles and fuels including information on whole-life costs, for example where new vehicles have higher up-front purchase costs, but low running costs;
- work with the industry and financial service providers to develop new ways in which vehicles can be bought, owned or leased;

- provide authoritative information on the environmental performance of new vehicles and fuels;
- encourage other appropriate measures which will support consumer take-up of cleaner vehicles for example, Transport for London's decision that high quality alternatively fuelled vehicles will be exempt from the proposed London Congestion Charge Scheme.

2.5 New Fuel Distribution Infrastructure

Government will facilitate the quick and smooth development of new fuel distribution infrastructure as it is needed.

2.5.1 New vehicles and fuels may call for new fuel distribution infrastructure, and Government has an important job in facilitating its smooth and speedy development. The successful establishment of the LPG network across the UK now nationwide, with over 1100 forecourts has provided useful and positive experience of how new fuel infrastructure can be facilitated, by close attention to planning, health and safety issues, and close working together with local authorities and the fuel industry. Indeed, this is exactly the type of contact which the Low Carbon Vehicle Partnership will facilitate.

2.5.2 The Government is now working to secure the development of the network of CNG outlets. The low fuel duty on CNG and *PowerShift* and *CleanUp* grants have generated a high level of interest in using natural gas among vehicle operators. But take-up of natural gas vehicles is still held back, partly by the lack of suitable vehicles and partly by the lack of refuelling stations.

2.5.3 The Government, with vehicle manufacturers, fuel suppliers and local authorities, is bringing together interested potential users and potential suppliers of natural gas vehicles and fuel to build confidence in the natural gas market, by ensuring that the arrival and take-up of vehicles using new fuels goes hand in hand with the rollout of the fuels a further example of the working together which the Low Carbon Vehicles Partnership will in future facilitate. Meantime, Government has introduced Enhanced Capital Allowances single year capital write-down for investments in CNG (also hydrogen) fuelling infrastructure in the 2002 Budget, following the Green Technology Challenge.

2.5.4 Looking further ahead, the Government is providing zero-duty financial support under the Green Fuels Challenge for demonstration pilots covering a range of alternative fuel infrastructures, to generate information on their environmental, health and safety performance, and build knowledge in the UK. These pilots relate to:

- **hydrogen** refuelling for the fuel cell buses to be tested in London in 2003;
- use of **biogas** from landfill sites, for local use in dedicated vehicle fleets;
- the use of **methanol** in dedicated vehicles, looking at health and safety and other aspects of this fuel.

2.5.5 A further round of the Green Fuels Challenge is currently (July 2002) in progress, aimed at the full range of alternative fuels, including **bioethanol**.

2.6 Transport Taxation

The Government will support the move to a low carbon transport system by ensuring the appropriate taxation of vehicles, fuels and infrastructures.

2.6.1 The Government has already taken important steps to support moves to a low carbon transport system, specifically through:

- introduction of a graduated system of VED for cars based on carbon dioxide emission levels;
- introduction of company car taxation based on carbon dioxide emission levels;
- the successful use of fuel duty differentials to support the UK's switch to ultra low sulphur fuels;
- the Green Fuel Challenge pilot projects (noted above); and
- the favourable fuel duty differentials for road fuel gases and biodiesel.

2.6.2 Taking these measures further, Budget 2002 announced:

- the creation of a new low-carbon car VED band for vehicles that produce 120g/km of carbon dioxide emissions or less, increasing the differential between the cleanest and most polluting vehicles to £100 a year;
- Enhanced Capital Allowances under the Green Technology Challenge for companies buying the most efficient cars and for investments in CNG and hydrogen fuelling infrastructure;
- fuel duty exemption for hydrogen in the future for a limited period to encourage its further development as a road fuel (subject to the outcome of a pilot project);
- a commitment to introduce fuel duty incentives favouring sulphur free fuels from 2003;
- a second round of the Green Fuel Challenge inviting industry to submit further practical proposals for the development of alternative fuels with duty reductions or exemptions.

2.6.3 The Government will continue to keep transport taxation under review, and look at further taxation policy avenues available, to further incentivise the use and development of low carbon vehicles and fuels.

2.7 European And International Actions; Standards and Testing Procedures

Government will work proactively with its EU and other partners in the international aspects of securing the development, introduction and take-up of new vehicles and fuels.

Government will ensure that appropriate standards and testing procedures are put in place for new vehicles, fuels, and fuel distribution infrastructure.

2.7.1 All aspects of transport are now international. Vehicles are developed, manufactured and marketed internationally, transport operators and private owners then drive them internationally, and vehicle safety and environmental standards are now set at EU level. When new technology is in the early phases of development it is necessary to avoid being too prescriptive. The European type approval process allows new designs and technologies to be considered on their individual merits, even if they do not fit easily into existing regulatory regimes. The UK Government will promote applications from industry that seek to take advantage of these special arrangements.

2.7.2 Alongside the EU, the organisations concerned with vehicle and fuel issues include the International Energy Authority (IEA); the United Nations Economic Commission for Europe

(UNECE); the Organisation for Economic Co-operation and Development(OECD) and the World Trade Organisation (WTO). The Government is involved in all these organisations, working for appropriate standards, clear common environmental goals, and to ensure that international legislation and other effort is well-focused on priority issues.

2.7.3 Key issues, which will continue to be best tackled internationally, include:

- negotiations within the EU, and with European, Japanese and Korean Car manufacturers, on the next steps on CO₂ emissions following the present Voluntary Agreement and the 140g CO₂/km target for 2008/9;
- development of EU Emission standards for vehicles following Euro IV;
- developing and agreeing an international protocol for measuring the tailpipe CO₂emissions of hybrid vehicles;
- developing and agreeing a lifecycle methodology to compare the life cycle emissions related to different technologies and fuel supply routes;
- ensuring consistent quality standards for new fuels as they emerge, including hydrogen and other new fuels such as methanol and similarly, consistent standards for new fuel distribution infrastructure and equipment.

2.7.4 This work will take place in Europe and within the more global standards setting arena of the United Nations Economic Commission for Europe based in Geneva, where both Japan and the United States are active participants.

2.7.5 The EC 6th Framework Programme for Research, Technology Development and Demonstration has identified sustainable development as a headline research priority. One theme will focus on the integration of hydrogen and fuel cells into environmentally friendly transport systems. The UK is fully involved in taking this forward.

2.7.6 Other countries are also taking action to promote low carbon fuels and technologies; in particular Japan, with new car sales of 4.3 million per year, has set itself the target of having 50,000 fuel cell cars in operation by 2010, and Germany has established the Transport Energy Strategy (TES), a partnership between Government, vehicle manufacturers and the oil industry with the aim of promoting alternative low-carbon fuels.

2.8 Health And Safety Matters

Government will continue to ensure that health and safety and environmental concerns are fully dealt with in the move to new vehicle technologies and new fuels.

2.8.1 New fuels and technologies may raise different health, safety and environmental issues. But the Government successfully regulates existing fuels and technologies, all of which involve health and safety issues. And that same experience and expertise will be applied in future, ensuring that standards deal rigorously with environmental and health and safety concerns to safeguard human health and the environment, giving the public, vehicle users and local communities confidence in the safety and environmental integrity of new vehicles, new fuels and new fuelling infrastructure

2.8.2 Liaison between Government and the Environment Agency and the Health and Safety Executive will continue to be fully ready to deal with future issues as they arise. The Low Carbon Vehicles Partnership will also cover environmental, health and safety matters.

2.9 The UK Emissions Trading Scheme

DfT will work with business transport users to develop projects through which carbon savings made in the transport sector can be brought within the Governments Emission Trading Scheme.

2.9.1 The Government launched the worlds first economy-wide greenhouse gas emissions trading scheme in April 2002. This allows participants to meet emission reduction targets at lowest cost by reducing their own emissions or, if it is cheaper, by buying emissions allowances from other participants who have found it worthwhile to beat their own targets. The Government is currently working to design a projects entry route to the scheme, through which approved emissions reduction projects will be able to generate emissions reductions credits that can then be sold on. Transport will be one of the priority sectors for the projects entry route into the scheme.

2.9.2 The Low Carbon Vehicle Partnership can help identify opportunities for emissions trading and develop emission trading projects.

2.10 The Governments Vehicle Fleet

The Government will make maximum use of new vehicles and fuels in its own vehicle fleets, and encourage other public authorities to do so.

2.10.1 This is particularly important, given the size of the UK public sector fleet, not only with more innovative fuels and vehicle technologies that may be viewed with some caution by many fleet operators, but also in having a significant influence on vehicle manufacturers, fuel suppliers and fleet operators in the private sector.

2.10.2 The Government is delivering on this objective:

- by developing targets to require all Government Department and Agency fleets to reduce carbon emissions by cutting business mileage and fuel consumption and by procuring more fuel efficient vehicles, including alternatively fuelled vehicles;
- by publishing, with the Local Government Association, a guide to inform local authorities of the benefits of using battery electric vehicles for niche tasks;
- through the Energy Saving Trust's *TransportAction* programme, which has established close links with local authorities and is helping them switch to cleaner fuels and technologies with advice, encouragement and grant through the *PowerShift* and *CleanUp* grant programmes.

2.10.3 This will be followed up by regional workshops targeted at public sector fleet managers to raise awareness of cleaner fuels and vehicles and offering opportunities to drive and trial the latest vehicles. A forum for Government fleet managers is being set up to exchange ideas, experience and best practice.

Section 3

Delivering the *Powering Future Vehicles* strategy

3.1 Delivering the *Powering Future Vehicles* strategy will take sustained effort, not only across the key Government Departments, but across all the stakeholders, in bringing about this major shift in vehicle and fuel technologies.

3.2 Consultation responses welcomed the Governments proposals for ensuring the highest level of concerted endeavour, and these proposals are now being implemented, with the setting up of the high level Ministerial Low Carbon Group and the supporting Official Level Working Group, alongside the Low Carbon Vehicles Partnership whose key role has been described in section 2.2.

Ministerial Low Carbon Group

3.3 The Ministerial Low Carbon Group will provide overall high level co-ordination of the *Powering Future Vehicles* strategy and will report annually to the Ministerial Committee on the Environment and to Parliament. The Groups reports will be published.

3.4 The Group brings together the Ministers with direct policy responsibilities for the transition to low carbon transport. The inaugural membership of the Committee will be:

- DfT David Jamieson MP, Parliamentary Under Secretary of State for Transport;
- DEFRA Michael Meacher MP, Minister of State for the Environment;
- HM Treasury John Healey MP, Economic Secretary;
- DTI Brian Wilson MP, Minister of State for Energy and Construction;
- Cabinet Office Lord Macdonald, Minister for the Cabinet Office

together with Ministers nominated by the Scottish Executive, the National Assembly for Wales and the Northern Ireland Executive.

3.6 The terms of reference of the Ministerial Group are:

To oversee and keep under review the implementation of the Governments Powering Future Vehicles Strategy for promoting the development, introduction and take-up of low carbon vehicles and fuels and to ensure the full involvement of the UK automotive industry in the new technologies and fuels; and to report annually on progress to the Ministerial Committee on the Environment and to Parliament.

Official Level Working Group

3.7 The Official Level Working Group will support the Ministerial Group, involving officials from the same Departments. It will also be responsible for monitoring the overall situation; ensuring policy coherence; and ensuring that all the necessary international issues are dealt with, initiating action where necessary. The Group will work closely with the Low Carbon Transport Partnership on issues such as identifying priorities, developing the UK response to external initiatives and identifying areas where UK initiatives would create business opportunities for the UKs automotive and fuel sectors.

Building synergy between Government programmes

3.8 One priority for the Official Level Working Group is to develop more systematic links between the Governments programmes which deal with promoting the development and introduction of low carbon vehicles and fuels including the *Foresight Vehicle* programme (a DTI responsibility), the New and Renewable Fuels Programme (DTI) which includes hydrogen initiatives, the *New Vehicle Technology Fund* (DfT) and the *TransportAction* programme (DfT).

3.9 These programmes, though related, have distinct objectives and stakeholders, and will continue as distinct programmes, dealing with different stages in the process of the development, introduction and market penetration of new vehicles. But stronger arrangements are needed to ensure that the programmes mesh together coherently, covering the different stages in the road to market without duplication or gaps, building new synergy between the programmes.

3.10 Specifically, Government is putting in place a single portal which would act as a clearinghouse, through which companies will in future be able to access the range of Government support for projects at different stages along the road to market, without the multiple applications which the present programmes entail and ensuring that ideas and proposals feed quickly into the right programmes. The Low Carbon Vehicles Partnership members have a vital interest in these programmes working well together, and the Government will wish to discuss with the Partnership the possibility of its Secretariat looking after the operation of the single portal, drawing on the Partnerships pivotal position and its detailed knowledge.

Annex A

Prospective new technologies and fuels

Conventional Technologies

1. Nearly all vehicles on the road at the moment are powered by internal combustion engines using petrol or diesel. Emissions of local air pollutants like particulates and NO_x have been reduced through improving engine technology and, most importantly, through the development of exhaust after-treatment technologies, like catalytic converters and particulate traps. Improvements in engine and vehicle design have also led to better fuel efficiency and lower CO₂ emissions.

2. Improvements in both of these areas will continue to be made; significantly cleaner conventional vehicles are in prospect. In particular, technical improvements are expected for diesel engines, with new de-NO_x and particulate trap technology leading to vehicles with diesels better fuel economy and hence CO₂ performance but, potentially, without the present penalty in terms of air quality emissions.

Existing Alternative Fuels

3. Some alternative fuels are already in use. The role and potential for three of these liquefied petroleum gas (LPG), compressed natural gas (CNG) and battery electric vehicles (BEVs), as well as the barriers to their greater uptake, has already been covered extensively in the report of the Alternative Fuels Sub-group of the *Cleaner Vehicles Task Force*^[5].

4. Bio-diesel and bio-ethanol, although not yet widely used in the UK, are used in significant quantities elsewhere in the world, and will be stimulated through the Green Fuels Challenge package announced in Budget 2001.

Future Vehicles

5. The new vehicle technologies discussed here are *those which rely on sources of motive power other than, or additional to, an internal combustion engine*, and which have the potential to help us move towards a low carbon economy and a more sustainable transport system in terms of CO₂, air quality and noise. Over the next ten years and beyond, two technologies in particular hybrid electric vehicles and fuel cells appear likely to move towards commercial viability and start entering the market in material numbers.

Hybrid Electric Vehicles

6. Hybrid electric technologies involve joining and using two types of power source together to maximise the benefits of each. For example, an internal combustion engine and electric motor can be combined to maximise fuel efficiency and reduce emissions. During normal driving, the engine provides most of the power, and charges the battery. In stop and go urban driving the electric motor provides the power. This is not the only hybrid option there are a range of others, offering different configurations and approaches. The system can offer twice the fuel efficiency of a conventional vehicle, with only half the CO₂ emissions, and with air pollution benefits in the most polluted areas. Hybrid vehicles technology therefore offer significant benefits, by using improvements in existing mature technologies to deliver high efficiency, low emission vehicles. The technical and market barriers to hybrid vehicles are low: they use the existing fuel infrastructure and the battery does not need off-road charging.

7. Whilst hybrid technology is a further step in the process of refining conventional engine technology, many commentators see it as a bridge from pure internal combustion engines to fuel cells. At the same time, hybrid technology may also be used in fuel cell vehicles, since hybrid technologies are essentially a means of micro-managing energy flows as vehicles go through the cycle of starting, travelling and stopping, and therefore can be relevant to any form of primary power source.

8. Hybrid vehicles are already commercially available. In the UK, both Toyota and Honda offer hybrid electric petrol vehicles for sale, and other manufacturers are likely to follow. The Government is currently supporting the introduction of hybrid vehicles with purchase grants of £1,000 through the *PowerShift* programme.

Hybrid diesel vehicles

9. The hybrid vehicles that are currently on the market are petrol engined. But hybrid technology is likely to be applied also to **diesel** vehicles, with hybrid diesel cars, lorries and buses becoming mainstream market technology, offering a 50% fuel and CO₂ reduction compared to the best current vehicles. In addition, the particulate and NO_x emissions from diesels are likely to improve significantly with new particulate trap and de-NO_x technology, and the combination of this and hybrid technology will deliver vehicles with significantly better total environmental performance.

Hybrid buses and taxis

10. Hybrid buses and taxis represent a particularly attractive application of the technology, since they operate mainly in urban areas, where the fuel efficiency and CO₂ reductions offered by hybrids is greatest, and where hybrids capability to run partly on zero tailpipe emission battery mode is of particular value. Also, the UK has a significant bus and taxi manufacturing sector, and has a strong industry interest in being in the forefront in the development of hybrid buses and taxis.

Fuel cell vehicles

11. A fuel cell combines hydrogen and oxygen to produce electrical energy. This electrical energy can be used to drive a vehicle, or indeed can be put to any other use. Fuel cell technology promises clean, efficient and quiet operation and is now being promoted for a range of operations including mobile phones, laptop computers, power stations, combined heat and power applications, including domestic-scale CHP, and motor vehicles. For transport applications, the hydrogen can be stored on the vehicle either in liquid or gaseous form, or in a hydrogen rich fuel such as methanol or petrol. The oxygen is taken directly from the air. Many different manufacturers are developing fuel cell prototypes.

12. Fuel cell vehicles will take longer to produce than hybrid technologies; the application of the technology to road vehicles is very new, and there are considerable further technical and economic hurdles, in terms of raising the performance of fuel cell stacks, maintaining sustained performance, and bringing down manufacturing costs. Views vary on the timescale, but most experts feel that fuel cell cars are not likely to reach viable mass-market cost before 2010 to 2015.

Fuel cell buses

13. However, fuel cell **buses** look likely to reach the commercial market sooner than cars or heavy goods vehicles. Buses have enough space to accommodate fuel cell stacks, fuel storage and any necessary on-board reforming. Buses also operate from and pick up fuel from depots, and do not need any new fuel to be available generally across the road network.

14. Buses typically work in areas where air quality is relatively poor and lower emissions are a priority. Fuel cell buses, which can operate with zero tailpipe emissions, have a particular

environmental value in such areas. The Government is strongly interested in bringing forward this application of fuel cell technology. Specifically:

- Transport for London, with eight other cities worldwide is taking delivery of three fuel cell buses in 2003, for road trialling. The Government is supporting this initiative through the *PowerShift* programmes *New Vehicle Technology Fund*, and as a pilot project under the *Green Fuels Challenge* programme with a duty exemption for hydrogen.
- and the Government is also establishing close links with other potential fuel cell bus projects. For example the EU-funded USHER (Urban integrated Solar to Hydrogen Energy Realisation) project based at Cambridge University plans to run up to three buses on hydrogen. Potentially the buses could be powered by fuel cells.

Auxiliary use of fuel cell units

15. Alongside the use of fuel cells to meet the motive power requirements of vehicles via an electric drive train, another potential application for fuel cells being actively developed by automotive and fuel cell companies is as an auxiliary power unit (APU) to meet the increasing electrical requirements of modern vehicles. Fuel cell APUs could also open the way for additional vehicles services, such as an air conditioning system which could be set to come on prior to returning to the vehicle, or small on-board refrigerator. Such systems might be based on a different type of fuel cell technology and could be incorporated inconventionally-engined vehicles, for example as a more efficient way of powering refrigeration units in food transport vehicles, with lower CO₂ and other emissions.

New Alternative Fuels

16. This section summarises the main fuels beyond LPG and CNG which currently look to be potential fuels for more sustainable transport, and discusses the issues surrounding their use.

Hydrogen

17. Hydrogen can be used directly as an energy source for either conventional internal combustion engines, or for fuel cells. It can be stored in vehicles either as a compressed gas or as a liquid. Alternatively, hydrogen can be generated via reforming chemical compounds such as methanol all of which present issues relating to cost, safety and public acceptance. It is recognised that there are some disadvantages associated with the use of either gaseous or liquid storage of hydrogen. These include the weight and volume of the storage vessels (limiting the vehicle range), and in the case of liquid storage the use of low temperatures and the losses associated with boil-off. Other methods of hydrogen storage, including the use of hydrides or carbon nanofibres, are being investigated but are further away from commercial deployment.

18. At present, hydrogen is generally produced either from reformation of natural gas or other hydrogen-rich raw materials, or from electrolysis of water. Potentially, it can also be produced through capture of pre-combustion of carbon, for example from fossil fuel power stations or at petroleum wellheads, though this technology is as yet more expensive than post-combustion capture of CO₂. Some research has also been carried out into the production of hydrogen renewably from biomass, for instance, from cyano-bacteria exposed to sunlight. However, this process appears to be some way off viability except on a very small scale. A more likely avenue for producing hydrogen renewably is through electrolysis using electricity generated from renewable sources, though costs will need to fall for this to be commercially attractive.

19. Although hydrogen used in a fuel cell is clean in terms of tail pipe emissions, its lifecycleCO₂ and other emissions depend on how the hydrogen is produced. Hydrogen fuelled fuel cells will only

be truly sustainable when the hydrogen they use is produced from sustainable energy sources, such as renewable electricity or eg. electrolysis of water using wind power. The speed at which this becomes possible depends on the pace at which economic and technically robust forms of renewable electricity generation become available. A positive dimension, however, is that hydrogen potentially represents one way of storing energy from wind, solar or other intermittent sources when it is not immediately needed, potentially improving the economic viability of various forms of renewable energy.

Hydrogen ICE vehicles

20. Hydrogen can be used as a fuel in internal combustion engines. At least one vehicle manufacturer is exploring this avenue. The benefits are that it uses conventional vehicle technologies which are well understood, familiar and proven, whilst delivering reduced emissions. However, it is unlikely, given the inherent inefficiency of the internal combustion engine, to deliver such substantial emission reductions as a vehicle with a fuel cell powering an electric drive train. Some commentators however believe that hydrogen powered internal combustion engines will be a useful stepping stone to fuel cells whilst others argue that hydrogen in the internal combustion engine is a regrettable diversion, potentially delaying the ultimate move to fuel cell vehicles.

Methanol

21. Methanol too can be used either in conventional internal combustion engines, or directly in fuel cells. Methanol is generally produced from natural gas, though it is technically, though not yet commercially feasible, to produce it from bio-mass sources, which would significantly reduce lifecycle CO₂ emissions. It has a lower energy content than petrol or diesel and consequently also requires a larger fuel tank. Used in conventional internal combustion vehicles, it should offer some improvements in local emissions, particularly for older diesel vehicles, though the main interest in methanol is as a fuel for fuel cell vehicles. However, the use of methanol raises a number of health and safety issues, since it is toxic to humans, burns with an invisible flame, and can potentially contaminate water tables, although it is biodegradable.

22. Methanol can also be produced from hydrogen and CO₂. Where the hydrogen is renewably produced and CO₂ is recycled, the resulting methanol can be regarded as carbon-neutral. This form of methanol can in effect be viewed as an alternative to compressed or liquefied gas as a way of conveying hydrogen (renewably produced or otherwise) from the point of production to the vehicle engine. The economics of the alternatives depend on the costs of the two routes and how these costs change in the light of technical progress. That is to say, the comparative cost of compressing or liquefying carbon, transporting it and storing it, as against the cost of capturing CO₂, and making transporting and storing methane. Health and safety issues will clearly also be important.

Cleaner gasoline

23. Cleaner gasoline is essentially a zero sulphur petroleum distillate. It can potentially be used in fuel cell vehicles. Gasoline has the advantages of being familiar to consumers, and being available through an existing delivery infrastructure. But the gasoline used in fuel cells will probably need to have a zero sulphur content (less than 10 parts per million), to prevent contamination of the reformer and fuel cell. Cleaner gasoline is of course still a fossil fuel.

Reformulated natural gas

24. Natural gas has a high hydrogen content, is relatively inexpensive and has a well established production and distribution infrastructure. Up to 10% hydrogen can be added to natural gas, making what is known as hythane, without necessitating changes to the distribution infrastructure. Natural gas can be stored in compressed or liquefied form. There is considerable experience in natural gas usage both within industry and in vehicle applications. Natural gas is a fossil fuel, though its carbon

intensity would be reduced if combined with hydrogen to make methane but only if the hydrogen is renewably produced.

Re-Fuelling Infrastructure

25. There are many possible ways in which hydrogen could be supplied to fuel cells. The choice determines the re-fuelling infrastructure or infrastructures which would be required.

26. The two main options are *off-board* production of hydrogen, which is then stored on-board as compressed or liquefied hydrogen gas or in adsorbed form; or *on-board* production by the reforming of a hydrogen-containing fuel..

27. Different fuel production and storage routes have different implications for distribution infrastructure.

Off-board hydrogen production at a central plant

28. Hydrogen compressed or liquefied could be produced at a central plant from a variety of feedstocks electrolysis of water, natural gas or gasoline. It would then be delivered to local distribution points. Although hydrogen is already produced and distributed commercially for industrial applications including oil refining, much greater capacity would be required, to support widespread transport use.

29. Hydrogen needs to reach petrol stations. A dedicated pipeline network is possible, but would be costly and disruptive to install. Distribution by tanker, as industrial hydrogen is already extensively distributed, seems likelier. However, as it would take some eleven of today's type of hydrogen delivery tankers to supply the hydrogen equivalent of one tanker of petrol, this is probably only a suitable option whilst the hydrogen vehicle market remains relatively small. Petrol stations would need new storage facilities, and new forecourt pumps.

Off-board hydrogen production on a forecourt or vehicle depot

30. Reformation of hydrogen or local electrolysis on filling station forecourts or vehicle depots would avoid tanker distribution of hydrogen or a hydrogen pipeline network. However, small-scale forecourt reforming or electrolysis could be more expensive. The forecourts or depots would need to be supplied with the feeder fuel for reformation or power for electrolysis. Natural gas is available through the pipe network in most but not all are as of the UK, but some additional capacity could be needed at some stage. The petrol distribution network is in place. Localised electrolysis would need enhanced electricity connections, and the technology would have implications for the wider electricity system. Hydrogen storage capacity would be needed on forecourts or vehicle depots.

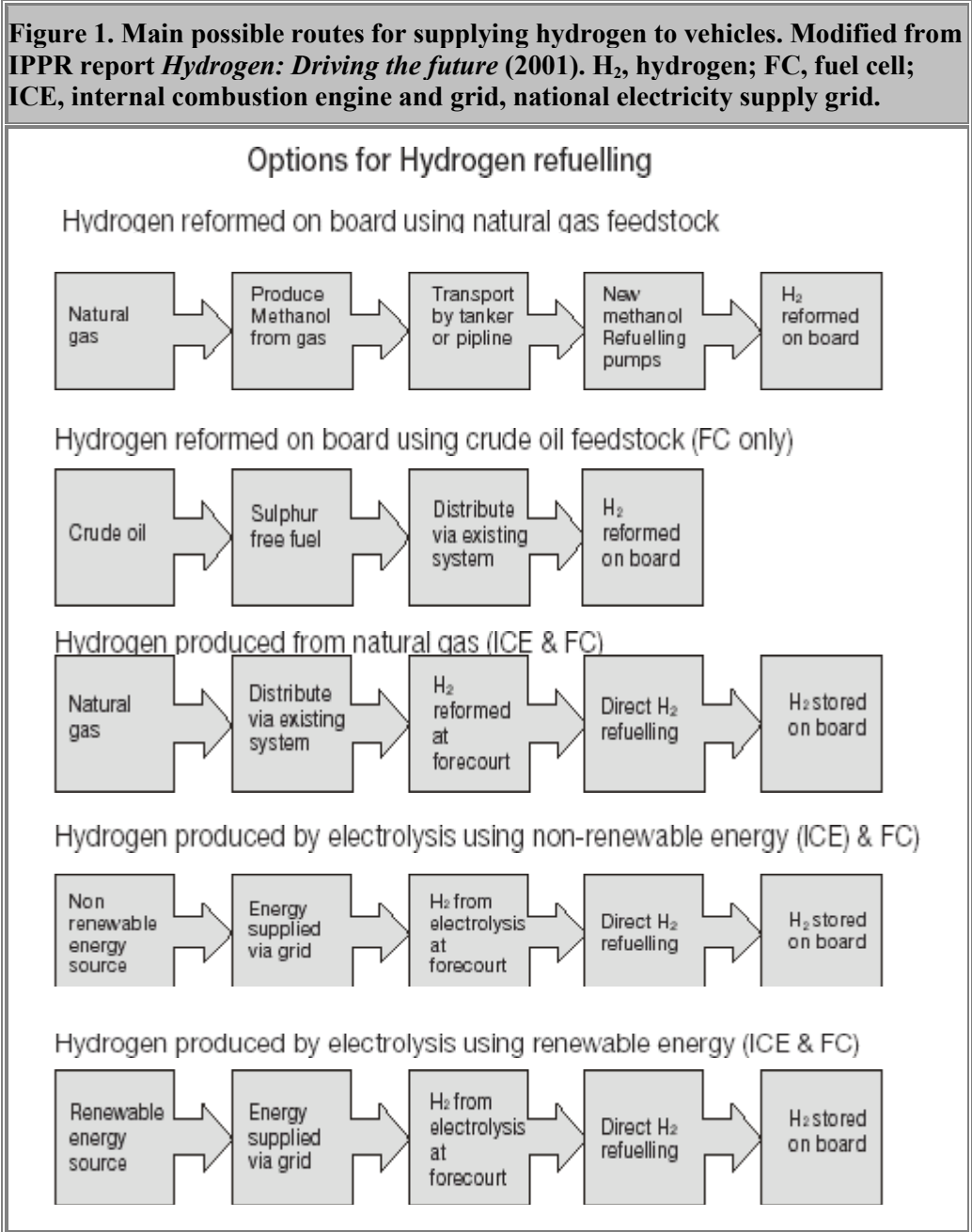
On-board hydrogen production

31. On-board fuel processing avoids the costs and safety issues around hydrogen storage problems, both on-board and off-board storage. But it can give rise to other problems, such as the weight penalty of an on-board reformer, contamination of fuel cells, and increased emissions associated with the use of feeder fuels other than pure hydrogen.

Re-fuelling infrastructure potentially a combination

32. It is not yet clear which re-fuelling route will be favoured ultimately. In fact, a variety of fuel cell technologies and re-fuelling options could be in operation alongside each other. For example, depot based vehicles, such as buses, which have the capacity to carry large storage tanks, may be powered by pure hydrogen, which would either be stored, electrolysed or reformed from another fuel at the depot. For this reason, and because buses tend to operate in urban areas where air quality

is a concern, it is widely predicted that buses will be some of the first vehicles to make use of fuel cell technology.



[5] The Report of the Alternative Fuels Group of the Cleaner Vehicles Task Force: An assessment of the emissions performance of alternative and conventional fuels. DTI (2000)

Annex B

Current government programmes and initiatives, which help the development of future vehicles

Programme	Brief description
	<p>PowerShift</p> <p>PowerShift provides grants towards the additional cost of new alternative fuel vehicles and towards the cost of converting existing vehicles to use alternative fuels. The main focus of the programme is supporting gas (LPG and natural gas), electric vehicles and hybrid vehicles. Administered by the Energy Saving Trust.</p>
	<p>CleanUp</p> <p>CleanUp part funds retrofitting of vehicles with emission reduction technologies to reduce the amount of harmful pollutants they emit. Administered by the Energy Saving Trust.</p>

Green Fuels

A programme, supported by a number of government departments led by HMCE, designed to ensure that road fuel taxation encourages the development of alternative transport fuels.

Challenge**Pilots****New Vehicle**

A DfT-funded initiative to support demonstration projects of innovative low-carbon vehicle technologies. Administered by the Energy Saving Trust.

Technology Fund**Foresight Vehicle**

A DTI collaborative research programme designed to promote the transfer of technology from the research base leading to the development in the UK of new automotive products and processes.

Programme

New & Renewable

A DTI collaborative industrial research and development programme designed to support the development of new and renewable energy technologies.

Energy Programme**Fuel Cell**

DTI collaborative industrial research and development programme designed to support the development of fuel cells for transport and other applications a sub programme within the New and Renewable Energy Programme.

Programme**Sustainable**

DTI programme designed to support the development of sustainable technologies in all sectors.

technologies

initiative

Green Technology

A Treasury co-ordinated scheme to offer to companies enhanced capital allowances for investment in designated green technologies.

Challenge

Road Haulage

Part of this DTLR scheme is designed to promote the more efficient use of HGVs through a Fuel Economy Advisors Scheme and also by promoting retrofitting through the CleanUp programme.

Modernisation

Fund