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Alternative Vehicle Fuels

This paper reviews the environmental and market drivers and government incentives that may influence take-up of the main alternatives to conventional vehicle fuels: petrol and diesel. These are road gas fuels LPG (Liquefied petroleum gas) and CNG (Compressed Natural Gas), bio-fuels, hydrogen fuels, including methanol and fuel cells.

Brenda Brevitt

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Summary of main points

Transport emissions are the fastest rising cause of greenhouse gases and account for around 25% of all UK carbon dioxide emissions. Finding an alternative to conventional fuels would help the UK meets its Kyoto targets. Vehicles running on cleaner fuels produce fewer harmful emissions, and can offer some savings on fuel costs, compared with petrol or diesel.

In addition to cleaner, low sulphur versions of the conventional vehicle fuels petrol and diesel, the main alternatives are currently road fuel gases LPG (liquefied petroleum gas) and CNG (compressed natural gas), bio-fuels and, more distantly, hydrogen fuels, including methanol; fuel cells, and electric vehicles.

As well as EU action, the UK government has introduced a range of fiscal incentives and initiatives to encourage the reduction of harmful emissions and a wider use of alternative, cleaner fuels, as the market and technologies develop.

The competitiveness of Natural Gas Vehicles (NGVs) compared with conventional vehicles will depend on a range of factors including ease of refuelling, comparative fuel costs and duty, engine lifetimes, performance and manufacturing costs. Grants of up to 75% are available from the Energy Saving Trust, through the PowerShift programme, towards of the cost of the conversion and purchase of gas and electric vehicles.

Vehicles could use hydrogen in a variety of ways; with minor alterations all conventional internal combustion engines (ICEs) powered by petrol can be made to burn hydrogen directly. The major stumbling block is the lack of infrastructure for the storage and distribution of hydrogen. Pure methanol can potentially offer reductions in emissions of major air pollutants compared with existing diesel fuels, but it is poisonous, and in the longer term, the main benefit is likely to be as an input fuel for fuel cells.

Fuel cells convert the energy stored in a fuel (for example hydrogen) into electrical energy by a simple electrochemical reaction in which oxygen and hydrogen combine to form water. Each fuel cell type, classified according to the nature of the electrolyte, requires particular materials and fuels and is suitable for different applications. If hydrogen is derived from non-fossil sources, such as renewables, or if waste CO_2 from fossil fuel hydrogen production is sequestered, then fuel cells offer the prospect of ‘zero emission’ power for transport and stationary applications.

Bio-fuels (bio-ethanol, bio-diesel and bio-gas) could play a major part in achieving the UK’s renewable energy targets for heat and power, with a more limited role in producing alternative vehicle fuels. An EC Action Plan, and two draft Directives published at the same time, place an obligation on Member States to comply with the introduction of bio-ethanol and bio-diesel, and allow for differentiated tax rates to operate in favour of these fuels.

CONTENTS

I Introduction

Transport emissions are the third largest[1] and fastest rising source of greenhouse gases[2] and account for around 25% of all UK CO_2 emissions.[3] Since 1970, total UK CO_2 emissions have fallen by 22%, with significant falls in emissions from power stations and industry, but those from road transport increased by 92%.[4] Finding a cleaner alternative to conventional fuels would help the UK contribute to the achievement of its Kyoto targets.[5] The government is also keen to reduce dependence on oil, given the vulnerability of supplies from politically unstable regions.

International scientists are clear that all countries will have to cut greenhouse gas emissions, particularly carbon dioxide, in order to prevent the harmful effects of climate change. The current view is that this should be done through a series of economic, political and social incentives that will lead to a significant reduction in emissions of atmospheric carbon, and move society towards a sustainable low carbon economy.[6]

Modern society is driven by its dependence on oil to fuel its transport needs. Ninety three per cent of all journeys in the UK are made by road vehicle, the overwhelming majority by car.[7] New UK car sales have increased over the last twenty years, with over 2.2 million sales in 2001.[8] Seventy per cent of households in the UK have regular use of a car, and there are an estimated 26.8 million regular drivers in the UK.[9]

Despite fuel price protests, the risks to health, road congestion, and road accidents and deaths, few people will sacrifice the convenience and mobility that personal transport affords, in favour of less driving or resorting to public transport. According to the Retail Motor Industry Federation (RMIF), 75 % of motorists would not use public transport to get to work, even if travel-to-work costs were halved. More and more freight is moved by road, adding to emission problems, noise nuisance and road congestion.

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1 HC Deb 19 October 2001 cc1361-1405

2 Greenhouse gases reduce heat loss from the earth; however an excess of greenhouse gases will retain too much heat and contribute to global warming. Gases having a global effect are Carbon dioxide, methane and Nitrogen oxides. http://www.aeat.co.uk/netcen/airqual/emissions/co2.html

3 Proposal for a European Directive relating to the quality of petrol and diesel fuels Regulatory Impact Assessment, DTLR August 2001.

4 *UK Emissions of Air Pollutants 1970 to 1999*, Annual Report from the UK National Atmospheric Emissions Inventory http://www.aeat.co.uk/netcen/airqual/emissions/den-naei.html

5 DETR Press Notice '*Michael Meacher welcomes Green Fuel Challenge Pilot Projects'* 19 December 2001. To meet its Kyoto obligation the UK needs to cut production of the main greenhouse gases to 87.5% of 1990 levels by 2012; the government have set a target of a 20% reduction in CO_2 emissions by 2010.

6 For a detailed discussion on this topic see Library Research Paper 01/106 *Climate change and the Kyoto protocol*. Dec 2001.

7 DETR Transport statistics 2001.

8 Provisional, based first three quarters Retail Motor Industry Federation http://www.rmif.co.uk

9 *ibid*

The convenience and dependence on the car comes at a price, however, not just for initial outlay, fuel and maintenance, but the problems associated with climate change, urban air pollution, noise pollution, and an unacceptable degree of dependence on oil from politically insecure sources. Vehicle emissions have been linked to atmospheric pollution, climate change, and deaths and deterioration in respiratory health, and the search for a vehicle fuel that will produce no harmful emissions and maximise fuel efficiency and economy has become the holy grail of cleaner vehicle fuel development. In some countries, however, addressing poor air quality, health concerns or road congestion may be given higher priority over enhancing vehicle performance and fuel efficiency.

Generally speaking there are three categories of fuels that represent options to the traditional road fuels, petrol and diesel:[10]

- Ultra-low sulphur versions of both petrol and diesel that may be used in existing engines, and which are commonly available. To encourage their adoption the Government has cut excise duty rates relative to the standard product.[11]

- Bio-diesel and road fuel gases (liquefied petroleum gas and compressed natural gas) that may be used in adapted vehicles, or those specifically designed for their consumption. Their availability is more restricted than ultra low sulphur diesel and ultra low sulphur petrol, though their adoption is encouraged not only by the existence of a duty rate differential, but also by grants for the conversion or purchase of vehicles under the 'PowerShift' programme. The scheme also provides grants for vehicles to be fully or partly powered by electricity.

- Alternative fuels that still require further research and development before being available for widespread use: bio-ethanol and bio-gas in the medium term; in the longer term, methanol and hydrogen. Under the 'Green Fuels Challenge', first announced in the November 2000 *Pre-Budget Report*, pilot projects for duty rate reductions or exemptions of these new fuels were introduced during the course of 2001.[12]

In the long term, a hydrogen economy, where the only emission is water, seems a distant, but not unattainable prospect.

This paper looks at the environmental case for developing alternative fuels, the market drivers, incentives, and changes in the structure of excise duties that may encourage their

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10 An introduction to this topic is given in an Energy Saving Trust leaflet *Clean Fuels Factsheet*, 2001. http://www.transportaction.org.uk/vpo/downloads/facts/Clean_Fuels_fact_sheet.pdf

11 The Government's policy to encourage the use of both these products is examined in some detail in, *Road fuel prices and taxation*, Library Research paper 01/52 11 May 2001.

12 For more details see *Pre-Budget Report* Cm 5318 November 2001 para 7.35-39

take-up, and the supply of these fuels. The paper concludes with Appendices giving background information on each of the main alternative vehicle fuels.[13]

II Climate Change[14]

A. The Kyoto Protocol

The Kyoto Protocol of the UN Framework Convention on Climate Change (UNFCCC)[15] represented an acceptance that climate change was caused by human activity. In 1998 the Intergovernmental Panel on Pollution Control (IPPC) was established to improve understanding of the risks of human behaviour on climate change.

The protocol has 84 signatories but only 33 have ratified the protocol and of those only one, Romania, is an Annex I country. The Protocol shall enter into force:

> on the ninetieth day after the date on which not less than 55 Parties to the Convention, incorporating Parties included in Annex I which accounted in total for at least 55 per cent of the total carbon dioxide emissions for 1990 of the Parties included in Annex I, have deposited their instruments of ratification, acceptance, approval or accession.

This achievement is some way off as so few of the major industrialised nations have ratified the protocol. Since the Bonn meeting, the EU has announced they intend to ratify by 2002.

> "Now countries can finally move ahead and ratify the Protocol," Ms Wallström added. "The European Commission fully intends to present a proposal for EU ratification before the end of the year so that the process can be completed in 2002. I urge other signatories to do the same so that the international community brings the Protocol into force in time for the World Summit on Sustainable Development in September 2002."[16]

The targets (as percentages of 1990 emissions) agreed under Kyoto are as follows:[17]

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13 For an analysis of other strategies for saving oil and carbon dioxide emissions in transport through technical changes, improving vehicle efficiency and reducing light vehicle and freight travel, the reader is referred to '*Saving oil and reducing CO2 emissions in Transport: options and strategies*', OECD / International Energy Agency, 2001.

14 Material for this section supplied by Stephen McGinness Science and Environment Section.
See also: Library Research Paper 01/106 *Climate change and the Kyoto protocol*. Dec 2001.

15 http://www.unfccc.org/resource/cop3.html

16 EU Environment DG Press release, *Joint EU Presidency and European Commission statement on the successful conclusion of the Bonn climate change negotiations*, 23 July 2001
http://www.europa.eu.int/comm/environment/climat/press230701.htm

17 http://www.unfccc.de/resource/docs/convkp/kpeng.html

Country	Target emissions as percentage of 1990 emissions	Country	Target emissions as percentage of 1990 emissions
Australia	108	Liechtenstein	92
Austria	92	Lithuania	92
Belgium	92	Luxembourg	92
Bulgaria	92	Monaco	92
Canada	94	Netherlands	92
Croatia	95	New Zealand	100
Czech Republic	92	Norway	101
Denmark	92	Poland	94
Estonia	92	Portugal	92
European Community	92	Romania	92
Finland	92	Russian Federation	100
France	92	Slovakia	92
Germany	92	Slovenia	92
Greece	92	Spain	92
Hungary	94	Sweden	92
Iceland	110	Switzerland	92
Ireland	92	Ukraine	100
Italy	92	United Kingdom of Great	
Japan	94	Britain and Northern Ireland	92
Latvia	92	United States of America	93

European Union involvement in the Protocol has been resolved as a European 'bubble' within which individual nations will have their own targets to meet those of Kyoto rather than those stipulated in the Protocol itself: [18]

Country	Target emissions as percentage of 1990 emissions	Country	Target emissions as percentage of 1990 emissions	Country	Target emissions as percentage of 1990 emissions
Austria	87	Germany	79	Netherlands	94
Belgium	92.5	Greece	125	Portugal	127
Denmark	79	Ireland	113	Spain	115
Finland	100	Italy	93.5	Sweden	104
France	100	Luxembourg	72	UK	87.5

Thus the UK's commitment is to have emissions totalling 87.5% (a 12.5% reduction) of the emissions level in 1990. There is no stipulation within the agreement on how cuts are to be made, or where the cuts should come from. The United Kingdom's Climate Change Strategy proposes a domestic goal of a 23 % reduction in greenhouse gas emissions by 2010.

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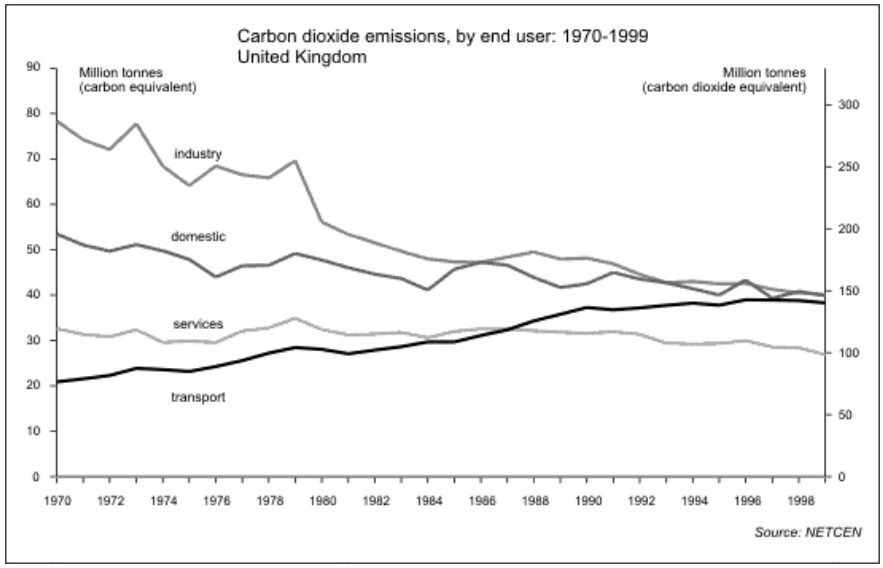
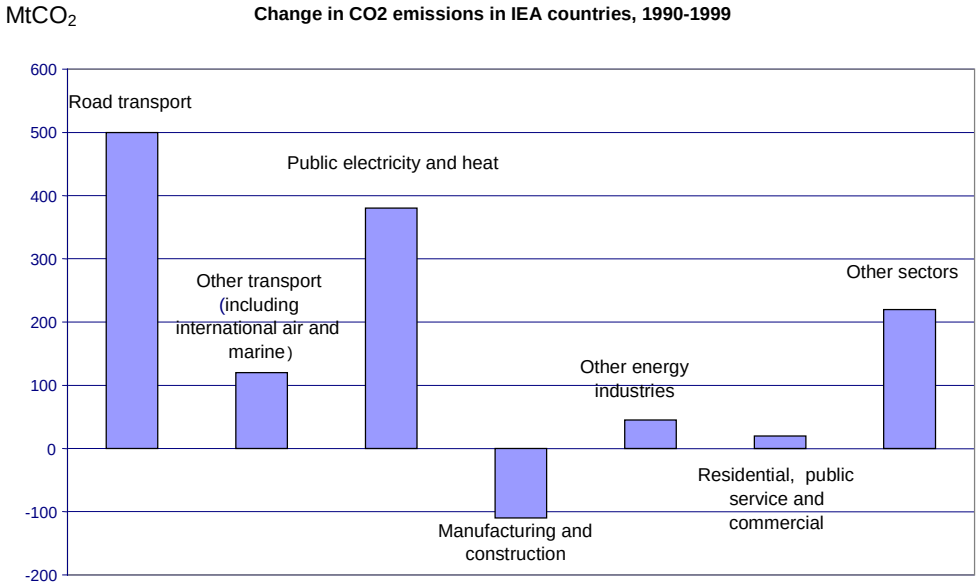
[18] DETR, *Climate Change: The UK Programme*, Cm 4913, November 2000 http://www.environment.detr.gov.uk/climatechange/cm4913/pdf/section1.pdf

The following graph taken from *The Environment in your Pocket 2001*[19] provides an indication of how the ratio of carbon dioxide emissions in the UK from the four major sources of greenhouse has changed between 1970 and 1999.

The domestic and service sectors, after some sharp drops in the 70's and 80's remained fairly stable while the industrial sector has shown a much greater tendency to reduce emissions, which are linked to energy use and therefore expenditure. Reducing unnecessary energy costs may reduce emissions.



The major growth in greenhouse gas emissions, offsetting in part the gains made by the reduction in industrial emissions, is transport. This profile is mirrored across IEA countries through the 90s.



Source: '*Saving oil and reducing CO2 emissions in Transport: options and strategies*', OECD / International Energy Agency, 2001.

[19] DEFRA 2001.

The third national communication under UNFCCC outlines the policies believed to contribute to meeting the commitment to Kyoto and the self-imposed commitment to reduce carbon dioxide emissions by 20%. Key policies include:

- European-level agreements with car manufacturers to improve the fuel efficiency of new cars by at least 25% by 2008-2009;
- A 10 Year Plan for Transport.[20]

The government expects there to be significant reductions in emissions of carbon dioxide, nitrogen oxides (NOx) and particulates ($PM_{10)}$ by 2010 as a result of actions set out under its 10-Year Plan for Transport, although the figures appear to show significant reductions in NOx and PM_{10} emissions without a plan, possibly due to other initiatives on emissions, and technological advances.[21]

Forecast 2010 CO_2 emissions in Great Britain

	Total emissions	Saving compared to 2000 (million tonnes of carbon)
2000	31.0	-
2010 without plan	31.7	+0.7
2010 with Plan	30.1	-0.9

Forecast 2010 NO_x emissions in England

	Total emissions (Kt)	Percentage change
2000	501	-
2010 without plan	213	-57.5
2010 with Plan	208	-58.5

Forecast 2010 PM_{10} emissions in England

	Total emissions	Saving compared to 2000 (million tonnes of carbon)
2000	20.3	-
2010 without plan	11.1	-45.3
2010 with Plan	11.0	-45.8

B. Air pollution and health

Clean air is essential to a good quality of life, yet each year many thousands of deaths are linked to the effects of air pollution. Improving local air quality is a key government aim. The earliest anti-pollution strictures came about due to bad air quality caused by the burning of fuels generating black smoke and soot. The main local air pollutants outlined in the table below illustrates how road transport (and thus vehicle fuels) contributes to air pollution.[22]

[20] http://www.defra.gov.uk/environment/climatechange/3nc/pdf/climate_3nc.pdf p24
[21] HC Deb 15 January 2002 cc198-9W

Main local air pollutants		
Carbon Monoxide	CO	A gas formed by the incomplete combustion of carbon-containing fuels. The more efficient the combustion processes the lower the emissions. The main outdoor source of CO is currently road transport, particularly petrol-engine cars
Nitrogen Oxides	NOx	All combustion products in air produce oxides of nitrogen: nitrogen dioxide (NO_2) and nitric oxide (NO) – collectively known as NOx. Road transport accounts for about 50% of total emissions, more than the electricity supply industry and the industrial and commercial sectors put together. NOx is also a precursor of ozone and therefore an indirect greenhouse gas.
Particulates	PM_{10}	Particulate matter smaller than 10 microns (10 millionths of a metre). They consist of primary particles arising from combustion sources (mainly road transport); secondary particles (mainly sulphate and nitrate formed by atmospheric chemical reactions); and coarse particles (suspended soils and dusts, sea salt, biological particles and particles from construction work). Ultra-fine particles (smaller than 2.5 microns) are mainly primary and secondary.
Sulphur Dioxide	SO_2	In the UK, the predominant source is the combustion of sulphur-containing fossil fuels, principally coal and heavy oils. Output from road vehicles is relatively small, but combustion of fuel (especially diesel) makes a significant contribution to emission levels in urban areas.
1,3 Butadiene		A gas at normal temperatures and pressures deriving mainly from the combustion of diesel and petrol engines.
Volatile Organic Compounds	VOC	In sunlight these react with NOx to form ozone. Can therefore be considered an indirect greenhouse gas. Ozone measured at a particular location may have arisen from VOCs and NOx emissions hundreds or thousands of miles away. So high concentrations generally occur downwind of the source emissions, most frequently in Summer, in the south, and in rural and suburban areas.
Benzene		One of the VOCs, its main atmospheric source has been the combustion and distribution of petrol, to which it has traditionally been added. New fuel standards introduced from January 2000 have set stringent limits on benzene levels in petrol.
Lead	Pb	Previously used as an additive to enhance the octane rating of petrol, most of the national airborne emissions of lead have arisen from petrol-engine vehicles, but they have declined since the phasing out of leaded petrol prior to 1 January 2000.

Source: HM Customs and Excise, Using the tax system to encourage cleaner fuels, November 2000

The quality of air has become of increasing importance as the association between the presence of various pollutants and a negative impact on public health has become better established. Showing association between a health effect and an air pollutant, however, is not the same as proving causality, and as COMEAP[23] notes, their best estimates are fraught with uncertainty. Their quantitative conclusions, confined to hospital admissions and mortality from all causes, are shown below.

Normally there are about 430,000 deaths in urban areas each year and around 530,000 respiratory hospital admissions. Estimated health outcomes attributable to pollutants are:

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22 HM Customs and Excise, *Using the tax system to encourage cleaner fuels*, November 2000

23 Committee on the Medical Aspects of Air Pollutants at http://www.doh.gov.uk/comeap/

Health outcomes GB urban		
PM_{10}	Deaths brought forward (all causes)[24]	8,100
	Respiratory hospital admissions brought forward and additional	105,500
SO_2	Deaths brought forward (all causes)	3,500
	Respiratory hospital admissions brought forward and additional	3,500
NO_2	Respiratory hospital admissions brought forward and additional	8,700

Source: COMEAP Quantification of the Effects of Air Pollution on Health in the UK Department of Health 1998

Deaths are affected by bringing forward the death- but it is impossible to say by how long – and admissions are affected in part by bringing forward the admission – but there may also be some truly new or additional admissions. The breakdown between the two is uncertain.

C. The Air Quality Strategy

The Air Quality Strategy for England Wales and Northern Ireland[25] released by the Government in January 2000 lays out the objectives for improving the air quality in the UK, to be achieved by 2008. The strategy targets eight of the main air pollutants: benzene; 1,3-butadiene; carbon monoxide; lead; nitrogen dioxide; ozone; particulate matter (PM_{10}) and sulphur dioxide.[26] In respect of PM_{10} and NO_2 however, it is unlikely the targets will be met, particularly in urban areas, and although particulate and nitrogen oxide emissions have fallen by about 50% since 1990,[27] the government are keen to investigate the potential of various fuels to further reduce these emissions.

Local authorities are responsible for monitoring emissions, and reviewing and assessing air quality for seven of those pollutants, ozone being excepted due to the effect of pollutants of multinational origins on the gas.[28] The role of the Government and the devolved administrations are laid out as providing:

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[24] Deaths brought forward – deaths occurring earlier than might have otherwise been expected, particularly amongst vulnerable groups, such as the very young or elderly, the sick, or urban poor. See COMEAP *Statement on long-term effects of particulates on mortality*, March 2001 for a discussion on the causal effect of ambient concentrations of fine particles and life expectancy. http://www.doh.gov.uk/comeap/statementsreports/longtermeffects.pdf

[25] *The Air Quality Strategy*, Cm 4548 (2000)

[26] The air quality strategy for England, Scotland, Wales and Northern Ireland: A consultation document on proposals for air quality objectives for particles, benzene, carbon monoxide and polycyclic aromatic hydrocarbons. DEFRA. 2001. Deposited Paper 01/1555

[27] HC Deb 19 October 2001 c1362

[28] Ozone is a bluish gas composed of three atoms of oxygen that is harmful to breathe. Located mainly in the stratosphere it absorbs a type of UltraViolet radiation (UVB) that can be harmful to DNA, and is linked to melanoma and skin cancer.

- A clear and simple policy framework;
- Realistic but challenging objectives
- Regulation and financial incentives to help achieve the objectives
- Analysis of costs and benefits
- Monitoring and research to increase our understanding
- Information to increase public awareness

The four main aims of the Strategy are listed as:

- Social progress which meets the needs of everyone;
- Effective protection of the environment
- Prudent use of natural resources; and
- Maintenance of high and stable levels of economic growth and employment

Air pollution measures are shown in either mg/m^3 which means a concentration of thousandths of a gram per cubic metre of space, or parts per million (ppm) so that for every million 'parts' of air so many will be the pollutant. The target levels presented within the Air Quality Strategy are generally accepted internationally. It is almost impossible however to set concentrations that will ensure no health damage.

The monitoring of air quality will, initially, provide a benchmark. This should identify those areas where the standards are not being met and whether work is needed to identify and either remove or simply disperse the source of this pollution.

Local authorities have a number of guides to help them draw up action plans and implementing their air quality objectives. Transport plans and powers to establish low emission zones can all be used to minimise the build up of pollutants in specific areas. What is not certain from the Strategy is whether the targets will reduce total emissions or simply encourage local authorities to ensure that pollution is 'spread around'. Neither is it clear whether failure to meet the stated targets will result in simple punitive measures or positive aid in managing intractable problems

III Fiscal incentives and excise duties[29'30]

The government has introduced a range of fiscal incentives to encourage wider use of alternative, cleaner fuels.[31] Motoring taxation is made up of two elements, Vehicle Excise Duty (VED), which can be considered a tax on ownership, and fuel excise duty, which is a tax on use. Although historically the VED was considered a hypothecated tax to pay for the building and maintenance of the road network, this has not been so since 1937 and it is now a general money raising tax.

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[29] Comment on excise duties and the PowerShift scheme supplied by Antony Seely, Business and Transport Section

[30] Advice on statistical tables and sources supplied by Paul Bolton, Social and General Statistics Section.

[31] HC Deb 10 May 2001 cc307-8W

A. Road fuel gases

Excise duty is charged on most types of hydrocarbon oil - that is, leaded, unleaded, and ultra-low sulphur petrol (ULSP), ordinary diesel and ultra low sulphur diesel (ULSD), gas oil and fuel oil, aviation gasoline (but not aviation kerosene used in jet engines) and road fuel gas. As with other excisable goods, VAT is charged on the full selling price, excise duty included.

Following the *March 2000* Budget, the rate of duty on unleaded petrol and ULSD was 48.82 pence per litre; on leaded petrol the rate was 54.68 pence per litre; on ordinary road diesel the rate was 51.82 pence per litre. All four of the duty rates were increased in line with inflation at this time.

By contrast the rate of duty on liquefied petroleum gas (LPG), and compressed natural gas (CNG) was frozen at the rate set in the March 1999 Budget at 15 pence per kilogram owing to its environmental advantages. Duty on road fuel gas is set per kg, although this duty rate of 15 pence per kg is roughly equivalent to 7.5 pence per litre.[32] The *Budget 2000* document made the following comments on taxing these alternative fuels:

> **Road fuel gases**
> **6.55** The Government has recognised that road fuel gases can offer reductions in particulates and nitrogen oxide emissions compared with conventionally fuelled vehicles. The duty rate on road fuel gases had been frozen since 1996, and Budget 99 reduced the duty by 29 per cent.
>
> **6.56** The differential in favour of road fuel gases has already led to increased take up of this fuel, with deliveries in the first nine months of 1999-2000 exceeding the total for the preceding year. The number of bi-fuel (petrol and LPG) light vehicles has increased by 10,000 since Budget 99 and the number of refuelling facilities offering road fuel gas has increased from around 150 at the end of 1998 to around 350 today. **To encourage greater use of road fuel gas, Budget 2000 freezes its duty rate, further increasing the differential between road fuel gas and conventional fuels.**[33]

When these provisions were debated at the Committee stage of the Finance Bill the then Financial Secretary – Stephen Timms – followed up on comments made by Edward Davey MP[34] on freezing the duty rate:

> The hon. Member for Kingston and Surbiton also referred to the freeze in duty on road fuel gas. Duty on road fuel gas was cut by 29 per cent. in the Budget last year--a substantial reduction. Since then, the number of dual-fuel--petrol and

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32 HM Customs & Excise Budget Notice 62/00, 21 March 2001
33 *Budget 2000* HC 346 March 2000 p 116
34 Standing Committee H 9 May 2000 c 53

> liquid petroleum gas--light vehicles has increased by 10,000. The number of refuelling sites has risen by 200 to 350, so it has more than doubled. Gas-powered vehicles have many benefits. They emit significantly fewer pollutants than do vehicles using petrol or diesel. We hope that, by freezing duty rates following the sharp reduction last year, thus increasing the differential in favour of road fuel gases, we shall encourage manufacturers to increase distribution and availability of this highly environmentally friendly fuel. We also hope that the lower cost to the consumer of using that fuel will help offset the cost of vehicle conversion. The hon. Member for Kingston and Surbiton is right to draw attention to that aspect of the clause, too. [35]

The Government's policy toward encouraging the use of LPG was set out in a written answer in February 2001:

> **Mr. Hill:** The Government have introduced a range of measures to promote the wider use of liquefied petroleum gas (LPG). The PowerShift programme, funded by my Department and administered by the Energy Saving Trust, provides grants towards the additional cost of vehicles fuelled by LPG. There is a low rate of duty on LPG and other road gas fuels--around 7.5p per litre, compared to 48.82p per litre for premium unleaded petrol and 48.82p per litre for ultra low sulphur diesel. From 1 March 2001, new LPG cars will benefit from a lower rate, under the new Vehicle Excise Duty system.[36]
>
> The number of LPG refuelling points is growing rapidly. There were around 100 in 1997. There are now around 660 sites in the UK and this number is expected to rise to over 1,000 by the end of this year, thanks to investment from the major fuel suppliers. Many of these new facilities will be on petrol station forecourts. The Government's revised transport planning guidance note (PPG13) will further encourage local authorities to view planning applications for refuelling facilities for cleaner fuels more favourably. This is expected to be published later this year.
>
> My Department's Ministers and officials have met a range of vehicle manufacturers to discuss the development of the gas vehicle market. The Energy Saving Trust is also in close touch with vehicle manufacturers, encouraging them to introduce production line gas vehicles. I am encouraged to know that several vehicle manufacturers are considering doing so. Grants under the PowerShift programme focus on new cars (but also those of up to one year old), encouraging manufacturers to develop high quality production line gas vehicles, so as to reduce the cost and lead to the wider use of gas fuelled vehicles. Also, the older a

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35 *op.cit.* cc 57-58

36 Under legislation introduced in the *Finance Act 2000*, from 1 March 2001 all cars registered for the first time are placed into one of four VED bands based on their rates of carbon dioxide emissions. Within each band, there is also a discount rate for cars using cleaner fuels and technology and a small supplement for diesel cars. This is discussed further: in "Vehicle Excise Duty", BTS standard note, 11 July 2001

> vehicle is, the harder is it to guarantee that a gas conversion will lead to emission reductions.[37]

In the March 2001 Budget the rates of duty on both leaded petrol and road diesel were unchanged: at 54.68 pence per litre and 51.82 pence per litre respectively.[38] To encourage the use of ULSP the rate of duty was cut by 2 pence per litre to 45.82 pence per litre with effect from Budget day with a similar cut in duty on unleaded petrol until 14 June 2001, whilst stocks of ULSP were rolled out. ULSD is charged the same duty rate – 45.82 pence per litre: this represents a duty cut of 3 pence per litre, with the aim of maintaining "the existing balance between the duty rates on the main forms of petrol and diesel."[39]

The European Commission is proposing that sulphur-free fuels (defined as those containing less than 10 parts per million (ppm) of sulphur) must be available in Member States by 1 January 2005, and that, by 1 January 2011, all petrol and diesel sold should be sulphur-free.[40] It also suggests that, in the case of diesel, the latter date should be subject to a review to be carried out by 31 December 2006. The proposal also requires that the sulphur content of fuel used in non-road mobile machinery and agricultural tractors should be limited to 2000 ppm, reducing to 1000 ppm in 2008. To allow zero sulphur fuel by 1 January 2005 is consistent with the entry into force then of the new Euro IV vehicle emission limits[41] and the requirement of some new automotive technologies to use such fuels in order to attain those limits.[42]

The background to the EU Auto-Oil programme and the emission Directives is outlined in a report entitled *The Environmental Impacts of Road Vehicles in Use – Air Quality, Climate Change and Noise Pollution* (DETR, July 1999).

The reduction arising from the use of sulphur-free fuel would make a major contribution to reductions in carbon dioxide emissions. However, in the short term, the savings could be matched by the increase in carbon emissions at refineries arising from the production of zero sulphur fuels, though the Commission expects the latter figure to decrease over time as improved refinery technology becomes available. So far as other pollutants are

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37 HC Deb 28 February 2001 cc 683-4W For further information on LPG, see the LPG Association internet site at: www.lpga.co.uk

38 HM Customs & Excise Budget Notice BN107/01, 7 March 2000

39 HM Treasury/DETR Budget press notice, *Protecting the environment and supporting Britain's road transport*, 7 March 2001

40 Draft Council Directive on the quality of petrol and diesel fuels and amending Directive 98/70/EC. COM(01)241.

41 Those complying with the requirements of Directive 98/69/EC relating to measures to be taken against air pollution by emissions from motor vehicles and amending Council Directive 70/220/EEC OJ L350 28.12.1988) and Directive 1999/96/EC on the approximation of the laws of the Member States relating to measures to be taken against the emission of gaseous and particulate pollutants from compression ignition engines for use in vehicles, and the emission of gaseous pollutants from positive ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles and amending Council Directive 88/77/EEC)

42 Select Committee on European security ninth report HC 152-ix 2001-02

concerned, the accompanying Regulatory Impact Assessment (RIA) estimates that the introduction of sulphur-free petrol in EU countries would decrease nitrogen dioxide emissions in 2010 by about 5%, and that particulate matter emissions by 2010 would be reduced by around 300 tonnes a year, implying a gain of 3,000 to 7,000 life-years.

In 2001, the separate duty rate on lead replacement petrol and 'super-unleaded' petrol was abolished. In future duty will be levied according to sulphur and aromatics content. Changes were also made to the tax-free mileage bands to encourage the use of cleaner cars for business purposes[43] and to VED for special groups of vehicles. A range of other measures to provide cheaper motoring for those reliant on a car, and to encourage the use of public transport and green travel plans, were also announced.[44]

In addition the rate of duty on road fuel gases was cut from 15p per kilogram to 9p per kilogram: this is 'broadly equivalent to a 3 pence per litre cut.'[45] *Budget 2001* commented as follows:

> The cut by 29 per cent in duty on road fuel gases in Budget 99, followed by a duty freeze in Budget 2000, has encouraged individuals and companies to convert to these less environmentally damaging fuels. Car manufacturers and fuel suppliers have responded favourably to this demand. In order to maintain the existing duty differential between road fuel gases and the most commonly available petrol and diesel, Budget 2001 cuts duty on road fuel gases to 9 pence per kilogram. Furthermore, to provide the stability needed to encourage growth in the road fuel gas market, duty on road fuel gases will not be increased in real terms until 2004 at the earliest.[46]

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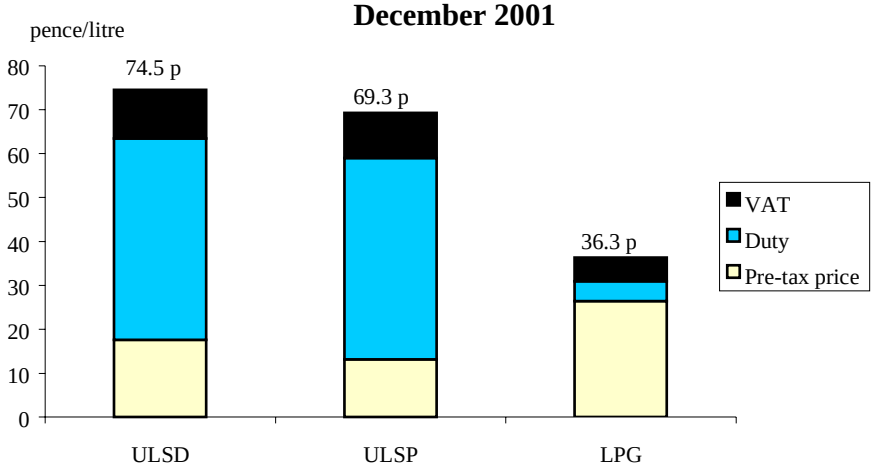
43 http://www.inlandrevenue.gov.uk/employers/expenses_benefits.htm
44 See Customs and Excise Budget Notes http://www.inlandrevenue.gov.uk
45 *Finance Bill 2001 Notes on Clauses*, March 2001
46 HC 279 March 2001 p 112

Components of the retail price of road fuels, December 2001



The chart above shows the pump price and its components for ULSD and Petrol and LPG.[47] It is clear that the pre-tax price of LPG is greater than petrol or diesel, but lower duty rates mean that only 27% of the retail price is tax, compared to 76% and 81% of petrol and diesel respectively. Details of duty rates on LPG in other EU Member States can be found in a recent European Commission report.[48]

In the November 2001 *Pre-Budget Report* it was noted that this cut in the duty rate on road fuel gases was "already contributing to positive growth in the road fuel gas market. The number of liquefied petroleum gas (LPG) refuelling sites is expected to exceed 1,000 by the end of 2001, compared with 100 in early 1998. LPG-fuelled cars are expected to rise to nearly 100,000 by 2006 - a four-fold increase from today."[49] The Energy Saving Trust's website provides details of all locations in the UK where LPG is available, and reports that as of 24 January 2002 there are 1,007.[50] Sites are also shown on the LPGA website.[51]

In 1998 the Chancellor announced that the extra costs of converting company cars to LPG or CNG would be disregarded for tax purposes; they were previously taxed as benefits in kind.[52]

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47 Institute of Petroleum Datasheet 12 November 2001.

48 European Commission, *Excise duty tables REF 1.1013*, November 2001 pp 27-28 The whole report is at: http://europa.eu.int/comm/taxation_customs/publications/info_doc/taxation/c4_excise_tables.pdf

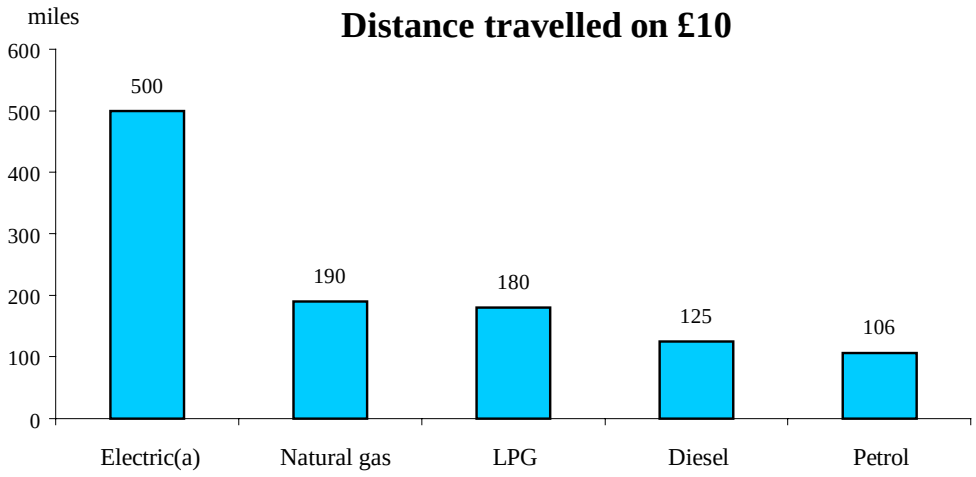
49 Cm 5318 November 2001 p 126

50 The map is available on the PowerShift internet site at: http://www.est-PowerShift.org.uk/ps_lpgmap.cfm. Further details on the current market for clean fuel vehicles in this country are given in *Clean fuel vehicles: Market Report*, Spring 2001, available on the site of Transport Action, the 'umbrella brand' for the Energy Saving Trust's environmental transport programmes, at: www.transportaction.org.uk/downloads/PowerShift_Market_Report.pdf

51 http://www.lpga.co.uk/england.stations.htm

52 HM Customs & Excise Budget Press Notice "Chancellor honours commitment on fuel duties to protect the environment" 9 March 1999

Vehicles running on clean fuels produce fewer emissions harmful to health, and can offer some savings on fuel costs compared to petrol or diesel.[53] The following chart compares the relative distances travelled by cars using a variety of alternative fuels against petrol and diesel:[54]



(a) Excluding battery lease costs
Source: Powershift (www.est-powershift.org.uk/ps_fuels_vehicles.html)

In Great Britain, the number of cars capable of running on gas (LPG or CNG) or gas/petrol combinations is shown below:

Number of vehicles dedicated to run on gas or petrol/gas combinations by tax class

Vehicles by Tax Class	*1997*	*1998*	*1999*	*2000*	*2001*
Private and light goods	6,689	10,121	14,421	21,098	23,533
Buses	31	53	97	121	140
Goods vehicles	75	93	141	171	227
Special vehicles	1,327	1,281	1,310	1,394	1,413
Other vehicles	965	986	1,041	1,184	1,381
Total	9,087	12,534	17,010	23,968	26,694

Source: HC Deb 29 January 2002 c202W

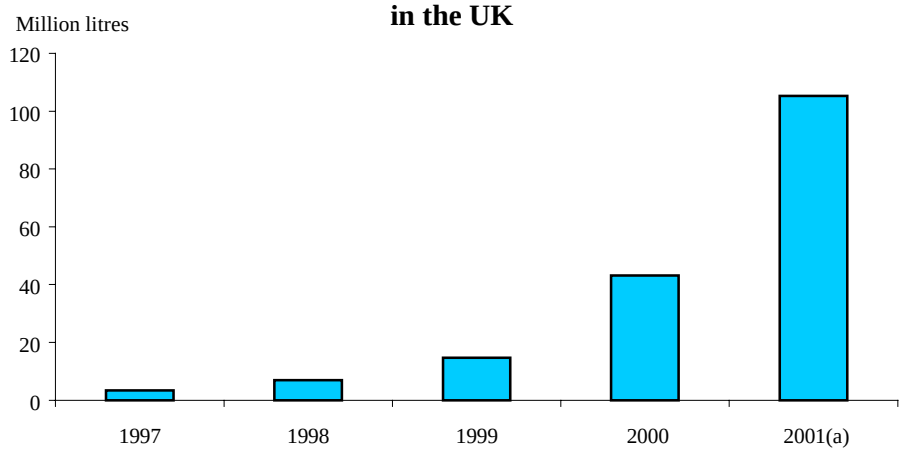
In mid-1999 bi-fuel vehicles outnumbered gas only vehicles by nearly 10,000.[55] By the end of the first quarter of 2000, 23,968 vehicles of all types were registered as being powered by either road fuel gases or bi-fuel. This was still less that 0.1% of all vehicles. The figures in the table underestimate the position because not all conversions of alternative

[53] See: AEA ETSU Study 'Alternative Road Transport Fuels: UK Field trials' Vol 1 and 2, DETR 1998.
[54] PowerShift figures at 2000 prices.
[55] HC Deb 31 January 2001 c402W

fuels are notified to the DVLA. It is estimated that in reality, there are around 50,000 LPG cars in the UK, with the number expected to rise by about 25,000 over the next year.

The following chart shows the amount of gas for road fuel released for consumption. The total has more than doubled in each of the last three years.

Quantities of gas for road fuel released for consumption in the UK



(a) Up to the end of November 2001
Source: Hydrocarbon Oils Bulletin, HMCE

B. Bio-diesel

Prior to the March 2001 Budget, when bio-diesel product was used as a substitute for ULSD, it was charged the same duty rate.

In the March 2001 Budget, the Government announced that it would introduce a new duty rate for bio-diesel in the 2002 Budget:

> Budget 2001 **announces a new duty rate for bio-diesel set at 20 pence per litre below the ULSD rate to be introduced in Budget 2002.** This will offset the additional production costs of bio-diesel and permit the UK to benefit from the reduced greenhouse gas emissions that this fuel can offer. Bio-diesel sourced from waste vegetable oils will also provide a useful outlet for oils that may otherwise be poured away into landfill sites or disposed of down the drain.[56]

This will be reviewed annually in the light of economic circumstances and any EU requirements.[57] It has been calculated that crude oil prices would have to reach between

[56] HC 279 March 2001 p 112
[57] HC Deb 22 October 2001 c61-2W

$55 and $70 per barrel before bio-diesel would become economic without tax concessions.[58,59]. The current price of Brent Crude is $18.79 p/bbl.[60]

During the progress of the Finance Bill in April 2001, the Liberal Democrats put down an amendment to the Bill, to cut the rate of duty on bio-diesel, and on bio-ethanol, to the same rate as road fuel gases.[61] The Government opposed this measure, criticising it as 'premature'; part of the speech made by Melanie Johnson, then Economic Secretary, is reproduced below:

> The Government are keen to stimulate development of viable alternative fuels that offer environmental advantages. Indeed, it was because of climate change benefits associated with bio-diesel that the Government announced the 20p per litre reduction in duty. Although we recognise that the promotion of bio-diesel can provide useful greenhouse gas emission savings that should not be achieved regardless of cost …
>
> It will take time to introduce a duty rate cut for an alternative fuel such as bio-diesel. Not only do we need to settle on a UK specification for bio-diesel to benefit from the duty reduction, and to seek the appropriate derogation from the EU mineral oils directive, we also need time to set up administrative arrangements to protect the revenue, and to protect legitimate bio-diesel producers, motorists and hauliers by ensuring that poor quality bio-diesel does not find its way into the UK distribution chain. Those are practical matters; they may involve time, but they are none the less relevant … Bio-diesel does not offer the same air quality benefits as road fuel gases … The Department of the Environment, Transport and the Regions has made an analysis; it is in the Library and hon. Members can study it.[62] Road fuel gases provide significant benefits relative to diesel--especially with regard to particulates and nitrous oxides--but there are no such air quality benefits from bio-diesel …
>
> The amendment also suggests a duty cut for bio-ethanol. The Government believe that would be premature. Greenhouse gas savings from ethanol depend very much on the feedstock used. The production of ethanol from wheat, for example, which was mentioned by several contributors to the debate, is well established, but unfortunately, on a life-cycle basis--taking account of the carbon dioxide implications of crop growing and processing the fuels, as well as its use as a motor fuel--it offers few greenhouse gas savings … There are few savings because wheat cultivation and ethanol production are both relatively energy-intensive processes, so the environmental case for the promotion of ethanol in the UK is weak, if wheat is to be the predominant feedstock. The feedstock does not

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58 'Europe to push for bio-fuels for road transport', *Petroleum Review* January 2002 p 9

59 *Europe Environment* 595 11 September 2001 1.12

60 At 31 January 2002 http://www.oilnergy.com/1obrent.htm#daily

61 HC Deb 24 April 2001 cc 208-219

62 It would appear that the Minister is referring to: DETR, *Environmental impacts of road vehicles in use: air quality, climate change and noise pollution*, July 1999 [Dep 99/1425], which is available on the Department's internet site at: http://www.dtlr.gov.uk/cvtf/impact/

> necessarily have to be wheat, but as there was some discussion of wheat I wanted to make that point.
>
> Greenhouse gas savings of about 80 per cent. can be achieved by using ethanol produced from woody--lignocellulosic--biomass feed stocks; for the benefit of Members who do not know much about the subject, I should explain that those are wheat straw and forestry residues. However, that process is still very much at the research and development stage. The first generation of commercial production plants is not likely to be operational until about 2004.
>
> Given the potential climate change benefits, we are keen to ensure that UK industry can contribute to research and development. That is why the Chancellor announced in the Budget statement that viable pilot projects for bio-ethanol would be supported through duty exemptions or reductions. That will help UK industry to build on existing biomass research, which is also supported by our new and renewable energy programme.[63]

There will also be support for hydrogen, methanol, bio-ethanol and bio-gas, in the form of duty reductions or exemptions, as incentive to move towards a hydrogen-based economy.

The Government's proposals concerning duty exemptions and reductions for pilot projects on new green fuels are discussed later in the paper.

The PowerShift programme

The government sponsored PowerShift programme was set up in 1996 and is operated on behalf of the DTLR by the Energy Saving Trust's (EST),[64] to help establish a sustainable market for clean fuel vehicles in the UK. Designed to complement the Treasury's efforts to provide fiscal incentives to develop the market, its objectives are to:

- Raise awareness of clean fuel vehicles
- Provide objective information for fleet operators
- Encourage the establishment of a refuelling infrastructure
- Establish standards for clean fuel vehicles
- Reduce the capital cost of clean fuel vehicles

The following PQ explains the scope of the programme:

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63 HC Deb 24 April 2001 cc 216-9

64 The Energy Saving Trust (EST) was set up after the 1992 Earth Summit in Rio de Janeiro, to help reduce CO2 emissions in the UK. It is a non-profit organisation funded by governments and the private sector. Energy Saving Trust, 21 Dartmouth Street, London SW1H 9BP Tel: 0207 222 0101 website: http://www.est.org.uk

Mr. Hill: The PowerShift programme, sponsored by my Department and operated by the Energy Saving Trust, provides grants towards the cost of converting new vehicles and those less than one year old to cleaner fuels including LPG. To be eligible for grant, conversion packages must be approved as safe and effective in reducing emissions. Grants range up to 75 per cent., depending on the reduction in emissions delivered.

Conversion packages eligible for grant are available for most cars. The number of cars whose conversions could attract the full 75 per cent. grant depends on the number of different cars, and different conversion packages, chosen by consumers.

The following table summarises the number of vehicles broken down by fuel type that have received grants from the PowerShift programme:

Fuel type	***1997-98***	***1998-99***	***1999-2000***	***2000-01[(2)]***
Liquefied petroleum gas	187	686	1,618	4,425
Natural gas	78	99	28	59
Electricity	38	47	105	82
Total	303	832	1,751	4,566

[(2)] Up to 31 December 2000

My Department is providing PowerShift with £9.9 million for the current financial year and £30 million over the next three financial years. My Department also sponsors the CleanUp programme, also operated by the Energy Saving Trust, which aims to reduce emissions from existing vehicles operating in urban areas. The programme includes projects to fit emission reduction technologies and to convert older vehicles to run on cleaner fuels where it proves cost effective and environmentally beneficial to do so. CleanUp is currently receiving £6 million for this financial year and £30 million over the next three financial years

My Department will also spend £9 million over the next three financial years to encourage the early introduction of technologies such as hybrid and fuel cell vehicles offering significant environmental benefits.

The CleanUp programme has only just been launched. However, it has already provided grants towards the cost of converting 25 existing London taxis to run on LPG. [65]

The figures above show that whilst the number of vehicles receiving PowerShift grants received has risen since their inception, applications and take-up is still at a very low level when compared to overall numbers of vehicles on the road.

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[65] HC Deb 6 February 2001 c459W

> Since the PowerShift programme began in 1996, the [Energy Saving Trust] has received a UK total of 3,809 applications, of which 2,642 were approved as eligible, covering the conversion of 12,404 vehicles to run on LPG.[66]

Reclaiming conversion costs, rather than receiving a direct payment, is seen by some as a disincentive to buyers. Grants offering 100% of conversion costs might act as a further incentive.

Applications are assessed and funding allocated by PowerShift on the basis of:

- Availability of funds (an extra £30m was awarded to the programme by the deputy prime minister in November 2000[67])
- Vehicle type approved by PowerShift
- Suitability of proposed use
- Impact on air quality and climate change
- Potential for developing a sustainable market
- Evidence of actions to secure fuel supply

Applications will not automatically receive funding.[68]

The programme focuses on those alternative fuels that are viable in the UK today, including electric vehicles, liquid petroleum gas (LPG) and compressed natural gas (CNG). According to the LPG Association, a properly engineered LPG conversion for cars should cost between £1,200 and £1,500. The process usually takes two to three days to complete. The average cost of converting a vehicle to run on CNG is £3,000.

Although conversion grants are open to car owners, both individuals and fleet car owners, many have been for lorry and bus conversions in the hope of reducing diesel emissions.

> **Mr. Hill** *[holding answer 13 November 2000]:* DVLA statistics show that from the end of June 1997 to the end of June 2000, the number of goods vehicles (over 3.5 tonnes gross vehicle weight) running on gas increased by 126 to a total of 175. Over the same period, the number of buses running on gas increased by 62 to a total of 103. DVLA's figures do not distinguish between the road fuel gases liquid petroleum gas and compressed natural gas. [69]

LPG conversion is easier as it is a petroleum-based fuel and it is cheaper to convert a vehicle with a petrol engine than a diesel one. Conversion is not an option for vehicles that run on lead replacement petrol or some specialist vehicles. Cars with the tank and

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66 HC Deb 10 January 2002 cc 983-4W

67 DETR press notice, *Boost for cleaner, more efficient vehicles*, 20 November 2000

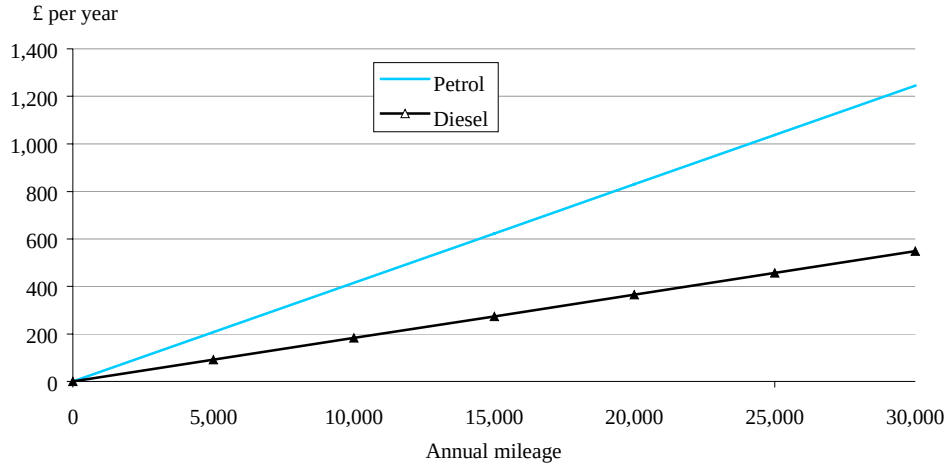
68 PowerShift, PO Box 5392, Northampton NN1 5YT Tel: 0845 602 1425
website: http://www.est-PowerShift.org.uk

69 HC Deb 14 November 2000 c585W

fuel delivery system already installed are neater than conversions, as the fuel tank sits in the space occupied by the spare tyre, rather than taking up valuable boot space.

Although LPG is approximately half the price of petrol due to the lower rate of duty, fuel consumption is about 20% more for LPG cars owing to its lower volumetric energy density. Overall, fuel costs are reduced by about 35% on conversion.[70] The following chart looks at how potential savings from converting to LPG increase with mileage.[71]

Potential savings in fuel costs through using LPG



The current average mileage is 9,400 a year.[72] Based on current fuel prices the annual savings against petrol would be £390 and £170 against diesel. It would therefore take over three years for a petrol driver to recover their conversion costs and longer for a diesel driver. The savings could be more significant for someone travelling much longer distances. Someone travelling 22,500 miles a year[73] could make annual savings of £940 through converting from petrol and £410 from diesel. In this case it could take less than two years before the conversion costs were recovered. The actual benefits from converting will depend on a large number of individual factors including actual conversion costs, current fuel efficiency and driving patterns.

PowerShift funding can be applied for through two routes:

i. PowerShift Register route - Grants offered to vehicle owners to reduce the capital cost of purchasing or converting a clean fuel vehicle from a PowerShift approved manufacturer or converter. This would be the normal procedure for most applicants.

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70 Colt's LPG fact sheet.

71 Fuel prices are average 2001 figures taken from Institute of Petroleum Oil Datasheet 12; fuel efficiencies are taken from *Energy Trends* December 2001, DTI

72 *Focus on Personal Travel 2001*, DTLR

73 The average mileage of company car owners in the 1995/97 National Travel Survey, *Focus on Personal Travel 1998*, DETR

ii. PowerShift Demonstration Project route — discretionary grants offered to a consortium to demonstrate a new clean fuel vehicle technology. This procedure should only be used for clean vehicles that are not commercially available or have not been demonstrated in the UK previously.

To apply for conversion under the PowerShift Register, the applicant selects the vehicles they wish to purchase or convert. Only clean fuel vehicles and conversions listed in the PowerShift Register[74] are eligible for grants.[75] Arrangements for a clean fuel supply are made either directly from a clean fuel supplier or through an existing public distribution outlet, and a PowerShift application form is completed. A funding decision will be made within one month of the date the application being received by PowerShift. It is stressed that an order should not be placed until a written offer of grant has been received. The order must be placed within three months of receiving the offer of grant and proof of order must be sent to PowerShift. Payment of grant will be received once the vehicles have been delivered by presenting PowerShift with the required documentation including a copy of invoice.[76]

A series of case studies of conversion strategies chosen by companies are published on the PowerShift website. Further information on the emissions and noise performance of cars sold in the UK is available from the Vehicle Certification Agency's web site.[77]

With the number of applications for conversions falling, largely due to LPG infrastructure problems, a consultation was launched in March 2001 on how PowerShift funding should be targeted over the next three years: [78]

On 10 October 2001, the Government announced a number of changes to the programme, as a consequence of this consultation exercise.

> Up to two million extra motorists will be able to buy cheap, green fuel with the aid of a new Government grant, Transport Minister David Jamieson announced today. ….. Previously available for purchase of new cars or conversions of vehicles up to a year old only, the grant will now be offered to owners who wish to carry out *PowerShift*-approved conversions on cars up to five-years-old for which quality emission-reducing conversions are available. The grants will cover

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[74] http://www.est-PowerShift.org.uk/bands_and_grants.htm (current at 17.01.2001)

[75] HC Deb 14 November 2001 c724W

[76] Copies of the PowerShift leaflets, *How to apply* and *How to apply: more details*, as well as grant application forms are available from the scheme's internet site.

[77] http://www.vcacarfueldata.org.uk/e_introduction.htm

[78] *Future direction of the PowerShift programme*, March 2001 [Dep 01/514]. Further copies are available on the Department's site at: http://www.roads.dtlr.gov.uk/consult/PowerShift/
Responses to the paper were published on 15 October 2001, available at: http://www.roads.dtlr.gov.uk/consult/PowerShift/

> up to 50 per cent of the cost of conversion, which can range from £1,300 to £1,800 …
>
> Key changes to the programme are:
> - Extension of grants for the conversion of vehicles to LPG of up to five years old as of 1 November 2001. Grants will range from 30% to 50% of the cost of conversion depending on the level of emissions improvement.
> - Grants for conversion of new light duty vehicles (such as cars and vans) have been revised from the consultation proposals, and will start from 1 April 2002. Grants will range from 30% to 40% of the premium or conversion cost of LPG depending on level of emissions improvement.[79]
> - Premium grant rates of an extra 20% will apply to production-line LPG models and LPG conversions for new vans and taxis, which deliver the largest air quality benefits.
> - Grant support for electric and heavy duty gas vehicles to continue at present levels given the continuing environmental benefits these vehicles offer.
> - Increased monitoring of LPG conversions by *PowerShift* to ensure quality is of the highest standards with tough action taken against converters not meeting these standards.[80]

It is estimated that if all eligible vehicle owners took advantage of the grants, there would be a cost to the Treasury of nearly £1.8 billion.[81] EST will continue to monitor conversions, as the older a vehicle is the harder it is to guarantee that conversion will meet emission reductions. There are no plans to extend the scheme to cars over five years old.

PowerShift will receive a total budget of £10 million in the current financial year.[82] In July 2001 the National Assembly for Wales contributed £80,000 towards a demonstration programme in Gwynedd, to assist the installation of LPG refuelling points, and to convert 20-30 vehicles in the area to LPG.[83] The Scottish Executive is providing a total of £0.5 million for PowerShift activities in Scotland in the current year. [84]

The PowerShift scheme is seen by some as an inadequate answer to high fuel prices in the Highlands, where there are calls for more comprehensive moves, such as a lowering of duty for conventional fuels. Take-up of LPG conversion grants in the Highlands under the

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79 Grants for conversion of new light duty vehicles (such as cars and vans) have been revised downwards, from 75%, following the consultation proposals, as it was concluded the emissions advantage of converting newer vehicles to LPG had reduced. HC Deb 19 October 2001 c1365

80 DLTR press notice 421, 10 October 2001

81 "Cut your bills with gas", *Daily Telegraph*, 13 October 2001, p9

82 HC Deb 15 January 2002 cc 6206-7W

83 National Assembly for Wales Press Release W-01780-*Env 'Assembly commits £80,000 to PowerShift demonstration programme for cleaner fuels in Wales*' 19 July 2001

84 HC Deb 26 January 2001 c734W

PowerShift scheme has been unexpectedly low, at 1% of the anticipated take-up of 400 cars.[85]

In January 2001, PowerShift commissioned research to determine the likely size of the market for vehicles powered by LPG, natural gas and electricity. Confirmed figures for 2000 show a 43% increase in the number of vehicles sold or converted. New forecasts for 2001 and 2002 were encouraging, predicting significant growth for all three vehicles types. TransportAction's first market report, published in April 2001, claimed that over two years 100,000 LPG vehicles could appear on the roads.[86]

The survey also highlighted six possible factors as to what could be holding back the UK market of sales of Cleaner Fuel Vehicles (CFVs).

- Doubt about government commitment to maintaining a differential between the duty on gas and conventional fuels
- Strength of the refuelling structure
- Length of time for capital return on vehicle conversion
- Perceived lack of awareness of alternative fuels
- Lack of confidence in CFVs
- Vehicle insurance (marginal impact)

Suggestions to boost sales include zero-rating road fuel gases from excise duties, and allowing hybrid car owners to pay a reduced duty on the petrol they consume. Car manufacturers might also be encouraged to devote a greater proportion of their marketing budgets to alternative fuels. Given the dominance of the internal combustion engine and the strong market drivers for improving the environmental qualities of petrol and diesel, this may take some time to achieve.

The Society of Motor Manufacturers and Traders (SMMT) Future Fuels Strategy Group produced a report *Towards a Shared Vision - Future Fuels and Sustainable Mobility* in September 2001, which, it hopes, will:

> advise on available options and share a long-term view with policy makers in government. This pro-active approach will ensure that government will be best placed to promote the most appropriate fuels and support the UK as a world leader in cleaner vehicle technologies. [87]

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85 "LPG gas plan blows up in ministers' faces", *Scotland on Sunday* 21, October 2001, p8

86 'Sales of 'clean fuel' vehicles to rise', *Financial Times,* 10 April 2001 p5 http:// www.transportaction.org.uk

87 SMMT Press Release *Alternative Fuels - SMMT looks to the future* 25 September 2001 http://www.smmt.co.uk/downloads/news/3826.pdf

Vehicle manufacturers appear to be divided on the opportunities presented by supplying LPG options across their ranges. This may be partly due to the sophistication of new models and the resultant high cost of converting them to run on another fuel.[88] The additional cost of the LPG option on a new Vauxhall is approximately £1,950 (Ford is in line with this), more than a PowerShift conversion, but with boot space retained and neater interior controls.

A Datamonitor report, *Global Auto LPG*, published in March 2001, stated that in order for the market to reach critical mass, vehicle manufacturers must allow conversions of their vehicles by specialists without invalidating factory warranties, seen as a strong disincentive to new vehicle owners. Approved conversion companies are listed on the LPGA website,[89] but the trade is largely unregulated and there are fears that cowboy operators and shoddy, or DIY conversion work may increase the risk of LPG being perceived as an unsafe product, thereby damaging the market. Training is also variable and unregulated, and there is no standard specification for kits, mainly imported from Europe, leading to variations in performance. There is a code of practice for installation, but not all sites offering the service have LPG approval, and the installation of tanks is not tested in the current MOT. Insurance is available with no premium loading for PowerShift conversions providing they are carried out by approved contractors.[90]

The UK government welcomed the adoption by the EC of a United Nations regulation on motor vehicles fuelled by LPG.[91] The regulation sets internationally recognised minimum standards for the components and complete installation of LPG for all types if motor vehicle. It is hoped this will lead to harmonisation of technical standards and encourage the development and use of LPG as a motor fuel.[92]

IV Other Government initiatives on alternative fuels

> Road transport produces far fewer emissions of local air pollutants than it used to – it takes 20 of the cars built today to produce as much local pollution as one built in the 1970's….Greener fuels have an important role to play in reducing the environmental impact of road transport, and helping to meet our environmental commitments.[93]

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88 "Green gas for less cash?", *Petroleum Review,* May 2001, p26

89 http://www.lpga.co.uk

90 DTLR Press Notice '*Government helps more motorists to switch to green, clean fuel'* 10 October 2001

91 Council Decision on the accession by the EC to United nations Economic Commission for European Regulation No 67 on motor vehicle fuelled by LPG. COM(1999)14 Final. June 2000.

92 European Parliament: briefing for UK members 8 June 2000

93 Letter from Michael Meacher and Lord MacDonald inviting participation in the Green Fuel Challenge. DETR '*Summary of the environmental assessment of proposals submitted in response to the Government's "Green Fuels Challenge*", February 2001, Deposited paper 01/824

A. Powering Future Vehicles

The government unveiled its latest plans to encourage the development of greener, cleaner vehicles of the future at the end of 2001.[94]

The draft 'Powering Future Vehicles' strategy[95] proposes 'to make the UK a world leader in the move to a low carbon road transport system, minimising the environmental impacts and maximising the benefit to UK industry.' An eleven-point strategy plan is proposed:

> 1. Promoting research, development and demonstration of new vehicles and new fuels;
>
> 2. Ensuring all decisions and regulatory arrangements take full account of environmental and health and safety matters.
>
> 3. Setting technical standards for vehicles, fuels and distribution infrastructure speedily and professionally.
>
> 4. Facilitating the quick and smooth development of any new fuel distribution infrastructure that may be needed.
>
> 5. Setting the right fiscal regime for vehicles and fuels.
>
> 6. Encouraging consumer take-up of new vehicles and fuels - including action to overcome financial and other market barriers.
>
> 7. Ensuring that transport is able to engage in the UK's carbon trading scheme
>
> 8. Working proactively with partners in the EU and beyond.
>
> 9. Making fullest use of new vehicles and fuels in the Government's own vehicle fleets.
>
> 10. Setting targets which will help promote the country's shift to low-carbon vehicle technologies and fuels.
>
> 11. Ensuring effective links between Government departments and programmes, in carrying through the Powering Future Vehicles strategy.

It also suggests that a feasible but challenging target for the proportion of low carbon vehicles sold within a decade, including hybrid and fuel cell vehicles, might be eight to twelve per cent, with a longer term target of similar magnitude by 2020 for fuel cell vehicles. This places the focus of the strategy on fuel sources with the potential to reduce carbon dioxide emissions.[96]

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94 DTLR/DEFRA/Treasury/DTI Press Notice 512 *Powering Future Vehicles* 3 December 2001

95 http://www.roads.dtlr.gov.uk/vehicle/environment/futurepower/index.htm

96 *ENDS report* 323 December 2001 p65-6

Responses to the consultation paper[97] will be used to prepare the *Powering Future Vehicles Strategy*, due in spring 2002. To emphasise its importance, the document also recommends the creation of a Ministerial Group on Low-Carbon Vehicles and Fuels, to include senior government ministers, reporting directly to the Ministerial Committee on the Environment, Chaired by the Deputy Prime Minister.

B. Cleaner Vehicles Task Force

The current policy on the use of alternative fuels is to make cars more environmentally friendly. Cars running on cleaner fuels made up less than one percent of the 29 million of vehicles on UK roads in 2000. The joint DETR/DTI Cleaner Vehicles Task Force was formed on 14 November 1997. According to its website,[98] the Task Force aimed to encourage people to build, buy and use vehicles that are:

- More fuel efficient
- Less polluting
- Quieter, and
- Less resource intensive

Publication of the Task Force's first report, *Driving the agenda*, was announced in July 1999.[99]

> **Ms Glenda Jackson:** The Cleaner Vehicles Task Force is publishing its first report today. The Task Force has developed recommendations that are both practical and cost-effective for reducing the environmental impact of new vehicles and improving the emissions performance of vehicles in use. …A copy of the report has been placed in the Libraries of the House[100]

The culmination of the Task Force's work was its final report, *The Way Forward*, [101] produced in June 2000.[102] It made a series of recommendations that fall into five sections:

- Transforming the market and achieving lower environmental impacts from vehicles in use through Government incentives, development of technology, and through better public awareness;

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97 http://www.roads.dtlr.gov.uk/conindex.htm
98 http://www.roads.detr.gov.uk/cvtf/index.htm
99 HC Deb 20 July 1999 cc478-9W
100 Deposited Paper 99/1424
101 http://www.dtlr.gov.uk/roads/cvtf
102 *The way forward: the final report of the Cleaner Vehicles Task Force*. DETR. June 2000

- The role of fleets in improving the environmental performance of new and current vehicles;
- Cleaner fuels and technologies;
- The role of low emission zones; and
- Making sure everyone plays their part - the importance of enforcement in maintaining improvements.

The report's action plan set out what was required by both industry and government to ensure that the recommendations of the Task Force could be put into practice.

As part of the Government's response, published in November 2001,[103] Deputy Prime Minister, John Prescott, announced a £69 million package of domestic measures to tackle pollution and promote greener vehicles.[104] This included £30 million for the PowerShift Programme, £30 million for the Cleaner Vehicles Programme and £9 million to support development of fuel cell and hybrid vehicles.

C. The Green Fuels Challenge

In the Pre-Budget Report in November 2000, the Government announced its 'Green Fuels Challenge' (GFC):

> In the longer term, the challenge will be to achieve cleaner, greener road transport. Ultimately it will be for industry to rise to the challenge of developing profitable alternative fuels and related technologies. Therefore, in the run up to Budget 2001, **the Government will invite British industry to develop proposals for practical alternative fuels. Following consideration of these proposals the Chancellor will announce major reductions in duty rates for the most promising environmentally friendly alternative fuels.** [105]

In the March 2001 Budget it was announced that a scheme to apply duty reductions for pilot projects on new fuels would be introduced:

> Other proposals made under the GFC offer potential for the medium to long-term but still require considerable research and development. To stimulate further work in the field of alternative fuels, **Budget 2001 introduces enabling legislation to allow for the introduction of duty reductions or exemptions for**

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[103] *The Way Forward. Government response to the final report of the Cleaner Vehicles Task Force*. Cm 4932. November 2000

[104] DETR Press Notice 707, *Boost for cleaner, more efficient vehicles,* 20 November 2000

[105] Cm 4917 November 2000 p 128

> **pilot projects.** Pilot projects for hydrogen, bio-ethanol, methanol and biogas are expected to be introduced during the course of 2001.
>
> Overall this approach towards green fuels provides for environmental benefits in the short term from LPG, CNG and bio-diesel, looks to new fuels for the medium-term with bio-ethanol and biogas, and paves the way for the future with the fuel-cell favourites of methanol and, most significantly, hydrogen. This demonstrates the Government's ongoing commitment to delivering both air quality and climate change benefits through increased use of more environmentally friendly alternative fuels in the UK and supports the UK's early steps towards a hydrogen-based fuel economy. The Government also proposes to consult on how to encourage the development, delivery and take-up of new alternative green fuels and technology.[106]

Provision was made to this effect under section 3 of the *Finance Act 2001*.[107] On 25 July 2001 the Government announced it was inviting applications for these pilots, and expected to announce successful bids this autumn; an extract from the press release issued at the time is given below:

> The Green Fuel Challenge was announced in November's Pre-Budget Report (PBR), inviting industry to develop proposals for practical alternative fuels. The PBR stated that, following consideration of these proposals, the Chancellor would announce major reductions in duty rates for the most promising environmentally friendly alternative fuels.
>
> More than sixty outline proposals were put forward in response to the Challenge, covering a range of potential options. A number of promising road fuels were identified which could potentially offer significant environmental benefits in the medium to longer term, but which still require further research and development: hydrogen, methanol, bio-ethanol and biogas. The Chancellor therefore announced in the Budget that the Government would support research and development into these alternative fuels, by offering duty exemptions or reductions for pilot projects that will begin the process of demonstrating the benefits of these fuels and exploring production issues. Those who responded to the PBR announcement are today being sent copies of an invitation from the Financial Secretary to submit more detailed applications. Anyone else who wishes to apply is also encouraged to do so.
>
> Pilot projects are intended to support research into, and the development and demonstration of, novel alternative fuels that have the potential to provide environmental benefits now or in the future. This may include issues relating to the production and use of these fuels. There is no guarantee that the duty exemption or reduction set for the fuel produced from a pilot will continue once

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[106] *Budget 2001* HC279 March 2001 p 113

[107] This provision was agreed without amendment and without debate at the Committee stage of the Bill (HC Deb 24 April 2001 c 222).

> the pilot project is completed. However, the pilot process will be used to inform decisions on the longer-term duty rates for the fuels in question. A paper setting out the application requirements, evaluation criteria and timetable for pilot projects under the Green Fuel Challenge is available from Customs[108] …
>
> Applications will be considered by an inter-departmental group, which will report to Treasury Ministers. They will decide the appropriate rate of duty for each pilot that they approve. The terms of operation of the individual pilots will be set by Customs and Excise. The successful bids will be announced in the autumn.[109]

The submissions were assessed against a range of criteria,[110] with an environmental assessment of the fuels a pre-requisite.[111]

More than sixty outline proposals were put forward in response to the challenge. Three successful project bids, from BP, Enertech and zero-m Ltd, were announced in the 2001 Pre-Budget statement.[112] They cover:

- Hydrogen fuelling infrastructure for fuel cell buses (BP)
- Capture, compression and use of landfill gas (bio-gas) in a variety of vehicles (Enertech)
- The testing of methanol in various vehicles, and in the refuelling infrastructure (zero-m Ltd)

There will be a second stage of bids for pilot projects in spring 2002.

D. Vehicle excise duty (VED)[113]

Since 1 March 2001, the current rate of VED for private vehicles has been £160. A lower rate (£55 less) was introduced for cars under 1100 cc on 1 June 1999; for cars under 1200 cc on 1 March 2001; and for cars under 1549 cc on 1 July 2001. This is thought to benefit 5 million car owners.

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[108] at: HM Customs and Excise Environmental Taxation Development Division 1st Floor West, New King's Beam House 22 Upper Ground London SE1 9PJ Email: pamela.london@hmce.gsi.gov.uk

[109] HM Treasury press notice 89/01, 25 July 2001

[110] DETR Press Notice 777, *Green Fuels Challenge consultation starts*, 14 December 2000

[111] DETR *Summary of the environmental assessment of proposals submitted in response to the Government's "Green Fuels Challenge*, February 2001, Deposited paper 01/824

[112] HM Customs and Excise Press Notice PR 69/01, *Minister announces green fuel challenge pilot projects*, 19 December 2001

[113] Further information on VED can be found in Library Standard Notes '*Vehicle Excise Duty'* and '*VED and small cars*', available from the Business and Transport Section of the Library.

The government also introduced a new system of VED for new cars, based primarily on carbon dioxide emissions. From 1 March 2001, all cars registered for the first time are placed into one of four VED bands based (see table below) on their rates of carbon dioxide emissions.[114] Within each band, there is also a discount rate for cars using cleaner fuels and technology and a small supplement for diesel cars.[115] As well reducing CO_2 emissions, the aim is that motorists should also save on running costs by using more fuel-efficient models.[116]

CO_2 emission level (g/km)	Car using cleaner fuels £	Petrol car £	Diesel car £
Up to 150g	90	100	110
151g/km to 165g/km	110	120	130
166g/km to 185g/km	130	140	150
186g/km and above	150	155	160

New, bi-fuelled cars are subject to VED in the lowest rate under the *Graduated Vehicle Excise Duty (Prescribed Types of Fuel) Regulations* SI93/2001.[117] The rate for new vans and other new vehicles, for which CO_2 emissions data are not currently available, is £160.

A major reform of lorry VED was introduced from December 2001, replacing the 100 or so existing VED rates with a system of seven broad rate bands. The Government also plans to introduce lower VED rates for lorries meeting the latest EC emissions standards, known as euro-IV, from around 2004. It will also review the current arrangements for paying lorry VED, with the aim of reducing administrative costs to hauliers.

After consultation, allocations from the £100 million Haulage Modernisation Fund, announced in the Pre-Budget Report November 2000, will include the following:

- £30 million for targeted support for retrofitting older lorries operating in areas of poor local air quality, such as Air Quality Management Areas, where nitrogen oxide and particulate emissions are most damaging. This will also enable hauliers to qualify for up to £500 lower VED rates;
- £15 million for advice on fuel efficiency, which should deliver savings of around 5 to 10 per cent in carbon emissions and similar reductions in the typical haulier's fuel bill;

[114] Further details can be found in DVLA Leaflet "INF96" entitled "Brand new car? The less it pollutes, the less you pay". http://www.dvla.gov.uk/newved.htm
[115] *Finance Act 2000* schedule 3
[116] "Choosing the clean vehicle option", *Energy & Environmental Management*, March/April 2001, p13
[117] HC Deb 2 November 2001 c906W

Consultation has just closed on a Treasury proposal to adjust to the current three bands of VED for motorcyclists to provide greater incentives for small bikes, which may replace some car journeys.[118] It suggests raising the lowest rate for VED from 150cc to 400cc.[119]

From April 2002, the benefit-in-kind tax charged for company cars will be based on the CO_2 emissions of a vehicle. This will apply to all company cars registered from January 1998 onwards. Further details can be found on the Inland Revenue website.[120]

E. Fuel efficiency labelling

The majority of current new vehicles produce 150-250g of CO_2 per km; the average is about 185g/km. The current EU aim is to reduce average fleet emissions rate to 120g/km by 2010, a cut of about 35%. It is being pursued through a strategy that includes a voluntary agreement with car manufacturers, a fuel efficiency labelling scheme and fiscal incentives. Manufacturers envisage an interim target of 165–170g/km by 2003, about 10% below 1995 levels.

The current UK fuel efficiency labelling scheme was introduced in October 2001 by the *Passenger Car (Fuel Consumption and CO_2 emissions information) Regulations* SI 2001/3523. They implemented Directive 99/94/EC *Consumer information on fuel economy and CO_2 emissions in respect of the marketing of new passenger cars* that was approved in December 1999 and came into force on 18th January 2001.

The regulations require new models in showrooms to display labels listing their CO_2 emissions and fuel consumption. The government chose to require labels showing absolute values, along the lines of labels introduced by the Society of Motor Manufacturers and Traders (SMMT),[121] despite a subsequent report, funded by the SMMT and DETR, that argued for a clearer, banded label system.[122] The major recommendation of the report was:

> The information provided by the UK on fuel economy labels and in guides for new cars should go beyond the minimal requirements of the Directive 99/94/EC, by enabling consumers to compare each model with models of the same size or class.

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118 http://www.hm-treasury.gov.uk/Consultations_and_Legislation/motorved/consult_motorved_index.cfm

119 *ENDS report* 323 December 2001 p20

120 http://www.inlandrevenue.gov.uk/cars.

121 SMMT Press Release *SMMT launches environmental label for new cars* 18 October 1999

122 *Choosing cleaner cars: the role of labels and guides.* Final Report of a Research Study on Vehicle Environmental Rating Schemes. TRI Record 00/10/0. Transport Research Institute, Napier University. Commissioned on behalf of the Information and Labelling Sub-Group of the Cleaner Vehicle Task Force by the SMMT with the DETR December 2000

The National Consumer Council also felt that the absolute approach was unhelpful to consumers, as it did not allow for easy comparison between vehicles. Research commissioned by the Cleaner Vehicles Task Force, which found that:

> although people liked the vehicle label launched earlier this year by the SMMT, they were confused by information on CO_2 emissions when it was given on an absolute basis. Consumers were more likely to be influenced to buy a more environmentally friendly car if vehicles were rated on a comparative basis. [123]

A report by the Advisory Committee on Consumer Products and the Environment, *Choosing Green*[124] also recommended a family of graded performance labels for cars, homes and domestic equipment.[125]

The DTLR issued a draft consultation paper that says that the present label should be reassessed to take account of the new systems of graduated VED, and company taxation based on CO_2 emissions. A consultation exercise on options for banded or comparative labelling will be piloted across the UK for twelve months from April 2002.[126] The National Society for Clean Air recommends a sliding scale for taxation with differentials between the top and bottom categories.[127]

The SMMT database shows a marked shift in buying patterns in 2001. It states that, "the new car market increasingly features smaller, cleaner petrol and diesel cars as buyers focus on CO2 based Vehicle Excise Duty (VED) and company car tax liabilities".[128]

F. The TransportAction CleanUp programme[129]

The TransportAction CleanUp programme was set up under the DETR (now run by the Energy Saving Trust for DTLR) in December 2000 with a budget of £6 million for 2000/01. The programme aims to reduce pollution from vehicles operating in urban areas, such as buses and taxis, by fitting emission reduction technologies and converting older

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123 *Cars, Carbon dioxide and consumers*, published jointly by the Society of Motor Manufacturers and Traders (SMMT) and the Department of the Environment, Transport and Regions (DETR) October 2001

124 *Choosing Green - towards more sustainable goods and services*. First report of the Advisory Committee on Consumer Products and the Environment. DEFRA 23 October 2001: http://www.defra.gov.uk/environment/consumerprod/accpe/report01/index.htm

125 DETR News Release 661, *Greener cars for a greener environment*, 20 October 2001.

126 HC Deb 21 January 2002 cc569-70W

127 "Government plans on car labelling come under fire", *ENDS Report, 323*, December 2001, p34

128 SMMT Press Release *Database confirms drop in CO2 output from new cars* 19 December 2001. http://www.smmt.co.uk/news/pressreleasedisplay.asp?articleid=347

129 TransportAction is an initiative run by The Energy Saving Trust and mainly funded by the Government. TransportAction is the 'umbrella brand' for the Trust's environmental transport programmes which include PowerShift and CleanUp

vehicles to run on alternative fuels, including LPG, where it proves cost effective and environmentally beneficial to do so

Prior to the scheme, PowerShift supported the conversion of 55 buses and 5 minicabs to run on LPG and during 2000, 37 buses and 57 minicabs were converted. The CleanUp Programme funded over 130 black cab conversions in the financial year ending April 2001.[130] Other initiatives include the fitting of particulate traps on urban buses.

G. Other campaigns and activities

The Government ran a "Running a Greener Vehicle" campaign in 1998 and a free leaflet is available from the DTLR. [131]

The Foresight Vehicle LINK programme, [132] launched in November 1997, is the UK's national automotive R&D programme. It aims to promote technology and to stimulate suppliers to develop and demonstrate market driven enabling technologies for future motor vehicles (cars, taxis, HGVs, buses, light commercial vans, etc.), which must satisfy increasingly stringent environmental requirements as well as meeting expectations for safety, cost, performance and desirability. £11.5 million of Government funding is being made available for research partnerships that bring together UK resources and expertise to create components and systems for vehicles of the future.[133] It is expected that this will be at least matched by industry.

The Alternative Traffic in Towns – ALTER scheme was launched in 1998 as a pilot project in Chester, under the UK Presidency of the EC. 120 local authorities and many capital cities in Europe signed up to the renewal of transport systems and the introduction of urban clean zones.

Motorvate was launched in June 2000 with a target to reduce vehicle fleet's carbon dioxide emissions by 12% over three years.[134] Fleet managers can receive advice from energy, environment and transport experts on the benefits of buying greener vehicles, achieving better environmental performance and the best techniques for fuel savings.[135]

Advice on 'greener' driving can be found on the 'doing your bit' website.[136]. A number of debates on clean fuels have taken place in the Commons[137] and there have been numerous answers to parliamentary questions on many aspects of alternative fuels in both Houses.

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130 HC Deb 26 January 2001 c732W
131 Ref 97EP0484
132 http://www.foresightvehicle.org.uk
133 http://www.foresightvehicle.org.uk/news/press02.asp
134 DETR Press Notice 399, *Get Motorvated MacDonald tells British business*, 6 June 2000.
135 http://www.greenerfleet.org.uk
136 http://www.doingyourbit.org.uk

Conclusions

Road traffic depends almost entirely on petroleum products. Almost 99 per cent of energy supply for road transport in OECD countries is derived from oil (petrol or diesel), whereas the main alternative fuels LPG and CNG represent a tiny share. Despite technical advances and initiatives to promote new, cleaner fuels, greenhouse gas emissions per litre of fuel consumed have not changed significantly over the past fifty years.[138]

Interest in cleaner, less polluting vehicles and fuel has grown rapidly in the UK over recent years, attributable to three factors:

- Increasing awareness of, and concern about, the environmental effects of vehicle use
- The financial savings that vehicle operators can make by switching to cleaner vehicles
- Increasingly stringent emissions legislation.

National fuel policies may favour air pollution abatement or the displacement of oil as the fuel of choice over concerns about reducing global levels of carbon dioxide, depending on the country and the stability of oil supplies.

The term 'clean vehicles' includes low emission conventionally fuelled vehicles as well as those powered by alternative fuels, and technological developments applied to alternative vehicles can apply equally to conventional vehicles. The life cycle emissions of some turbo-injection diesel engines running on low sulphur diesel fuel can compete on favourable terms with other alternative fuels regarding carbon dioxide emissions. Other measures, such as traffic calming, road tolls, premium parking fees, on-board computer technology and efficient management of freight may all have a role to play in the short term in reducing greenhouse gas emissions from transport.

There are a number of alternative fuels for vehicle transport. Many fuel flexible vehicles already incorporate features that allow them to use fuels such as ethanol or bio-diesel at certain ratios, and with minor modifications, across a wider range of fuel mixtures, without requiring major investments in vehicle or refuelling infrastructure.

However, alternative fuels will not penetrate most vehicle markets whilst the range of conventional petroleum products remains at such a competitive price, servicing larger, more powerful petrol models. Increased fuel efficiency may actually increase the number of car journeys. Many car owners are less concerned with vehicle and fuel costs, and less willing to trade-off vehicle size and weight, and marketable attributes, such as air-conditioning, for increased fuel efficiency or better emission standards.

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[137] HC Deb 27 March 1996 cc1115-8; HC Deb 4 July 2001 cc374-80; HC Deb 19 October 2001 cc1361-1405.

[138] *Saving oil and reducing CO2 emissions in Transport: options and strategies*, OECD / International Energy Agency, 2001. Chapter Four

The main obstacle to marketing alternative fuels is the lack of reliable refuelling infrastructure. Refilling vehicles must be made as convenient as filling a car with petrol, but developing a widespread national network requires investment and national, regional or local policy initiatives to overcome 'chicken and egg' barriers. Some infrastructure already exists that could be adapted at minimal expense to distribute alternative fuels compatible with today's cars; other fuels, such as LPG, need more specialist facilities and will require considerable investment where no such facilities exist. In the UK, there are over 1000 LPG stations. Fuel handling systems for alcohol fuels need to be equipped with alcohol resistant-materials, due to their corrosive properties.

The main market barriers to the promotion of alternative fuels, apart from the preferential price of oil, are technical problems in fuel production and distribution; lack of public acceptance or awareness of benefits; costs; geographical constraints; legislative, safety and environmental barriers, and 'chicken and egg' barriers. Not all barriers apply to all alternative fuels.

Most alternative fuels contain less carbon per unit of energy than petrol or diesel, but on a 'well to wheel' or life cycle emission basis, they may not necessarily emit fewer total emissions overall, depending on how the fuel is produced, refined, distributed and stored.[139]

In the short term, it is unlikely that any of the alternative fuels reviewed could displace 10 per cent of current usage of oil, or bring significant reductions in carbon dioxide emissions. In the next five to ten years, LPG and CNG will be more widely available and gaining market share across vehicle ranges. In some areas of the world, alcohol fuels produced from cellulose sources (methanol and ethanol) and bio-diesel promise the largest reductions in CO2 emissions in the medium term, but would require substantial changes to agricultural systems that may be incompatible with agricultural regimes. Fuel conversion capacity may be a limiting factor in some cases. In the longer term, vehicle efficiency and fuel processing and distribution efficiency will have both improved, so life cycle emissions for most fuels will decline. The best estimates suggest that it will be at least 2030 before fuel cells powered by renewable hydrogen become the norm.

UK government policy is to promote the use of alternative fuels, such as LPG and CNG, through tax incentives, preferential fuel excise duties, promotion schemes and the provision of retro-fitting conversion grants, through the PowerShift scheme. The European Union is also supporting the use of cleaner fuels, and the promotion of bio-fuels.

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[139] See *Saving oil and reducing CO2 emissions in Transport: options and strategies*, OECD / International Energy Agency, 2001. Figure 4.1 for an estimate of CO2 equivalent life cycle emissions for each of the major alternative fuel compared to petrol.

Further information

Auto Industry: a large source of automotive information relating to industry, government, technology, data, and news in the UK. http://www.autoindustry.co.uk/index.asp

LPG sites on the Internet via Lange Gas http://www.langegas.com/linksle.htm

Alternative Fuel Information sources (strong US bias)
http://www.cleanvehicles.com/cleanv/information/pdfs/Reports/Fuel/Information%20sources.pdf

California Hydrogen Business Council
http://www.ch2bc.org/bulletin/bulletin20010708.htm

Fuel Cell today website: http://www.fuelcelltoday.com

The UK Hydrogen Energy Network http://www.h2net.org.uk/

EyeForFuelCells http://www.eyeforfuelcells.com/index.asp

Internationalfuelcells http://www.internationalfuelcells.com

A hydrogen Economy http://www.hydrogen.co.uk/index.htm

The Hydrogen and Fuel Cell Letter http://www.hfcletter.com/

Birmingham University, School of Chemical Engineering Fuel Cell Network
http://fuelcellnetwork.bham.ac.uk

"On the road to a hydrogen economy", *ENDS Report*, 311 (December 2000), pp20-4

"Future prospects for world LPG" & "Green gas for less cash?", *Petroleum Economist*, November 2000 & May 2001

Some details on the use of alternative fuels in other European countries is provided on the site of the 'Zeus' (Zero Emissions in Urban Society) project, funded by the European Commission, which promotes the uptake of clean, alternative fuel vehicles. http://www.zeus-europe.org/fuels.html

Appendix One. Road gas fuels

Natural gas is in abundant supply, and relatively cheap, and used directly as a motor fuel or for the production of fuels derived from it, (such as methanol or hydrogen reformed from natural gas) could make significant inroads into replacing oil-based fuels. More gas is needed to produce an equivalent amount of a liquid fuel than using it directly as a motor fuel, due to conversion losses. Liquefied Natural Gas (LNG) is stored as a liquid at low temperatures (–260^{o}F at atmospheric pressure, at 1/600th of the volume of the gas as a vapour). Porous storage materials are being developed to store methane on board vehicles without having to pump it up to dangerous high pressures.[140]

Though Compressed Natural Gas (CNG) and Liquefied Petroleum Gas (LPG) are technically fossil fuels, they have received much attention to date as viable alternative vehicle fuels. LPG offers similar environmental advantages to CNG, though neither can match bio-diesel from the specific standpoint of reducing emissions of carbon dioxide.[141] In March 1996, ETSU (Energy Technology Support Unit) published *Alternative Road Transport Fuels – A Preliminary Life-cycle Study for the UK*. Among the conclusions in the report were the following:

> For the reduction of urban pollution, the most appropriate alternative fuels are LPG, natural gas, electric power and alcohol fuels. With respect to greenhouse gases, bio-fuels have particularly low life cycle CO_2 emissions; natural gas and LPG also give CO_2 savings compared with petrol. Their consequential effect on health and the environment would be the subject of further research.

ETSU found that purpose-built CNG or LPG vehicles received relatively favourable assessments, when comparing their emissions of various pollutants with diesel (though LPG buses produced more carbon monoxide). However, more stringent European emission standards, and voluntary agreements among European vehicle manufacturers, mean that emissions from all vehicle types are expected to fall by another 25% by 2006, and fuel efficiency increase by 25% more than the average in 1995 by 2008. [142]

The EC has targeted natural gas to replace 10% of petroleum-based fuels in the transport sector by 2020. [143]

A. Compressed Natural Gas

Natural gas is predominantly methane (roughly 94% CH_4) and is the fuel people use for cooking and to heat their homes. In order to contain sufficient volume of gas in a

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[140] "Pressure's off for methane", *Financial Times,* 24 January 2002

[141] *Automotive fuels for the future: the search for alternatives* (International Energy Agency 1999) p70

[142] HC Deb 19 October 2001 c1362

[143] European Natural Gas Vehicles Association http://www.engva.org/view.phtml?page=pa.phtml

conventional sized fuel tank, natural gas is either compressed or liquefied in order that it can be carried and used by a vehicle. CNG cylinders are usually fitted under the carriage or roof. The CNG leaves the cylinder at high pressure and passes through a master shut-off valve to a regulator, where it is injected into the engine compartment at atmospheric pressure and mixed with air.

CNG offers significant air quality benefits, particularly in terms of reductions of particulates PM_{10}[144] and NOx, although there is a small increase in carbon dioxide emissions. CNG engines also tend to be less noisy than heavy diesel engines. However, as more stringent emission criteria are introduced, particularly the Euro IV emissions standards from 2005, together with the increased use of after-treatment devices, such as particulate traps, the margin in environmental performance may diminish. CNG powered NGVs present a lower fire and explosion hazard, partly due to the fact that, in the open air, any leakage of natural gas would disperse quickly.

Worldwide there are probably over a million natural gas-powered vehicles (NGVs) in operation, with over 60,000 NGVs in the United States, 40,000 in Canada, where there is a network of 125 public refuelling stations, and 285,000 in Argentina.[145] Italy, which has been using natural gas as a fuel since the 1940s, has over 300,000 vehicles. Russia, with over 300,000 vehicles, has plans to convert one million cars over the coming decade. NGVs are also long established in Australia and New Zealand. Other countries, such as Uzbekistan, Indonesia, Mexico, Venezuela and the Philippines, also use CNG, through economic necessity or lack of reliable oil supplies.

The majority are ordinary petrol powered cars and vans which have been converted to have a "bi-fuel" capability; in other words they have two separate fuel systems and can switch between petrol and natural gas (methane) at the flick of a switch. Some diesel vehicles can operate in a "dual-fuel" mode, whereby a mixture of fuels, usually diesel and natural gas, is used.[146] Dedicated vehicles have natural gas as their only fuel.

In the UK, bi-fuel and dual-fuel vehicles currently have an advantage given the relatively sparse network of gas-filling stations. However, they have less power and manoeuvrability due in part to the extra fuel tanks that have to be fitted to contain the CNG. When fuel costs alone are taken into account, CNG is the cheapest of all the fossil fuels to use at around 6p per mile, compared to 10p or more for petrol.

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[144] Particulate pollution is currently measured by mass of PM_{10} – particles below 10µm (one µ or micrometre is one ten thousandth of a metre) but evidence is mounting that smaller particles present the greatest threat to health. There have been calls for a new metric measure to be introduced based on $PM_{2.5}$ or even on the number of particles. *ENDS Report* 314 March 2001.

[145] LPG Association figures.

[146] *PowerShift:Clean Vehicle information for the UK,* http://www.est-PowerShift.org.uk/ps_natural_gas.html

The kits needed to convert cars to gas running cost about £3,000. Conversion has proved popular for trucks, buses and larger vehicles, such as refuse collectors. Although significant increases are expected in sales and conversions of CNG vehicles in 2002, the extra weight and cost of the on-board storage tanks makes conversion to natural gas more expensive than LPG for smaller vehicles.

Natural gas is delivered from storage areas to most parts of the UK by a network of pipelines, but distribution outside the network is expensive and limited in capacity. CNG is more difficult to handle and requires storage at higher pressures. Refuelling options for natural gas vehicles range from cheap, slow fill compressors that can refuel a vehicle overnight, to high-tech stations that can refuel a vehicle in a similar time to petrol. Natural gas is an excellent engine fuel, but neither form of on-board fuel storage for cars is as convenient as the storage of petrol or diesel, hence its use in heavier vehicles, such as buses and lorries. Many fleets have their own dedicated refuelling facilities. According to PowerShift, the economics of installing a large refuelling station works best when fleets of 15 or more larger vehicles are involved.

There are around twenty public refuelling points for natural gas. British Gas, which has a gas-fuelled fleet, was instrumental in taking the first steps towards establishing a network of natural gas-refuelling stations. An expansion of the network will be needed if there is to be a significant move from bi-fuel gas/petrol cars to dedicated natural gas vehicles. Two pilot projects, with Manchester city council, and the Mayor of London and Transport for London, aim to bring prospective CNG users and suppliers together to encourage transport operators to invest in NGVs.[147]

The cost competitiveness of NGVs compared with conventional vehicles will depend on a range of factors including comparative fuel costs and duty, engine lifetimes, performance and manufacturing costs. For example, a vehicle powered only by CNG, which would be less expensive than a dual-fuelled CNG/petrol vehicle, would still be significantly more expensive to manufacture than a conventional vehicle, largely due to the high-pressure gas storage tanks. However, the relative costs of natural gas and petrol, and economies of scale through mass production, could lead to the CNG vehicle becoming more competitive.

B. Liquefied Petroleum Gas

Liquefied Petroleum Gas is a mixture of propane (C_3H_8) and butane (C_3H_{10}), which occurs naturally in gas fields, where it is flared off during natural gas extraction, and is also produced during the oil refining process. It is derived from the two sources in approximately equal quantities. LPG sold in the UK is approximately 93% propane and 7% butane, whereas in most of Europe the proportion of butane is much higher,

[147] HC Deb 19 October 2001 c1367

approximately 70%.[148] Harmful, wasteful, flaring of LPG may be reduced by the introduction of 'flaring taxes' by some countries[149] making it worthwhile for oil companies to harness it rather than burning it as a by-product. The Energy Savings Trust[150] and LPG Association website give further information on production of LPG.[151]

LPG is a gas at room temperature and pressure but is stored under pressure as a liquid in order to achieve higher fuel densities. It is often used as a bottled gas for cooking where there is no gas pipeline nearby. In 1999, LPG accounted for approximately 2.8% of total global energy consumption and 6.4% of the global petroleum used for energy purposes. LPG compares favourably with petrol and diesel on the relative energy consumption used in refining LPG compared to ULSP and ULSD.[152] In most sectors, the consumption of LPG depends on the sophistication of the supply and distribution infrastructure, and on the availability and price of the alternatives.[153]

Almost all LPG vehicles sold in the UK can operate as bi-fuel vehicles[154] – changing over to petrol running at the flick of a switch. Dedicated LPG vehicles are likely to become the norm as the number of refuelling points increase. Apart from the fuel storage and delivery mechanisms, LPG engines are very similar to petrol engines, and deliver similar performance. Fuel is delivered to the engine as a gas from separate fuel tanks, controlled by a regulator. Most systems use 'lambda'[155] sensors, which measure the amount of oxygen in the exhaust gas and alter the air/fuel ratio accordingly.[156] LPG liquefies readily under pressure, so fuel tanks and supply hoses are not exposed to the very high pressures associated with other fuels. Tanks also have shut-off valves to prevent overfilling, adding to LPG's reputation as a safe form of fuel.

However, it is customary for national authorities to impose extra safety requirements over and above those that apply to petrol or diesel vehicles. In the UK installations have to meet the requirements laid down in the *Road Vehicles (Construction and Use) Regulations* SI 1986/1078. The UK is already a signatory to the technical requirements of an international United Nations regulation 67 adopted by Europe on motor vehicles fuelled by LPG. It is hoped that harmonised technical standards will encourage the

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148 Colt's LPG Fact sheet http://www.clean-vehicles.com/cleanv/information/pdfs

149 The potential for using tax instruments to address non-greenhouse gases. OECD. http://www1.oecd.org/env/docs/es/epocdaffecfa99110ES.pdf

150 http://www.est-PowerShift.org.uk/ps_liquid_petrol_gas.html (current at 28.12.2001)

151 http://www.lpga.co.uk/contents.htm

152 See HC Deb 26 January 2001 cc733-4W

153 "Future prospects for world LPG", *Petroleum Review*. 54 (646) November 2000, pp 16-9

154 For example, Daihatsu, Daewoo, Ford, Nissan, Vauxhall and Volkswagen.

155 The Greek letter 'lambda' represents the ideal stoichiometric [numerical relationship of elements and chemicals as reactants and compounds in chemical reactions] 14.6:1 air/fuel ratio in engineering terms

156 Gas Oxygen sensors usually based on Zirconium Oxide (ZrO_2) cells can measure a wide range of air/fuel mixtures

development and use of LPG as a motor fuel.[157,158] Still to be resolved is the issue of LPG laden cars not being able to enter the Channel Tunnel.[159]

It is estimated that by the end of 2001 there were 60,000 vehicles running on LPG in the UK,[160] and with fiscal incentives, this could rise to 250,000 by 2004. [161] Of the estimated 6 million LPG vehicles worldwide, over one million run in Italy, 790,000 in South Korea, 530,000 in Australia and nearly 400,000 in Holland.[162] All taxis in Tokyo run on LPG. UK fleets operating LPG include several police and fire authorities, local authorities, vehicle manufacturers, Philips Electronics and the John Lewis retail group. The Government Car and Despatch Agency, which provides ministerial cars, runs about one third of its allocated car fleet and about one sixth of its van fleet on LPG, including one Jaguar and a limousine,[163] and LPG vehicles are used in the Buckingham Palace fleet.[164]

Projected sales of LPG cars of over 50,000 are anticipated in 2002. Actual sales and conversions in 2000 reached a total of 20,576. The total UK gas fleet could reach 125,000 by the end of 2002.

There are over 1000 LPG refuelling sites in the UK; the industry is installing roughly one new LPG per day. Many of the latest sites are located at petrol stations and the major LPG Association suppliers, including Shell, BP, Calor Gas, British Gas and Conoco are investing in refuelling infrastructure. A list of retail sites and a map are shown on the PowerShift website.[165]

Compared to petrol or diesel powered cars, LPG cars produce substantially lower emissions of carbon dioxide and particulates, which can contribute to respiratory disease. LPG contains virtually no sulphur, and evaporates quickly, minimising the risk to soil and water from accidental spills.[166] Therefore, the argument is that greater use of LPG would make a positive contribution to local air quality and health, and help to reduce harmful greenhouse gas emissions.

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157 European Parliament briefing on the council decision (COM (1000) 14 final) on the accession by the EC to United Nations Economic Commission for European Regulation No 67 on motor vehicles fuelled by LPG

158 See also RIA 01/111 Amendments to the *Road Vehicles (Construction and Use) Regulations* 1986 (as amended) to recognise the latest European directive and United Nations ECE regulations and to introduce in-service requirements to improve road safety. DTLR. 2001

159 HC Deb 19 October 2001 c1367

160 *Energy Trends* December 2001 p18, DTI

161 LPG Association figures – *Petroleum Review* May 2001 pp26-7

162 LPG Association figures.

163 http://www.gcda.gov.uk Personal conversation 4 .01.2002

164 "They're changing the gas at Buckingham Palace: The Royal garage is going green", *Daily Telegraph*, 2 January 1998

165 http://www.est-PowerShift.org.uk/ps_lpgmap.cfm current at 28 December 2001.

166 "Green cash for less?", Petroleum Review May 2001, pp26-7.

Emissions vary depending on the quality of the LPG system used and air quality benefits are greatest when delivered in urban areas and in larger diesel vehicles. LPG vehicles produce less CO_2/km than their petrol equivalents but marginally more than diesel equivalents. Good LPG systems will emit less NOx (nitrogen oxides), hydrocarbons and carbon monoxide than petrol equivalents, and less NOx, hydrocarbons and particulates than diesel equivalents. They will also emit fewer toxins, such as aromatic hydrocarbons (for example benzene) and are quieter than diesel or petrol equivalents. Engine life is said to be longer using LPG and fuel economy is also cited as a positive reason for running a car on LPG.[167]

Certain sectors of the market for LPG vehicles are close to being sustainable,[168] but PowerShift grants are still seen as critical funding to the long-term success of these vehicles.

Local authorities may be in a position to encourage take-up of alternative fuel vehicles by banning petrol and diesel vehicles (apart from emergency vehicles and buses) from town centres or urban pollution hotspots by declaring Local Air Quality Management Area (LAQM).[169] As gas powered vehicles are generally less noisy than conventional counterparts, local authorities may consider allowing such vehicles to deliver at more sensitive times, such as evening or early mornings, easing congestion and enabling some companies to reduce their fleets.[170] There is currently a night time curfew on heavy goods vehicles crossing London.

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[167] Ibid. See also HC Deb 26 January 2001 c734W

[168] HC Deb 11 May 2001 cc436-7W

[169] Section 101 of the *Local Government Act 1972* enables the Local Air Quality Management functions to be undertaken jointly by two or more neighbouring authorities that wish to co-operate together.

[170] HC Deb 19 October 2001 c1363

Appendix Two. Hydrogen fuels

Hydrogen is a versatile fuel that can be used in either adapted internal combustion engines or fuel cell vehicles. Direct use in an internal combustion engine would emit only a small amount of NOx and no CO_2.[171] Hydrogen powered vehicles are credited with the potential to eliminate toxic emissions, greenhouse gases and noise pollution, with the only emission from the tailpipe being water vapour. The transport sector is seen as central to a hydrogen economy, and the emergence of fuel cell electric vehicles that will be more efficient than conventional engines but require hydrogen fuel has increased the prospects of hydrogen becoming a mainstream fuel. However, a market dominated by fuel cell vehicles is still a distant prospect; best estimates are that it will be 2015 before there is enough on board hydrogen reforming capacity and 2030 at the earliest before reliable, economic fuel cell models reach the market.[172] A full description of the current state of fuel cell development is given in a Library Standard Note '*Fuel Cells technologies*.

Hydrogen has to be manufactured if it is to be used as an energy carrier. It is produced in one of two ways, either directly from fossil fuels or by electrolysis[173] of water. Not all the industrial production processes are energy efficient. If the latter process is driven by renewable electricity produced from biomass, solar, or wind, then the hydrogen fuel could be said to be a zero emission fuel. Using an energy source reliant on fossil fuels means greenhouse gases emitted at point of production increase the hydrogen's overall life cycle emissions of greenhouse gases.

Until more hydrogen is produced from renewable sources, there are two possible routes for the development of hydrogen as a transport fuel. Both initially involve hydrogen being produced from fossil fuels. First, some fuel cell vehicles are being developed that produce hydrogen on board, reformed from either methanol or sulphur free petrol. The government has allocated £9 million to support development of fuel cell and hybrid vehicles.[174] The other pathway is based on direct hydrogen refuelling of vehicles, using decentralised hydrogen production from natural gas. Opinion is divided over which pathway will predominate, but the evidence suggests that decentralised production from natural gas is likely to produce fewer greenhouse gas emissions and be more cost effective. On board reformers are more costly than storing externally produced hydrogen and can reduce vehicle efficiency and more greenhouse gas emissions from a cold start.

Julie Foley gives an account of the policy implication of developing hydrogen as a fuel for road vehicles in *Hydrogen: Driving the Future*, Institute for Public Policy Research

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171 "Which way to energy utopia?", *Nature* (414), 13 December 2001, pp682-4

172 *Saving oil and reducing CO2 emissions in Transport: options and strategies*, OECD / International Energy Agency, 2001. Chapter Four

173 Electrolysis is the splitting of acidified water into its component elements by passage of an electric current, yielding 2 volumes of hydrogen for every volume of oxygen produced.

174 "Give it some gas", *Green Government*, September 2001, pp26-8

(IPPR) July 2001, which is available on the Internet.[175] She states that the introduction of hydrogen vehicles is bedevilled by a classic 'chicken and egg' problem. On one hand, vehicle manufacturers will not invest in hydrogen vehicle production plants until there are a sufficient number of places for refuelling. On the other, fuel suppliers will not invest in an entirely new hydrogen-refuelling infrastructure until there are a sufficient number of vehicles on the road for using it. What is missing is the initial catalyst to get the market going. Government, she says, is uniquely placed to provide this by co-ordinating policies to ensure stimulation of the zero emission vehicle market and development of hydrogen refuelling infrastructure goes hand in hand.

She suggests the formation of a high level Hydrogen Task Force, charged with developing a 10-Year Hydrogen Strategy to identify ways in which policy can facilitate the development of a hydrogen transport economy. Government and opposition parties, industry, environmental and consumer groups should focus on the short and medium term market options with the lowest levels of greenhouse gas emissions. The long-term aim should be to develop a refuelling infrastructure that supports hydrogen produced from renewable energy, as part of the long-term strategy for electricity generation from renewables. She considers that options for the use of hydrogen as a power source for stationary applications should also be considered.

Foley acknowledges the role of government in kick-starting the market for hydrogen vehicles, starting with bus fleets, as their combination of on-board storage space, fixed routes and depot refueling offer the easiest starting point. EU finance will be provided to trial three hydrogen buses in London between 2003 and 2005. Foley recommends that the government follow up the pilot with Hydrogen Shift Grants to support the development of infrastructure and the purchase of hydrogen vehicles, managed along similar lines to the existing PowerShift scheme. PowerShift, she suggests, could be well placed to assume this role due to its expertise and contacts in supporting the LPG and CNG market. She also notes that the Greater London Authority already has powers to set a Zero Emission Bus (ZEBUS) mandate, along the lines of legislation in place in California, which other local authorities could set, specifying a proportion of zero emission buses amongst local fleets.

She sees the next stage of market development in fleet vehicles, with incentives for public authorities and companies that agree to replace a proportion of their fleets with hydrogen vehicles. Local authorities might also exempt quieter hydrogen vehicles from night time delivery bans. Incentives to encourage the private car market should be introduced, particularly through tax exemptions on VED and company cars. Finally, she suggests that hydrogen produced from renewable sources should be included in the Climate Change Levy and the fuel itself be exempted from fuel duty.

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[175] http://www.ippr.org.uk/research/files/team20/project12/hydrogenreport.pdf

Storing sufficient hydrogen on board cars is a problem to be overcome in order to satisfy consumer demand. For hydrogen cars to fuel a comparable journey of 600 kilometres on one tank of fuel would require around 5 kilograms, or 180 litres of hydrogen. The average petrol tank holds about fifty litres, therefore a pressurised tank of this size would simply take up too much space, compared with buses that have space in which to put them. Carrying high-pressure tanks would increase the risk of explosion. The California Air Resources Board reported that 'hydrogen is not considered a technically and economically feasible fuel for private automobiles now or in the foreseeable future'.[176]

A. Methanol

Methanol (CH_3OH) is an alcohol that is a liquid at room temperature and can be stored and distributed in liquid form in much the same way as petrol is now. This directly benefits motorist as it avoids the need to use heavy, pressure gas storage tanks and gives the vehicle a longer range. World output was 11.4bn gallons in 1998. Used in internal combustion engines (ICEs), pure methanol can potentially offer reductions in emissions of major air pollutants compared with existing diesel fuels, but less so with petrol.

However, methanol is poisonous; colourless, with virtually no odour, water supply contamination is a risk. According to Foley:

> Methanol is a poisonous toxin that can be absorbed through the skin. If it came into widespread use as a transportation fuel, there could be an increase in the number of deaths due to inhalation or even ingestion of the fuel. One energy company has gone as far as saying that it could become the centrepiece of yet another group of class action lawsuits akin to the recent litigation against tobacco companies. Whilst some vehicle manufacturers continue to develop fuel cell vehicles with on board hydrogen production from methanol, it appears that interest in methanol is on the wane. In January 2001, General Motors publicly stated that it was no longer going to consider producing hydrogen from methanol (General Motors, 2001).[177]

Already well served with abundant geothermal sources for electricity generation, Iceland is hoping to achieve a hydrogen based fuel economy, based on methanol as a by-product of its metal production industry, within thirty years.

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[176] "The promise of methanol fuel cell vehicles", *Petroleum Review*, December 1998, pp34-5

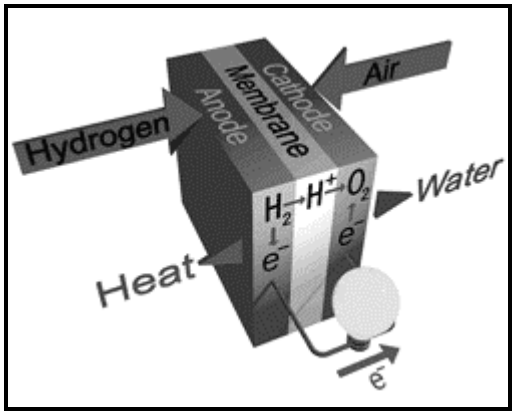
[177] Julie Foley, *Hydrogen: Driving the Future* Institute for Public Policy Research (IPPR) July 2001. http://www.ippr.org.uk/research/files/team20/project12/hydrogenreport.pdf

Appendix Three. Fuel Cells[178]

The government initiated the Advanced Fuel Cells Programme in 1992 to assess the commercial prospects for advanced fuel cells. Energy Paper 62 of 1994[179] identified that the programme should focus on solid oxide fuel cells (SOFCs) and solid polymer fuel cells (SPFCs). More recently, the programme has widened to consider a greater range of fuel cell technologies. The focus of the programme is on improving the prospects for the commercial uptake of fuel cells by making them more economically attractive whilst encouraging competitive businesses to develop technologies and quantify the environmental benefits and drawbacks of such systems.

Fuel cells are catalytic devices that convert the energy stored in a fuel (for example hydrogen) into electrical energy to turn an electric motor. They generate electricity from a simple electrochemical reaction in which oxygen and hydrogen combine to form water. There are several different types of fuel cell but they are all based around a central design, which consists of two electrodes, a positive anode and a negative cathode, separated by a solid or liquid electrolyte that carries electrically charged particles between the two electrodes. A catalyst, such as platinum, is often used to speed up the reactions at the electrodes.

The following diagram shows the basic design of a fuel cell assembly.



Unlike a conventional battery, there are no stored chemicals. The reactants are fed continuously into the cell where they generate electric power. Fuel cells are classified according to the nature of the electrolyte. Each type requires particular materials and fuels and is suitable for different applications. Individual fuel cells are assembled together to form fuel cell stacks, which produce enough electricity to run a vehicle.

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[178] See Library Standard Note 'Fuel Cell Technologies' http://hcl1.hclibrary.parliament.uk/Notes/ses/Energy/FuelCellsTechnology.pdf

[179] New and Renewable Energy: Future prospects in the UK' *Energy Paper* 62 DTI March 1994 Deposited Paper 10620

The most popular type of cell used by the car industry in prototype models is the Proton Exchange Membrane Fuel Cell (PEM), which operates at room temperature.[180] The other contender is the Solid Oxide Fuel Cell; this requires an operating temperature in excess of 600^{o}C, and needs several minutes to warm up.

Much development work is still required for fuel cells. At the present time, there are a number of technical and logistical issues that need to be resolved before a working fuel infrastructure is in place. There is no common standard for the fuel and until refuelling is as convenient as refilling a conventional vehicle, the market will be slow to grow.

Foley states:

> Many of the energy companies are exploring the option of using petrol to produce hydrogen on board the vehicle. Given that there are already petrol refuelling stations up and down the country the rationale for using petrol to produce hydrogen at first seems sensible. It has the advantage of being widely available and also familiar to consumers. However, it should be noted that the petrol we currently put into our vehicles is not necessarily the same kind of petrol that would be required for fuel cell vehicles. Some of the technologies used to extract hydrogen from petrol are easily damaged by impurities such as sulphur. The sulphur content of ultra low sulphur petrol and diesel currently available are unlikely to be considered low enough for use in a fuel cell vehicle. Fuel suppliers would also have to meet the costs of producing 'clean' petrol with all the sulphur removed. [181]

B. Government support for Fuel cells

The following extract from a paper, *Energy Costs in 2050*, which is being considered by the Energy Review, set out the prospects in the UK for fuel cell technology.[182]

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[180] Each PEM fuel cell uses a thin catalyst-coated membrane that is enclosed between graphite or ceramic plates. One side of the membrane acts an anode, and is exposed to hydrogen gas. The other side of the membrane serves as the cathode, and is bathed in air to provide oxygen. At the anode side, a catalytic reaction occurs, causing the hydrogen to be separated into protons and electrons. The protons diffuse through the membrane and reach the cathode. The electrons, however, cannot pass through this membrane and go round the membrane to reach the cathode thus causing an electric current as they travel. Once the electrons reach the cathode, another catalytic reaction takes place as the recombined hydrogen atoms join with oxygen to produce water.

[181] Julie Foley, *Hydrogen: Driving the Future* Institute for Public Policy Research (IPPR) July 2001. http://www.ippr.org.uk/research/files/team20/project12/hydrogenreport.pdf

[182] http://www.cabinet-office.gov.uk/innovation/2001/energy/ag2contents.shtml

6.4.3 Fuel cells

For transport applications, emissions reductions depend greatly upon fuel source. Although fuel cells are more efficient than internal combustion engines this advantage is lost if petroleum based fuels are used, as on-vehicle reformation of petroleum (to produce hydrogen) absorbs considerable energy. The role of the fuel cell in securing significant carbon emissions advantages is therefore intimately bound up with the development of low carbon supplies of hydrogen and the infrastructure, including storage that might be needed to facilitate this.

A PQ outlined government support for fuel cell research:[183]

Mr. Wilson *[holding answer 16 November 2001]:* I have been asked to reply.

The Department has been supporting fuel cells research and development for many years, through the DTI Sustainable Energy Programme and the Engineering and Physical Science Research Council. Since 1992 the DTI has supported 147 fuel cell projects with a total DTI spend of £11.8 million. The current DTI programme is spending about £2 million per annum, with the Engineering and Physical Sciences Research Council (EPSRC) spending about the same on basic research related to fuel cells.

The Energy Review currently being conducted by the Performance and Innovation Unit is considering the role of new technologies including fuel cells, in conjunction with other energy matters, as part of its review of strategic issues surrounding energy policy. It is due to report to my right hon. Friend the Prime Minister by the end of the year. Fuel cells may also be used to replace or supplement the internal combustion engine in vehicles. The Government will shortly be issuing a consultation draft of their "Powering Future Vehicles" strategy for promoting the development, introduction and take-up of hybrid, fuel cell and other low-carbon vehicle technologies.

In another PQ further information was given:[184]

The DTI is currently supporting the first UK demonstration of a 200 kW fuel cell combined heat and power unit at Woking borough council. Although there are a number of different fuel cell technologies, significant cost reductions will be necessary before they will be fully commercial for electricity generation.

Other major programme developments and progress against targets for the DTI Advanced Fuel Cells Programme can be found in the annual report 2000/01.[185]

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[183] HC Deb 26 November 2001 c694W
[184] HC Deb 22 November 2001 c395W
[185] DTI renewable energy programme annual report 2000/01 ETSU-R-103. DTI 2001

Although there are currently no targets for sales of fuel cell vehicles, the government is consulting on a suggested target for the proportion of low carbon vehicles sold within a decade, including hybrid and fuel cell vehicles of around eight to twelve per cent, with a longer-term target of similar magnitude by 2020 for fuel cell vehicles.[186]

In the United States, the current Bush administration announced that it would introduce a new public-private research programme, Freedom Car, whose main goal will be to encourage the development of hydrogen-based fuel-cell technology. This supplants an eight-year programme, Partnership for a New Generation of Vehicles, introduced in 1993 by the Clinton administration, which focused on achieving greater fuel economy in petrol driven family cars. Twenty five per cent of spending under the programme went on fuel-cell research.[187]

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[186] DTLR/DEFRA/Treasury/DTI Press Notice 512, *Powering Future Vehicles*, 3 December 2001.

[187] "US plans fuel-cell venture", *Financial Times,* 10 January 2002, p28

Appendix Four. Bio-fuels

Bio-fuels could play a major part in achieving the UK's renewable energy targets for heat and power, with a more limited role in producing alternative vehicle fuels. The carbon dioxide generated by bio-fuels was absorbed originally from the atmosphere by growing plants, and although small quantities of fossil fuels are required to produce or convert bio-fuels, their overall life-cycle energy balance is thought to be carbon neutral. The fuels covered by the DTI Bio-fuels Programme are municipal and general industrial wastes, landfill gas and other bio-fuels (agricultural and forestry residues, and energy crops).[188] Availability of bio-fuels through the forecourt is unlikely; distribution from processing plant to fleet users, and direct to fuel blenders, is a more practical scenario.

The Green Fuels Challenge includes incentives to encourage the use of alternative fuels, including those derived from biomass. The DTI have produced a guidance document highlighting some of the organisations involved in promoting the use of bio-fuels in the UK.[189]

A. Bio-ethanol

Bio-ethanol is a simple alcohol that can be used as a conventional fuel extender in existing petrol vehicles, as well as potentially in diesel vehicles. Fuel blends have the advantage that they do not require major investment in vehicle or refuelling infrastructure. Ethanol as a road fuel is produced primarily from starchy products, such as corn and wheat, and woody/cellulose sources like sugar cane. In the UK bio-ethanol can be produced from sugar beet and wheat, and some agricultural wastes.

In Brazil, where there is a thriving alcohol fuel economy under its Proalcool programme, 119 million hectalitres of ethanol were produced from sugar cane in 2000. Distilleries enjoy state support but there are no specific tax concessions. However, the government has announced that all petrol sold in retail outlets in future should contain 24% of ethanol (compared with 22% now), and as much as 26% by then end of 2002.[190]

Processes involving woody or plant tissues are still at the demonstration stage but these materials offer better opportunities than starch based alcohol to reduce carbon dioxide emissions. Ethanol produced from conventionally harvested grains and distillation techniques has relatively high emissions. Forestry or agricultural waste products, such as straw or wood waste, and woody crops, like elephant grass or short-rotation coppice, are usually available on a commercial scale without the need for intensive cultivation. Woody components can also be burned to power and heat the ethanol production process. The

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[188] DTI Renewable Energy Programme Annual Report 1000/01/ ETSU-R-130 DTI November 2001
[189] http://www.dti.gov.uk/renewable/pdf/bio.pdf
[190] Bold developments in several EU member states. *Europe Environment,* 603 15 January 2000 p 1.18

biomass component of municipal waste could also be used, providing it could be separated at a reasonable cost.

The climate change benefits also depend to a large extent on how the crop is produced for ethanol. Intensive wheat farming requires heavy machinery, fertilisers and pesticides, and the distillation process is also relatively energy intensive. At the end of 2001, British BioGen, the trade association for the UK's emerging bio-energy industry, held a seminar on the theme of *Bio-ethanol: future transport fuel*.[191] This generated sufficient industry interest for the DTI to support future R and D calls for proposals.

There are estimated to be one million dual-fuelled vehicles in the United States. Most vehicles can operate on a blend of up to 15% of bio-ethanol in petrol. Higher ratios are possible but engine modifications are required, and some petrol is still required to allow easy starting of the engine. As a petrol extender, bio-ethanol provides fewer air quality benefits from the UK perspective. Since the introduction of catalytic converters in 1993, the potential of bio-ethanol for reducing carbon monoxide is less of a consideration. Less is known about the benefits of diesel/ethanol, known as Oxy-diesel, mixtures.

Several EU countries are announcing programmes for manufacturing bio-ethanol from sugar and agricultural alcohol to be used as a petrol replacement, which may stimulate the international market in this product. France is the leading producer of ethanol for motor fuels in Europe, but Sweden and Spain are increasing their output. Approximately 2.3 million hectolitres were produced in the EU in 2000.[192]

B. Bio-diesel

Bio-diesel is produced by mixing vegetable or animal oil with a small quantity of methanol in a process known as esterification.[193] Potential fuel crops include rapeseed oil, soyabean oil, palm oil and used vegetable oils. In northern Europe oilseed rape is the most appropriate crop for the climatic conditions, but requires intensive agricultural practices, pesticides and fertilisers. There are some adverse impacts on vulnerable farmland habitats and bird species.

Total European bio-diesel output in 2000 was 700,000 tonnes, with half the total production coming from France, followed by Austria, Germany, Italy, Spain and Sweden. This still represents only 6 % of world production.[194] A draft European specification for bio-diesel has recently been developed, and production targets have been set of 2.3 million tonnes by 2003 and 8.3 million tonnes by 2010, in order to reduce greenhouse and

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[191] British BioGen seminar *Bio-ethanol: future transport fuel*. 13 December 2001

[192] *Europe Environment* 603, 15 January 2002, p 1.18

[193] Esterification is a reaction of an alcohol with an acid to produce an ester and water.

[194] *Saving oil and reducing CO2 emissions in Transport: options and strategies*, OECD / International Energy Agency, 2001. Chapter Four

air polluting gas emissions. [195] Zero fuel duty rates in Germany, Austria, Italy and Spain and a variable duty regime in France may further encourage production of crops.

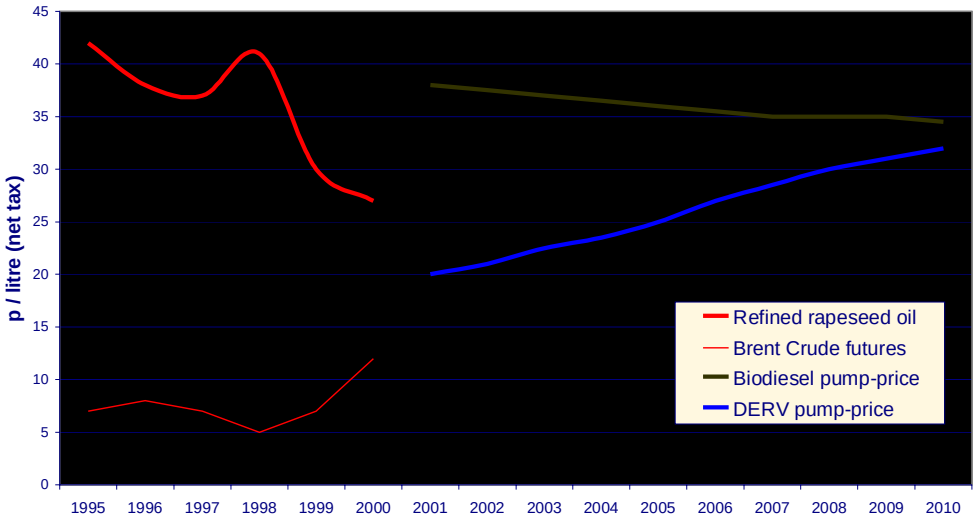
Current diesel engines can operate with up to 5% diesel extension using bio-diesel. Emissions depend on the type of vehicle and fuel specification, but there are few air quality benefits relative to conventional diesel. Bio-diesel is non-toxic and biodegradable, making it suitable for use on inland waterways and other sensitive marine environments. Like bio-ethanol, climate change benefits ultimately depend on how the crop is produced.

For bio-diesel from waste vegetable oil, greenhouse gas emissions depend on whether the used vegetable oil is otherwise recovered and used in animal feed, or whether it is disposed of as a waste product. Some UK companies have specified that they will not support feed products containing used vegetable oil.

According to the British Association for Bio Fuels and Oils (BABFO) [196] there is considerable potential in the UK to produce bio-diesel and bio-ethanol crops, particularly on land set-aside for oilseed rape, and the conversion of some land used currently for wheat production. However, the potential for production will be governed by the duty rate for either as a road fuel, the costs of crude oil and oilseed rape, and any changes to regimes for sugar beet and wheat.[197]

The graph below shows the historical prices of refined rape oil, Brent crude and projected pump prices of bio-diesel and DERV *(p/li net of tax).*

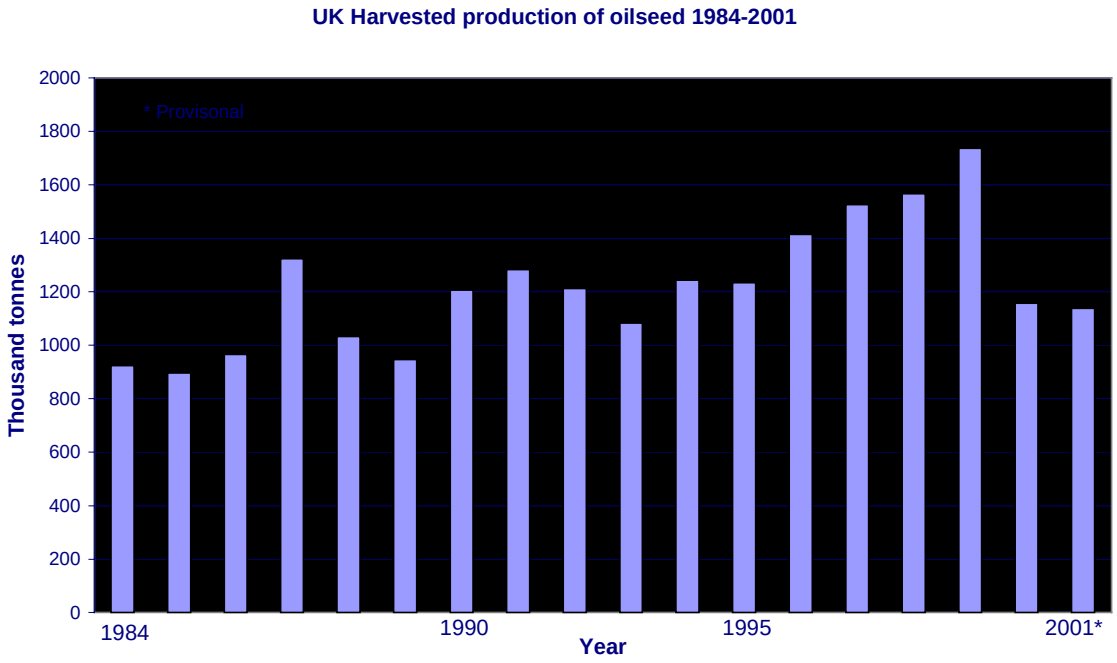
Historical prices of rapeseed oil and Brent Crude Futures, and projected pump prices of biodiesel and DERV



Source: BABFO, 2001.

[195] P Cleary "Liquid Bio-fuels in the UK", *Green Government* September 2000.
[196] Curlow Court, Spalding, Lincolnshire, PE12 9QQ. Tel: 01406 350848 http://www.bio-diesel.co.uk
[197] http://www.bio-diesel.co.uk/press_release/submission_for_bio-fuels_5.htm#SECTION I:

Taking the pre tax prices of fossil diesel and bio-diesel projected for 9 years, on certain assumptions, and duty subventions, BABFO believe there could be little to choose between the two on cost at the end of the period. Presently, bio-diesel is a little less than twice the price of its fossil fuel equivalent.



The chart above shows the figures for UK harvested production of oilseeds. Announcing the figures, Elliott Morley said: [198]

> DEFRA has recently commissioned a six-month study, on behalf of the Government Industry Forum in non-food uses of crops, to provide an independent, comprehensive and rigorous evaluation of the comparative energy, environmental and socio-economic costs and benefits of bio-diesel production in the UK. The study will compare results with those for other relevant green fuels and relevant energy saving measures.

BABFO also contend that the scope to recycle waste vegetable oil would be an important benefit of enhanced production of bio-diesel in the UK. It makes this point in its submission to the Green Fuels Challenge:

> Recycled vegetable oils (RVO, which may also contain animal and fish oils) and recycled tallow can make an excellent contribution to bio-diesel production. Such use turns these materials from a potential liability to a useful constituent of road transport fuel. In the UK, probably up to 75,000 tpa or more of RVO is potentially available. At present RVO goes into animal feed (or into landfill or down the drains to cause serious problems).

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[198] HC Deb 10 January 2002 cc990-1W

> An active bio-diesel industry able to pay a reasonable price for this material would certainly assist in a sound recycling activity and decrease the amount of RVO being dumped. However, the waste oils have to be collected and cleaned before they can be esterified into bio-diesel and this is not without cost. (The majority of businesses involved in reclaiming used cooking oils are members of BABFO). The cost of RVO may be either side of 20 pence per litre depending on location and initial quality.
>
> Tallows, originating from far fewer sources are simpler to deal with. Again, up to about 100,000 tonnes per year could be available given correctly priced outlets for fuel use.
>
> A duty rate for bio-diesel of nil or even that already given to the road gas fuels would be likely to ensure that waste oils were collected and used for fuel production.[199]

Countries such as the USA and Canada, which contain large areas where there is a considerable amount of waste biological material that might be turned to bio-fuel, should find it more feasible to have bio-fuel oriented industry. Each country already has ethanol subsidies in place, though not specifying particular crops most effective for carbon dioxide reductions. Ethanol accounts for 3 % of light vehicle fuel consumption in the United States.[200]

C. Bio-gas

Bio-gas is produced from landfill gas and can be used in vehicles converted to run on CNG, if sufficiently refined. However, it is more commonly used as a conventional fuel. It is often used in Third World countries for heating and cooking but is often ignored in developed countries because its variable composition of methane, carbon dioxide and other gases prevent its use in conventional power systems. As the proportion of carbon dioxide increases, the fuel becomes progressively more difficult to ignite.[201] Consequently, much landfill gas is vented to the atmosphere, making a significant contribution to greenhouse gas emissions. Bio-gas production at a landfill sites will become part of the overall waste disposal strategy at new sites under the Landfill Directive.

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[199]) Re-Cycled Materials

[200] *Saving oil and reducing CO2 emissions in Transport: options and strategies*, OECD / International Energy Agency, 2001. Chapter Four

[201] Ignition cannot be maintained beyond a CO_2/methane ratio of 3:1 (Nyeloff and Gungel Energy, *Agriculture and Waste Management*, 1975

D. EU action

The promotion of bio-fuels has been one of the Community targets since the early 1990s.[202] Although bio-fuels are unlikely to completely replace other motor fuels – current EU usage of bio-fuels being less than 0.5% of petrol and diesel consumption - the EU would like to see in the short to medium term, the exploitation of bio-fuels in existing vehicles and distribution systems. This is in spite of the fact that the cost of producing bio-fuel two to four times higher than for petrol or diesel.[203] There is support for blending bio-diesel with diesel, although any formal obligation to incorporate bio-diesel would not be acceptable at present due to lack of production and distribution facilities, and raw materials, EU wide.[204]

The European Committee for Standardisation (CEN) was asked to work on standardising bio-fuels, and has tabled proposals to set specification levels for bio-fuels.[205] Tax incentives to promote wider take-up would require a change in the current EU tax regime. Legislation currently allows exemptions solely for 'pilot projects'. The EU Court of First Instance issued a ruling declaring the French ETBE production support system illegal as it had gone beyond the stage of a pilot project.[206]

An action plan on alternative fuels for vehicles, adopted by the European Commission in November 2001, predicts a minimum use of 2% of bio-fuels by 2005, rising to 6% by 2010 and 8% by 2020, along with 5% hydrogen and 10% natural gas. Two draft Directives published at the same time will place an obligation on Member States to comply with the introduction of bio-ethanol and bio-diesel, and allow for differentiated tax rates to operate in favour of these fuels.

The proposed Fiscal Directive[207] amends Directive 92/81/EEC on the harmonisation of excise duties on mineral oils. It will permit, but not oblige, Member States to reduce excise duties on pure bio-fuels or fuels blended with bio-fuels in proportion to the percentage of bio-fuels incorporated into the final fuel product.[208] The mechanism will operate between 1 January 2002 and 31 December 2010, and must take account of changes in prices of raw materials so that there is no over-compensation for the extra manufacturing costs. However the effective level of taxation of the final product should not be less than 50% of the ordinary excise duty for the corresponding product. Countries

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202 "Development plan in the works", *Europe Environment,* 580 12 December, 2000.

203 *Saving oil and reducing CO2 emissions in Transport: options and strategies,* OECD / International Energy Agency, 2001. Chapter Four.

204 *Europe Environment* 580, 12 December 2000, 5

205 *Europe Environment* 580 12 December 2000, 5

206 *Europe Environment* 595 11 September 2001, 1.11

207 Proposal for a Council Directive amending Directive 92.81 EEC with regard to the possibility of applying a reduced rate of excise duty on certain mineral oils containing bio-fuels and on bio-fuels. COM (2001) 547 Final
http://www.europa.eu.int/comm/taxation_customs/proposals/taxation/com20011107/fuel_text_en.pdf

208 *Europe Environment* 600, 20 November 2001, 1.4

that already exempt bio-fuels in their pure state may do so until 2003. There is an optional reduction for bio-fuels consumed by local passenger transport vehicles, including taxis.

The proposed Incorporation Directive[209] will require Member States to ensure that by 31 December 2005 a minimum 2% of agricultural-based fuel is used in all transport sector petrol and diesel fuels sold. Based on the energy content of the fuels, this should increase at a rate of 0.75% per year to reach 5.75% in 2010.[210] The Directive seeks to set a minimum objective for the use of bio-fuels in all types of fuels; all fuels sold in 2009 should contain a minimum of 1% of bio-fuels. The Communication accompanying the Directives gives a comprehensive overview of the state of bio-fuel production in the European Union.[211]

The Commission hopes these initiatives will make a substantial contribution to the 20% substitution of oil with alternative fuels target set in its Green Paper '*Towards a European Strategy for the security of energy supply*', published in November 2000.

> Member States should make a firm commitment to achieving the ambitious and realistic objective of the White Paper for 2010; namely, 7% of bio-fuels and a target of 20% for 2020 for all fuel substitutes.
>
> The gap between the prices of bio-fuels and competing products would be reduced by measures that, initially, could be of a fiscal nature.[212]

France, Spain, the Netherlands and Italy have fiscal programmes for increasing the production of ethanol. France has also encouraged the use of bio-fuels for many years, including since 1992 a generous tax exemption under the Domestic Tax on Consumption of Petroleum Products.[213]

A bio-fuel distillery plant in France will go ahead in 2002, in parallel with the achievement of European targets on the introduction of bio-fuels, and as a direct consequence of the Commission's bio-fuels package.[214] In 2001, France made tax concessions for a further 155,000 tonnes of ETBE (Ethyl Tertio Butyl Ether) and two new production units will be commissioned in 2003, although the market share will still fall short of its target of 2% by 2005.

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209 Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of bio-fuels for transport. COM(2001)547 Final

210 *Europe Environment* 600 20 November 2001 1.4

211 Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the regions on alternative fuels for road transportation and on a set of measures to promote the use of bio fuels. COM(2001)547 final. November 2001.

212 *Towards a European strategy for the security of energy supply*, Green Paper. COM(2000) 769 Final. p49

213 ibid

214 Bio-fuel distillery in France, *Europe Environment* 603 15 January 2002

A contact group will be established to recommend ways in which natural gas and hydrogen fuels can be introduced into the transport market, in particular refuelling for NGVs and the incentives that might be needed. It is scheduled to report in 2002 and thereafter, every two years.

Support for the Commission's plan has not been universal.[215] The European Environmental Bureau (EEB) called on the EC to withdraw its proposal to make the consumption of bio-fuels mandatory for all Member States. They are concerned that the intensive farming practices and less stringent pesticide controls on non-food crops may damage biodiversity and endanger wildlife. The European Agricultural Alcohol Producers' Union (UEPA) disagrees, adding that set-aside is intended to reduce food production, not to serve environmental goals. [216]

Further EU action, through the European Climate Change Programme, could boost the market for other plant-based products, such as biopolymers and bio-lubricants, sometimes used in car manufacture, given appropriate market substitution incentives. [217]

Spain has one distillery on stream and another on the way, to convert ethanol into ETBE, which can be mixed with petrol. Sweden consumes imported ethanol in a variety of ways, mainly to make fuel mixtures for petrol and diesel engines. A new domestic distillery was inaugurated in 2001. Italy plans to use its distillation over-capacity to process wine surpluses, since its 2001 budget includes funding to allow tax relief for ethanol and ETBE. Poland plans to use ethanol and ETBE in petrol mixes.

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[215] "Brussels in push for bio-fuels", *Financial Times,* 2 August 2001

[216] Europe Environment 596 25 September 2001 1.10

[217] "Climate change action could boost plant-based products", *ENDS Report,* 323 December 2001, pp33-4

Appendix Five. Electric vehicles

PowerShift estimate that it costs as little as 1p per mile to run a car on electricity. The great advantage of electric vehicles is that they are extremely quiet and produce no tailpipe emissions. They are most suited to cars and vans operating set journeys in city areas requiring limited range (of about 50 miles).

An electric vehicle can be fully recharged from any 13amp socket in up to seven hours. Alternatively, they can be part-charged when stopped for shorter breaks, thereby increasing range. Fast charging facilities are feasible but the cost is likely to be prohibitive. Depending on the source of energy used to charge the vehicle, either nuclear or renewable sources rather than coal, the vehicle might be said to have near zero emissions.

Hybrid electric-petrol cars, with petrol engines to maintain battery charge, offer the advantage of a wider ranging vehicle with significant emission benefits. There are two types of hybrids; 'series hybrids' in which the ICE acts as a generator producing electric current for the motor, or 'parallel hybrids' in which both the electric motor and the engine can drive the wheels. The electric fuel system is used at lower speeds and for stop-start driving in urban areas. The fossil fuel is used either to drive the vehicle directly outside urban areas, to travel at higher speeds or to recharge the battery. The latest models do not require external charging and are capable of running up to sixty miles or more on a gallon of petrol. In many cases, batteries are leased rather than purchased outright, at a cost of £60 to £100 per month.

According to PowerShift, pure electric vehicles are a niche market, comprising mostly local authority vehicles. The conventional fuel system is replaced by batteries and electric motors, and may be purpose-built or derived from standard production models. The most common battery type is still the lead-acid battery, but current research is focusing on alternative 'high performance', small, light batteries that can offer higher ranges.

The extra cost of buying an electric car varies from zero to £5,000, before any PowerShift grant; the government is supporting purchase grants of £1,000 through the PowerShift programme.[218] In 2000/02 there were 115 grants made for pure electric vehicles and 550 for hybrids. The growth in sales of electric powered vehicles is steadily increasing; 369 electrically powered vehicles were sold in the UK in 2000 and over 2000 are expected to be sold in 2002, a five fold increase. The vast majority will be hybrid petrol/electric vehicles. Currently, only two models are in commercial production, the Toyota Prius and the Honda Insight. Annual UK sales of the hybrid Toyota Prius are expected to top 2000 in 2002, around 90% of the UK electric car market. However, this is minimal compared with Japan where 50,000 are on the road since sales started there in 1998. [219]

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[218] HC Deb 19 October 2001 c1368

[219] http://www.forecastcenter.com/public/guest/electric%20vehicle.htm

Vehicle Excise Duty on electric cars and motorcycles was removed in the March 2001 budget.[220] In September 2000, the Cabinet Office took delivery of a battery powered car, one of fifteen on trial in the capital over two years, as part of the Th!nk@bout London initiative, a partnership between Ford Motor company, the Energy Savings Trust, Transport Action PowerShift, KwikFit, London Electricity and Hertz.[221]

[220] HM Treasury/DETR Press Notice HM/DETR 1, *Budget – protecting the environment – roads,* 7 March 2001

[221] Cabinet Office Press Notice CAB 152/01, *Whitehall thinks green,*11 September 2001