Recent developments in road transport fuels

Introduction

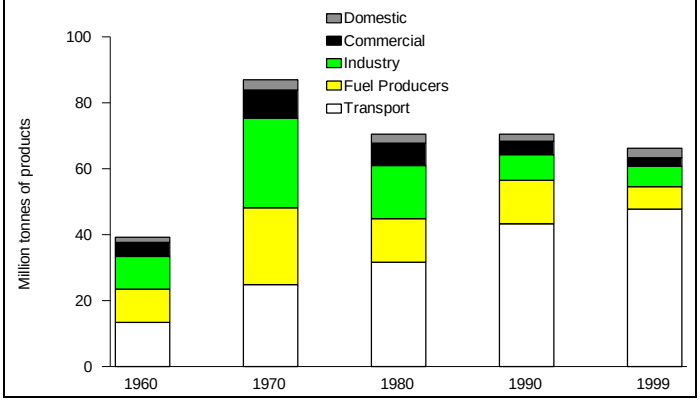
This article is an update on historic trends in the production and consumption of road transport fuels in the UK. While concentrating on petroleum based fuels, it does include some background information on the use of other fuels. Wherever possible, relevant data have been updated to cover 1999, but some background information included in previous versions of the article has been removed.

Overall use of fuels in transport

Transport service industries such as road and rail freight operations, and industries associated with transport such as the manufacture of motor vehicles, make a significant contribution towards the UK economy. They are implicitly involved in all of the UK's trade with other countries as well as with virtually all commercial operations within the UK. In line with the increasing importance of these sectors to the UK economy, the use of transport fuels has similarly increased.

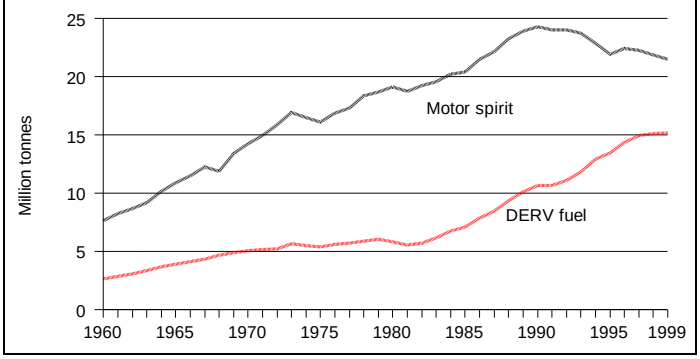
Chart 1 shows how transport use of petroleum products has changed between 1960 and 1999. Total consumption of petroleum products for transport uses in 1999 was 47.9 million tonnes, 3½ times the level of 13.4 million tonnes consumed in 1960. Use by the transport industry has increased from 34 per cent of total energy uses of petroleum in 1960 to 72 per cent in 1999.

Chart 1 Use of petroleum products for energy by main sector, 1960 to 1999



Motor spirit and DERV fuel

Chart 2 Deliveries to the UK inland market, 1960 to 1999

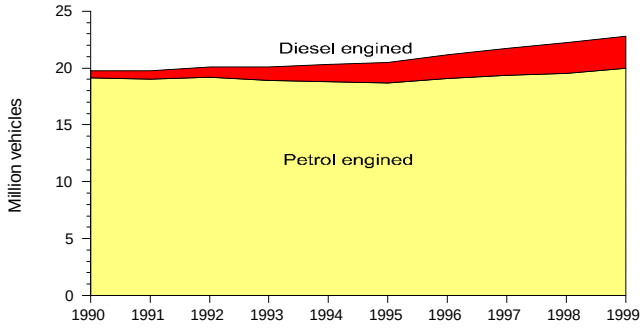


The major fuels used for road transport purposes are motor spirit and DERV fuel, more commonly referred to as petrol and diesel. Whilst other fuels are used, these two form the major source of energy used for transporting goods and people on UK roads, and are dealt with in more detail later. Chart 2 shows the long-term pattern of change in the amount of these two transport fuels delivered to the internal UK market. From 1960 to 1990, the amount of motor spirit consumed in the UK increased three-fold, from 7.7 million tonnes to 24.3 million tonnes. In the same period, DERV fuel use increased four-fold, from 2.6 million tonnes to 10.7 million tonnes. Between 1990 and 1999, consumption of motor spirit decreased by 11½ per cent while use of DERV fuel increased by 43 per cent, although the rate of increase has slowed in recent years.

Several factors are behind the differing trends for motor spirit and DERV fuel. During the early 1990s there was a significant differential between DERV fuel and motor spirit prices, the majority of which was 4-star leaded petrol. For example, in 1990, the average retail price of a litre of 4-star petrol was 44.87 pence, compared with 40.48 pence for a litre of DERV fuel, a 10 per cent saving. In addition to the attraction of lower prices at a time when fuel prices were generally rising, diesel-engined vehicles offered efficiency gains compared with petrol-engined vehicles. While diesel-engined vehicles are priced at levels comparable with their petrol equivalents, they deliver better miles per gallon. In the National Travel Surveys for 1996 to 1998, carried out by the Department of the Environment, Transport and the Regions, diesel-engined cars averaged 51 miles per gallon of fuel, compared with 33 miles per gallon for petrol-engined cars.

Together these factors resulted in the increase in diesel-engined cars in use in the UK seen during the 1990s, as Chart 3 illustrates. Looking at the numbers of cars registered in the UK, in 1990 there were 19 million petrol-engined cars registered in the UK compared with 0.6 million diesel-engined vehicles. By 1999, the number of diesel-engined vehicles had more than quadrupled to 2.8 million cars, while petrol-engined vehicles had increased to 20 million vehicles.

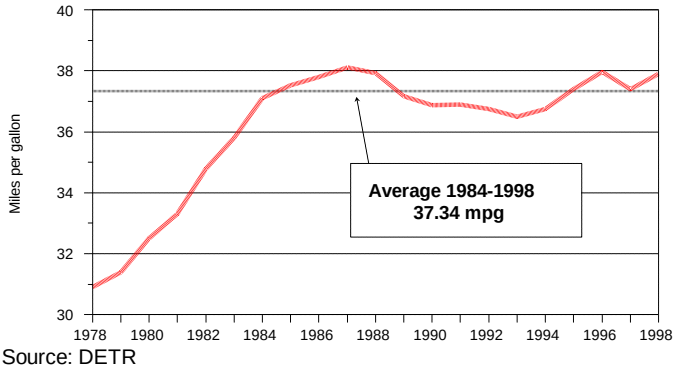
Chart 3 Private cars registered in the UK, 1990 to 1999



Source: DETR

The switch to diesel-engined cars is one of the factors behind the reduction in motor spirit consumption and also the increase in consumption of DERV fuel, although the latter is mainly due to increased volumes of freight traffic on the UK's roads leading to increased DERV fuel consumption. An additional factor is the increased efficiency of modern petrol-engined cars as well. Chart 4 illustrates how the average fuel consumption of new two-wheel drive petrol-engined cars has developed since 1978.

Chart 4 Average new petrol-engined car fuel consumption (miles per gallon), 1978 to 1998

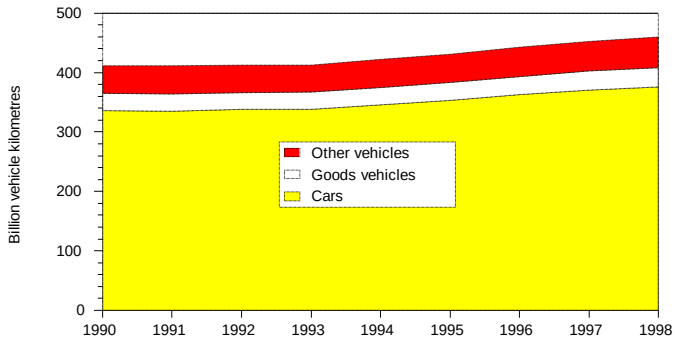


Source: DETR

The major improvements in efficiency were initially seen during the 1970s and early 1980s as manufacturers responded to the impact of high fuel prices. Since then, car manufacturers have continued to make improvements in efficiency, but to some extent these have been offset by other factors, e.g. increased engine and car sizes and increased extra features within cars, that work to increase fuel consumption. For example, running a car's air-conditioner can increase fuel consumption by 10 per cent. While the average fuel consumption of new petrol-engined cars has remained relatively steady since the mid-1980s, natural wastage has led to older cars dropping out of the UK vehicle fleet as they have been replaced with newer, more efficient vehicles. For example, in 1990, cars first registered in 1985 and earlier years made up 52 per cent of the total number of cars licensed in the UK, while in 1999 they made up only 14½ per cent.

As such the overall efficiency of the UK car fleet, both petrol and diesel–engined, has increased during the 1990s. The average overall fuel consumption of the petrol-engined car fleet during 1989-1991 was 29 miles per gallon, which improved to 33 during 1996-1998. Similarly the diesel-engined fleet average fuel consumption improved from 41 miles per gallon on average during 1989-1991 to 51 during 1996-1998. This larger increase in efficiency in diesel-engined cars explains why, despite the decrease in petrol consumption seen during the 1990s, there has continued to be an increase in the total distance driven by cars as a whole during the 1990s, as Chart 5 illustrates. The distance driven by goods vehicles, although small compared to the distance driven by cars, increased by 10 per cent between 1990 and 1998. This reflects the fact that, although the total volume of goods moving by road has remained fairly steady during the 1990s, goods tend to be moved further than before. For example, in 1990, 25 per cent of goods moved were transported more than 100 kilometres. In 1998 this proportion had increased to 30 per cent.

Chart 5 Road traffic by type of vehicle, 1990 to 1998



Source: DETR

Chart 6 UK deliveries of motor spirit by type, 1990 to 1999

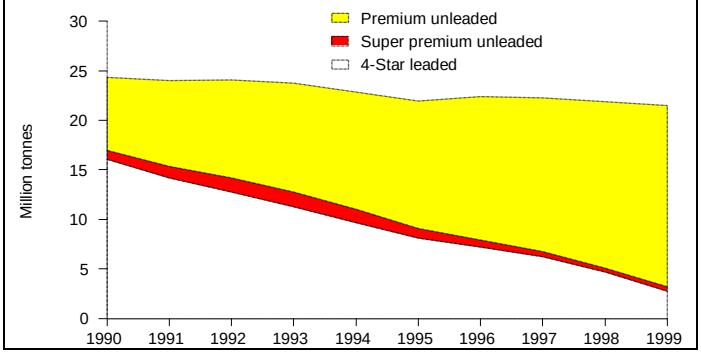


Chart 6 shows the trend in recent years for the total deliveries into the UK market for the two grades of unleaded fuel, premium grade and super premium unleaded. Premium unleaded is the most common grade used, with super premium grade having a higher octane number. The chart also shows the decline in sales of leaded petrol during the 1990s. The relatively low price for unleaded petrol during the early 1990s (primarily due to a beneficial rate of duty compared to 4-star) was a factor in the move away from leaded petrol in the UK. This trend was helped by the mandatory fitting of catalytic converters to new vehicles.

It is significant that, since duty rates harmonised in 1994, the price of premium grade unleaded petrol has generally been below that of DERV fuel. The government's strategy over the last decade has been to reduce the consumption of all road transport fuels as part of the UK reducing its overall level of emissions of greenhouse gases and pollutants. Although it was announced in the 1999 Pre-Budget report that the appropriate level of fuel duties will be set on a Budget by Budget basis, the fuel duty escalator - annual fuel duty increases above the rate of inflation - was employed from 1993 to 1999. This resulted in general increases of between 3 per cent and 6 per cent in real terms applied each year to all road fuel duties.

In 1997, a differential rate of duty was introduced for Ultra Low Sulphur Diesel fuel (ULSD). This extra differential has been used to allow producers to cover the extra costs of providing the ULSD, either through funding changes in refinery processes or through covering the additional cost of importing these lower sulphur products. The introduction of this duty differential has had a significant effect on moving customers over to what is regarded as a more environmentally friendly fuel. As such, HM Customs & Excise estimate that, as at the end of 1999, virtually all sales of DERV fuel are now of ULSD.

UK Motor Spirit and DERV Fuel Retail Markets

Table 1 shows the recent changes in the proportion of the retail market in motor spirit and DERV fuel accounted for by super/hypermarkets and other retailers. After rapidly increasing their market share during the early 1990s, progress has slowed recently. Of the 74 per cent of the motor spirit retail market in 1999 accounted for by retailers other than super/hypermarkets, some 65 per cent is estimated to be accounted for by companies that are UK-based refiners of fuel, (for example, BP, Esso, Shell, Texaco, etc.), with the remainder being accounted for by other companies acting solely as retailers in the UK or companies with refining facilities in other countries with a presence in the UK retail market. The general flattening of the upward trend in super/hypermarkets share of retail deliveries since 1995 reflects increased action from other retailers to preserve their market share (for example the *Pricewatch* campaign operated by Esso). The increases seen in 1998 and 1999 in the super/hypermarket share of sales is due to a slight increase in their sales, but also reflects the decline in overall deliveries of motor spirit over the period.

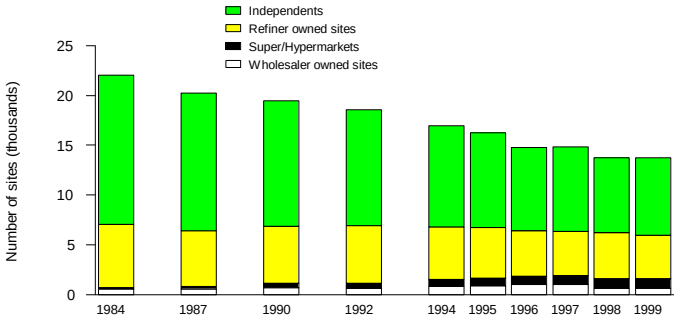
Table 1: Super/Hypermarket % share of UK retail deliveries
(Share of total UK deliveries given in brackets)

	Motor Spirit		DERV Fuel	
1990	8	(8)	--	--
1991	11	(10)	2	(1)
1992	13	(13)	3	(1)
1993	15	(15)	7	(2)
1994	18	(18)	11	(4)
1995	22	(22)	15	(5)
1996	22	(21)	15	(6)
1997	23	(22)	17	(7)
1998	24	(24)	17	(8)
1999	26	(25)	19	(9)

The increased competition in the retail market in recent years has led to falling profit margins. Whilst companies such as the major oil companies and the super/hypermarket chains can rely on a high volume of sales to maintain their level of profits, smaller oil companies and the independent retail sector have been put under great pressure. Chart 7 details the changes in the number of sites retailing motor spirit in the UK over recent years. Between 1990 and 1999, the total number

of retail sites in the UK decreased by more than a quarter, from 19,465 to 13,718 sites, although the rate of closures has slowed in most recent years. Within this total change, the number of independent retail sites decreased by more than a third while refiner owned sites decreased by a quarter. In contrast, the number of super/hypermarket sites more than doubled over the same period, which, given their greater average throughput per site, is why the rapid increase was seen in their share of total retail deliveries.

Chart 7 Numbers of petrol retail sites in the UK, 1984 to 1999



Source: Petroleum Review

Note: In 1997 a revised methodology was introduced which resulted in the inclusion of 871 sites previously missing from the survey, hence the apparent slight rise in numbers between 1996 and 1997.

Lead Replacement Petrol (LRP)

As part of a European strategy to reduce pollution from road traffic (known as the Auto-Oil Directive), leaded petrol (4-star) was banned from general sale from 1st January 2000. Lead in petrol does two things. Firstly, it improves the octane rating, making it less prone to 'pinking' or 'knocking'. This is when the petrol ignites uncontrollably, potentially causing damage to the engine. Secondly, it also protects the engine from wear around the seats of valves, known as Valve Seat Recession (VSR). Cars that run on unleaded fuel have very hard valve seats to resist this type of wear.

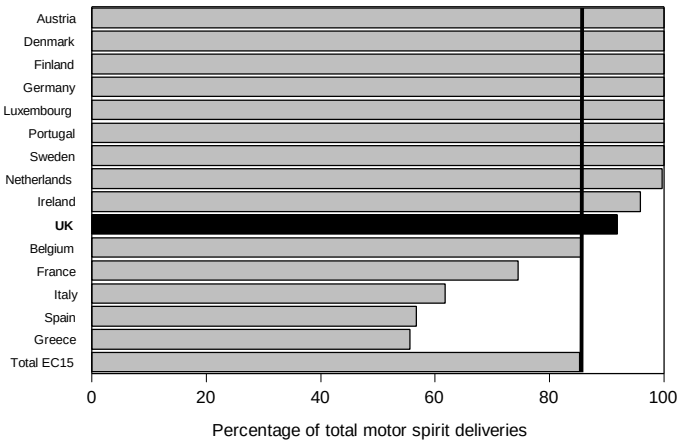
Some cars that use leaded petrol could safely use Super unleaded petrol with no adjustment necessary. Others could use premium unleaded petrol but require some adjustment to the ignition timing in order to use the Premium grade Petroleum unleaded fuel. However, some other cars rely on the lead in petrol either to protect their engines from premature wear (mostly older cars) or for the higher octane rating it gives the petrol. Vehicles that require leaded petrol for its high octane rating can use Super Unleaded petrol where it is available or LRP (Lead Replacement Petrol), which contains an AWA (Anti-Wear Additive). An AWA is an alternative to lead to protect the engine's exhaust from excessive wear. Vehicles needing the protection from wear that leaded petrol provides can use LRP or buy an AWA for mixing with unleaded fuel of the correct octane rating or can have the engine modified to run on unleaded fuel.

In response to the upcoming ban on general sales of leaded petrol, LRP began to be widely available as a direct substitute for leaded petrol from the autumn of 1999. Where petrol stations offer LRP, it has replaced 4-star at leaded petrol pumps. Pumps dispensing the new fuel are clearly labelled and have a wide nozzle that does not fit the fuel filler of cars equipped with catalytic converters. Using LRP gives consumers a fuel with the correct amount of additive and allows them to fill up in exactly the same way as before, with the additive used in place of lead being in most cases potassium. For those that require the protection from valve wear that lead gives, the DETR has granted permits to three companies (Bayford Thrust, Associated Octel and BWOC Ltd) to continue to sell leaded petrol to specialist users. More information on the scheme along with details of filling sites where leaded petrol is available can be found at "**www.bayfordthrust.co.uk**" and "**www.octel-corp.com**".

International comparison

It is worth noting that the top five fuel markets in the EU (Germany, Italy, France, Spain and the UK) together accounted for 80 per cent of motor spirit consumed in the EU in 1999, and 79 per cent of DERV fuel. In these top five markets, hypermarket retailers have a significant share of the market - around 50 per cent of sales in France, 20 per cent in Germany, and 26 per cent in the UK. They have only had a small impact on the fuel markets in Spain (around 2 per cent) and Italy (virtually zero). As in the UK, there has been a move during the 1990s throughout the EU towards the increased use of unleaded motor spirit. Chart 8 shows the proportion of total motor spirit sales in each member state accounted for by unleaded fuel in December 1999, just before the ban on sales of leaded petrol mentioned above came into effect. At 92 per cent the UK was above the overall EU average of 85 per cent.

Chart 8 Unleaded motor spirit deliveries as a percentage of total motor spirit deliveries in the EU, December 1999



Source: Eurostat

LPG and other alternative fuels

Using petroleum gases as road fuels rather than petrol or DERV fuel produces lower emissions of carbon dioxide and other pollutants, and also reduces engine noise pollution. The government has encouraged the use of these fuels by reducing the rate of duty applicable on gas when used as a road fuel from 33.14 pence per kilogram in November 1994 to the current level of 15 pence per kilogram. Equivalent rates of duty for unleaded and lead replacement petrol as at 20th March 2000 are 66.39 and 69.31 pence per kilogram respectively, and 57.61 pence per kilogram for ULSD DERV fuel. It was also announced in the 2000 Budget that the duty rates for road gases would remain frozen, while those for other road fuels would increase. Because of these financial and environmental benefits to their use, gases are being increasingly looked at as an alternative source of energy for the transport industry. Currently road fuel gases, such as liquefied petroleum gas and compressed natural gas are the most viable alternatives to petrol and diesel vehicles, offering mainly air quality benefits.

Liquefied petroleum gas (LPG or Autogas) has attracted major investment in infrastructure and LPG fuelled vehicles from both fuel and vehicle suppliers. It offers the environmental benefits of substantial reductions in Carbon Monoxide emissions, Oxides of Nitrogen emissions and Ozone forming potential when used instead of either petrol or diesel. In addition it reduces emissions of particulates by 90% and is 50% quieter compared to diesel engines. These current significant benefits that LPG offers will, however, be eroded over the next few years as conventionally fuelled vehicles will be subject to tighter fuel specifications and exhaust emission limits.

LPG is made up of propane or butane gases put under pressure so that they liquefy. Vehicles can be made to run on LPG in a number of different ways. There are dedicated cars which use LPG as their only source of fuel. Although it is possible to buy such vehicles in many countries in the world,

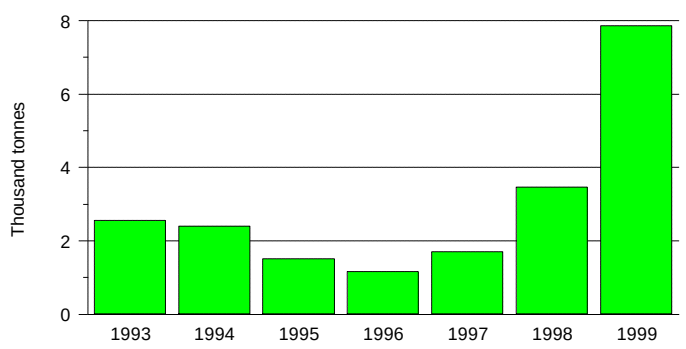
this is only just starting to happen in the UK. In this country, it is usually necessary to purchase and convert a petrol-engined car to run on LPG. This is relatively straightforward as LPG is spark ignited, similar to the way petrol is used. However, the cost is likely to be around £1,000 to £1,500. Diesel engines are much more difficult to convert as the compression ratio has to be altered and an ignition system added.

The Energy Saving Trust's Powershift programme aims to develop a sustainable market for alternative fuelled vehicles in the UK by providing information, reducing the capital cost of alternative fuelled vehicles and expanding the infrastructure for such vehicles. Powershift can provide grants of between 25 and 75 per cent of the additional costs of purchasing a gas (compressed natural gas or LPG) or electric vehicle compared with the equivalent petrol or diesel model. Information is available at "**www.est.org.uk/est/what/powershift**" on what changing over to these fuels involves (including details of the grant available to help with the cost of converting vehicles over to run on LPG).

In addition to single-fuel vehicles, there are also bi-fuel vehicles. These vehicles have their petrol engines converted so that, at a flick of a switch or by computer control dependent on the driving conditions, the vehicles switch between burning LPG or petrol. The conversion of a petrol engine, having a spark ignition, is relatively simple and low cost. The conversion of a diesel engine requires more fundamental and expensive modifications. Since these vehicles run on both LPG and petrol, the advantages associated with both fuels are achieved. The engines run more efficiently on petrol at higher speeds, but run with less emissions on LPG at lower speeds. In addition these hybrid vehicles are mostly cheaper to buy or convert than the dedicated alternative. Assuming proper installation and use, LPG powered vehicles should be at least as reliable and durable as petrol or diesel models with similar performance being seen and in some cases maintenance intervals are extended. However, with both single and bi-fuel vehicles, the gas is stored in special fuel tanks that make the vehicles heavier than normal and also result in some loss of carrying space. The LPGA (Liquefied Petroleum Gas Association) has set a series of standards which have contributed to LPG's excellent safety record in terms of storage, transportation and use. Following extensive safety tests, LPG is generally considered to be a safer alternative to petrol due to its more resistant fuel tank.

LPG is a well established technology with over 4 million LPG powered vehicles in use worldwide. Japan has the highest LPG use in the world (1.8 million tonnes per annum) with 90% of its taxis running on this gas. Italy has the highest number of vehicles running on LPG with around 1,100,000 followed by Australia with 490,000, North America with 400,000 and the Netherlands with 360,000. Despite the fact that the UK has one of the highest concentrates of vehicles per mile of road in the world, it is estimated that there are currently only around 15,000 - 20,000 vehicles running on LPG (as at July 2000) and just 490 refuelling sites (as at August 2000). An up to date list of LPG refuelling sites can be found at "**www.autogas.co.uk".**

Chart 9 UK consumption of road fuel gas (1), 1993 to 1999



(1) Based on details of value of tax paid to HM Customs & Excise for gas used as a road fuel, converted to mass equivalent

Even though its use in the UK is still relatively tiny when compared with the size of the motor spirit market, the use of gas as a road fuel in the UK (including LPG and natural gas) is increasing, as shown in Chart 9. Road fuel gas consumption in the first quarter of 2000 was nearly three times greater than the amount consumed in the first quarter of 1999. The current growth rate of LPG in the UK is over 200 per cent per annum. This is due to the fiscal incentives offered by the Chancellor which have resulted in a typical forecourt price for LPG of around 40p per litre compared with around 80p per litre for petrol, although performance is approximately 20 per cent poorer for LPG in terms of distance travelled per litre. It is forecast by some industry analysts that by the end of the end of 2003 LPG will have a 1 per cent share of the UK road fuel market.

In addition to LPGs, natural gas is also being used, either in a compressed or liquefied form. As well as producing even less emissions when burned than LPGs, reducing its environmental impact and also reducing vehicle maintenance, in many countries natural gas represents a more readily available fuel than refined petroleum products. As such, it is often a lower priced fuel on an energy equivalent basis than petrol or DERV fuel. Its use can also be quite significant in some countries with over a million natural gas powered vehicles worldwide. The majority of these are in Argentina (450,000) and Italy (320,000). Its use is relatively limited in the UK with just 800 natural gas powered vehicles and 18 refuelling stations at the end of 1999. The Natural Gas Vehicles Association forecasts that there will be around 200,000 natural gas powered vehicles in the UK in 5 years and that by 2004 natural gas will have a 1 per cent share of the UK road fuels market.

Currently, the use of natural gas as a road fuel is an expensive alternative. A natural gas powered bus costs between £20,000 and £30,000 extra compared with one that runs on diesel. Due to its highly volatile nature, to be able to carry useful quantities of gas on a vehicle, natural gas has to be placed under high pressure and, if in the liquid form, refrigerated as well. The vehicles also have to have more physical adaptations to cope with the higher pressures involved. These give natural gas two main disadvantages over LPG; the weight of the vehicle has to be that much greater (with corresponding implications for the payload that can be carried, passenger space and safety), and it requires specialised refuelling facilities. It is thus mostly being used in the UK in trials of fleet freight vehicles and some passenger vehicles rather than in cars.

In the longer term, emerging technologies such as hybrid electric and fuel cell vehicles offer the prospect of significant emission reductions for both toxic pollutants and greenhouse gases. The DTI's FORESIGHT vehicle and advanced fuel cell programme provides research funding and expertise to encourage development in this area. Hybrid vehicles contain a small conventional engine and one battery powered engine to minimise emissions and improve fuel economy. Although such vehicles are already on sale in Japan, development is limited by the extra costs involved with this type of engine. Fuel Cell vehicles offer the same benefits as hybrid vehicles, but are still at the demonstration stage, where the major problem is supplying the hydrogen that such vehicles would require. Large scale production is not expected for at least ten years, but limited production should start well before then.

There are numerous sources of additional information on the use of LPGs for road transport. In addition to the sources of information given above, "**www.ecogas.co.uk**" contains useful information. Three useful sites have been found related to natural gas vehicles. "**www.ngvc.org**" and "**www.iangv.org**" are sites related to organisations of companies with an interest in developing the use of natural gas as a road fuel. "**www.snafu.de/innotec/NGVeurope**" is the site of an EU-

funded project to increase the use of natural gas within the European Union.

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