A CLEAN LICENCE? Graduated Vehicle Excise Duty

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The March 1998 Budget included proposals for an environmentally-graduated Vehicle Excise Duty (VED) for cars, with the least-polluting cars attracting the lowest annual charge. This proposal fits with the stated aims of successive governments to use "market mechanisms" to achieve environmental goals. This briefing considers graduated VED against other options to achieve these aims.

BACKGROUND

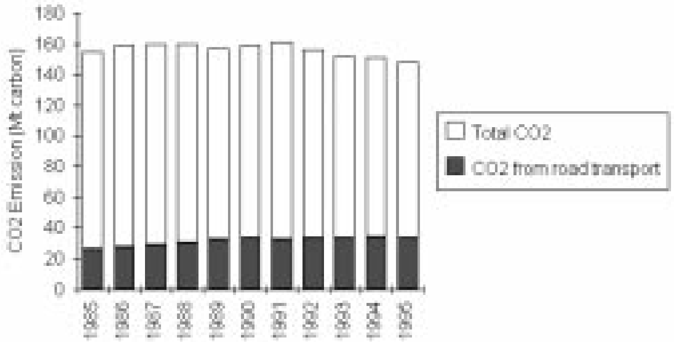
The idea of an environmentally-graduated VED for cars suddenly re-surfaced in the March 1998 Budget, when the Chancellor announced his intention "*to reduce the licence fee for cars with the lowest emissions*" and that for the "*cleanest and smallest cars*", this cut would be by £50 pa. At current VED levels, this would set its starting rate at £100 pa, while the Treasury statement accompanying the Budget stated that "*less environmentally-friendly cars*" would pay "*more than at present*". The Government will shortly be consulting on the environmental criteria to be used, with the intention, as detailed by the Budget 'Red Book', of:

- providing a tax incentive for the ownership of less polluting cars, and;
- reducing emissions of CO_2, NO_x and particulates.

This second aim covers two main - and possibly conflicting - environmental goals. The first is to reduce CO_2 (carbon dioxide), the main greenhouse gas (see POSTnote 100), where there are both EU commitments (the UK is legally bound to a 12.5% reduction by 2008-2012) and more demanding national 'aspirations' (where the aim is to reduce emissions to 20% of 1990 levels by 2010). **Table 1** shows that petrol fuelled vehicles account for about two thirds of CO_2 emissions from the road transport sector shown in **Figure 1**. CO_2 production is an unavoidable consequence of burning fossil fuels. With vehicles, it is not practicable to use 'end of pipe' technologies to remove it from exhaust gases. The only option is to burn less fuel, either by improving fuel efficiency, or reducing the total distance travelled.

The second is to reduce emissions of two other substances - NO_x (nitrogen oxides) and particulate matter (PM - small particles - of which PM_{10} - those measuring less than 10μm - are of most concern). These can affect local air quality and have implications for public health (see POST Reports 17 and 82). Motor vehicles (particularly diesels) are important sources of both pollutants, accounting for nearly half of total NOx emissions and one quarter of all PM_{10} in 1994 (Table 1). Both petrol and diesel exhausts are a significant source of NO_x (Table 1),

FIGURE 1 RECENT TRENDS IN UK CO_2 EMISSIONS



Source: National Atmospheric Emissions Inventory

TABLE 1 CO_2 NO_x AND PM_{10} EMISSIONS FROM ROAD TRANSPORT (1994)

	Total emission	Road transport	Petrol exhaust	Diesel exhaust
CO_2 Mt	149.4	30.6	19.5	11.1
NO_x Mt	2.22	1.1	0.65	0.44
PM_{10} t	250	65	12	49

Source: DETR "Transport Statistics Great Britain. 1997" and the National Atmospheric Emissions Inventory.

which is formed from the reaction between nitrogen and oxygen present in the air (emissions depend mainly on the combustion temperature and air to fuel ratio inside the engine). PM_{10} is composed of carbon and unburnt or partially burnt compounds from the fuel or lubricating oil, and emissions depend largely on fuel type (diesel exhausts from HGVs are the main source of PM_{10} from road transport, see Table 1) and engine efficiency.

REGULATORY FRAMEWORK

Emissions of NO_x and particulates from new cars are limited by standards prescribed in EU Directives (**Table 2**). These have been introduced in Stages - Stage I Directives (91/441 and 93/59) were implemented in 1992/93 and the current standards (Stage II) have been in force since 1996/97. Proposals for Stage III limits are expected to be agreed soon, and will apply from 2000/01. Commission indicative proposals for Stage IV standards (for 2005)are currently the subject of negotiation.

Although the Commission has considered setting similar limits for CO_2 emissions from new cars, it has yet to do so. In 1996 the Council agreed that the average CO_2 emissions from new cars across the European fleet should be reduced from the current figure of ~185g (of

TABLE 2 EC LIMITS FOR NO_x AND PM EMISSIONS FOR NEW CARS

Stage	Date	Car	PM g/km	NO_x+HC g/km	NO_x g/km
I	1993	Diesel	0.14	0.97	
		Petrol		0.97	
II	1997	Diesel	0.08	0.7	
		Petrol		0.5	
III	2001	Diesel	0.05	0.56	0.5
		Petrol			0.15
IV	2005	Diesel	0.025		0.25
		Petrol			0.05

Note: Stage I and II set limits for combined NO_x/ Hydrocarbons (HC)
Source: RCEP 18th and 20th Reports

TABLE 3 LIFE-CYCLE EMISSIONS (G/KM) FOR DIFFERENT FUELS

Fuel / Car1	Emissions[2]		
	CO_2	NO_x	PM
Petrol (+TWC)3	210	0.3	0
Diesel	154	0.7	0.2
LPG (dual-fuel)4	181	0.3	0
CNG (dual-fuel)	162	0.2	0
Biomethanol	63	0.4	0
Bioethanol	105	0.5	0
Biodiesel	59	1.1	0.2

Notes 1. For medium car of 1.4-2.0 litre engine capacity; 2. Averaged across all driving conditions (hot engine); 3. TWC - three way catalyst; 4. Dual-fuel can run on petrol or gas.

Source: "UK Petrol and Diesel Demand", ETSU, 1994

carbon) / km to 120g / km by no later than 2010 (equivalent from reducing petrol consumption from around 81 / 100km to ~51 / 100km). This was to be achieved in large part through a voluntary agreement with car makers through the European Automobile Manufacturers Association (ACEA), topped up by fiscal measures and a fuel economy labelling scheme. Binding emission limits would be considered if this approach failed. Negotiations are still on-going - ACEA's best offer so far is a target of 140g / km by 2008, but the Commission wishes to link the setting of fuel efficiency targets to the outcome of fuel quality rules of the so-called Auto / Oil draft directive which is under discussion between the Council of Ministers and European Parliament.

FACTORS AFFECTING EXHAUST EMISSIONS

In general, the amount and type of emissions from motor vehicle exhausts depend on factors such as:

- fuel / engine / catalyst types and designs
- other aspects of car design (weight, transmission, aerodynamics, etc);
- age and state of maintenance of the car;
- driving conditions and habits.

Each of these factors may influence emissions in different ways, so that measures designed to minimise levels of one type of pollutant may lead to increased emissions of another. The effect of these factors and the trades-offs that arise are explored in more detail below.

Fuel Type

In addition to petrol (which fuels 90% of Britain's 21.2 million private cars) and diesel (which fuels virtually all the rest), 'alternative' hydrocarbon fuels include liquid petroleum gas (LPG - a mixture of propane and butane), compressed natural gas (CNG - mainly composed of methane) and various biofuels (alcohols and biodiesel). Only 4,100 British cars currently use these alternative fuels. They have been assessed, alongside 'conventional' fuels by the Energy Technology Support Unit (ETSU)[2]. The relative benefits of each were compared on a life cycle basis, taking into account the energy requirements and emissions from their production, supply and end-use in vehicles. Life-cycle emissions for medium size (i.e. 1.4-2.0 litre) cars averaged across different driving conditions are included in the fuel data in **Table 3**.

As far as CO_2 is concerned, all the fuels assessed showed lower overall emissions than petrol[1]. Diesel engines are inherently more efficient than conventional petrol engines, while CNG and LPG contain proportionately less carbon and more hydrogen than petrol, and so produce less CO_2 on combustion. The biofuels (diesel derived from oilseed rape, methanol from short rotation coppice and ethanol from wheat) show the biggest potential reductions in CO_2 emissions, which are counterbalanced by CO_2 taken up as the fuel crops grow (figures in Table 3 are thus emissions from growing, transporting, processing and distributing the fuel).

Turning to NO_x , only CNG shows a small reduction in emissions compared with a petrol car with a three-way catalyst (TWC), which reduces NO_x emissions by up to 90% (Table 3). Without a TWC, petrol cars would emit much higher levels of NO_x than any of the other fuel options in Table 3 (see later). Finally, Table 3 shows the higher levels of particulate matter (PM) associated with diesels (both normal diesel and biodiesel) - in the region of 0.2g / km. In contrast, PM emissions from the other fuels are thought to be negligible - tail-pipe measurements suggesting about 0.01g / km for petrol cars.

Engine Design

Engine design is another key factor. It not only influences exhaust gas composition , but also dictates which tail-pipe technologies (eg catalysts, particulate traps) can be used to decrease emissions further. Both areas have seen significant technical advances recently, some of the most important approaches are outlined below.

1. CO_2 emissions from petrol and diesel also depend on its chemical composition. For instance, the US 'reformulated gasoline programme' has led to the development of fuels that contain additives (oxygenates) to decrease emissions of substances such as carbon monoxide, hydrocarbons, etc. They slightly increase (by 1-2%) CO_2 emissions.

2. While the ETSU study is the most comprehensive available, it was conducted in 1994, using data for dual-fuel cars. It is likely that gas cars would compare even more favourably with petrol or diesel versions if the most recent monofuel designs were included in the comparison.

A strong focus is on improving petrol engine fuel efficiency, to reduce CO_2 emissions. Advances in engine design and management systems (e.g. electronic fuel injection) have led to the development of lean burn engines. These are similar to conventional engines in that the air and fuel are mixed before entering the cylinder, but can operate on mixtures as lean as 25:1 (air:petrol). This improves fuel economy (and correspondingly reduces CO_2 emissions) by around 20% compared with conventional engines (with a ratio of around 15:1). Even leaner air:petrol ratios (up to 50:1) are possible in direct injection engines, where petrol is injected directly into the cylinder. Companies which have developed such designs claim increased power outputs of up to 10% (because the engines are more thermally efficient) combined with improvements in fuel efficiency (and thus reductions in CO_2 outputs) of 20-30%.

Similar improvements have been made in the design of diesel engines, based on the development of sophisticated electronic management systems that control injection pressure, timing and volume in response to conditions inside the engine. These have allowed the development of small direct injection diesel engines. Although yet to be fitted to production cars, these promise significant improvements in fuel economy (and thus reduced CO_2 emissions) combined with reductions in emissions of particulates and NO_x. Other design techniques such as exhaust gas recycling (EGR) - where gases from the exhaust are routed back into the cylinder - and turbo-charging can also help to reduce emissions of NO_x (in both petrol and diesel engines) and PM (in diesel).

Catalysts and Traps

Emission control systems such as TWCs (which have been fitted to all new petrol cars sold in the EU since 1993) are also developing. With petrol engines, one drawback to current TWCs is that they work best when 'warmed up', a process which occurs only after a few kilometres' driving. A cold TWC removes only ~75% of NO_x - a hot one ~90% (see **Table 4**). New designs of TWC incorporate various ways of pre-heating the catalyst. Table 4 also shows another 'downside' of TWCs - they reduce the fuel efficiency of cars, causing a slight increase in CO_2 emissions.

Another drawback with current TWCs is that they cannot be fitted to cars with modern lean burn or direct injection petrol engines. These actually generate significantly less NO_x than their conventional counterparts (because the air to fuel ratios used involve lower combustion temperatures), but the high proportion of oxygen in the exhaust gases prevents standard TWCs from reducing the NO_x that is formed. However, new designs of catalysts are compatible with the newer petrol engines. These use traps, which store NO_x temporarily, reducing it only when sensors in the exhaust detect low oxygen levels, e.g. during hard acceleration. If the NO_x 'store' is full, sensors send a signal to the engine to reduce oxygen in the exhaust temporarily (by increasing the petrol content of the mixture).

TABLE 4 EFFECT OF HOT AND COLD TWCs ON CO_2 AND NO_x

Car	Hot / cold	CO_2 g/ km	NO_x g/km
Petrol no TWC	Cold	206	2.27
	Hot	161	2.25
Petrol + TWC	Cold	216	0.63
	Hot	195	0.27

Note: Figures quoted are for medium size cars
Source: "UK Petrol and Diesel Demand", ETSU, 1994

Diesel exhausts are also incompatible with current TWCs, partly because of the high oxygen content of the exhaust stream, and partly because chemicals from the fuel (particularly sulphur) adversely affect the catalyst. As noted previously, engine design (direct injection, engine management, EGR, turbocharging, etc.) is seen as the main way forward in reducing NO_x and PM emissions from diesel engines, although there has been progress in developing new catalysts for reducing NO_x emissions for cars using low-sulphur diesel. As far as PM emissions are concerned, there is currently little prospect of 'bolt on' particulate traps / filters (e.g. similar to those currently used on new heavy diesel vehicles such as buses and lorries) that are compact and efficient enough for small diesel vehicles such as cars.

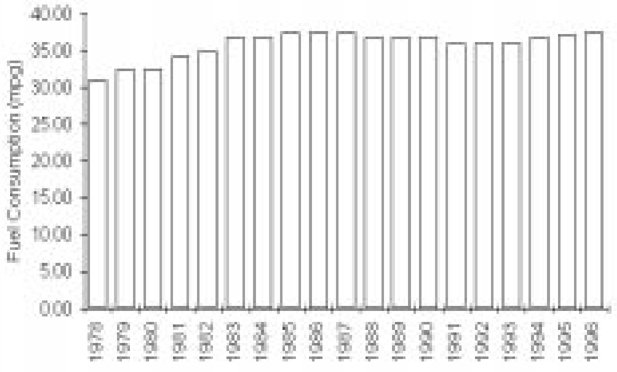
Other Aspects of Car Design

Other aspects of car design affect fuel economy, and thus also CO_2 emissions. Recent approaches include:

- Development and use of lightweight materials to reduce vehicle weight without compromising safety. Examples include resin (fuel tanks and bumpers), aluminium and magnesium (engine components and body parts), ceramics (engine components), and carbon fibre, extruded aluminium and ultra lightweight steel (body shells).
- Increased use of wind tunnel testing and supercomputer modelling to design aerodynamically efficient cars with minimum wind resistance.
- Improved transmission system efficiency - for instance the new continuously variable transmissions (CVTs) - which help minimise power losses.
- Use of low resistance tyres to improve fuel economy.

While these and other approaches have potential for improving fuel economy, **Figure 2**, shows this has largely failed to materialise, since the (registration weighted) average fuel consumption of new (two-wheel drive) petrol cars has remained more or less static since the mid 1980s. The Royal Commission on Environmental Pollution (RCEP) have suggested this is because the fuel efficiency improvements have been offset by other factors, such as safety features (air bags,

FIGURE 2 TRENDS IN AVERAGE NEW CAR FUEL CONSUMPTION



Source: "Transport Statistics Great Britain", 1997, DETR

side impact bars, etc. which add to the weight of the car), fashions (e.g. for faster, more powerful cars), increased specifications (e.g. air conditioning), etc.

Age and State of Maintenance

RCEP's 18th Report considered how the age and state of maintenance of a vehicle affected exhaust emissions. This concluded that diesel cars were fairly robust, with PM, NO_x and CO_2 emissions not being significantly age related. However with petrol cars, TWC performance could decline significantly with age, leading to increased emissions of NO_x (as well as hydrocarbons and carbon monoxide). For instance, surveys of emissions from petrol cars fitted with TWCs have shown that while most emit between 0.1-0.2g/km of NO_x when new, by the time they have travelled 80,000 km, this range has broadened to ~0.1 to 1.0g/km.

TWCs are vulnerable to damage, including grounding, bump starting, water, running out of petrol and overheating. Some estimates suggest that the average effective lifetime of a TWC is only around three years. British cars' mean age in 1996 was 7.3 years. This means that a significant proportion could be operating with sub-optimal catalysts, since the emissions part of the MoT test only detects gross failures in TWCs. However, this issue is currently being addressed by a EU Directive on 'on board diagnostics (OBD)'. This is currently being drafted, but will set durability limits for exhaust equipment for all new cars from 2001.

Driving Conditions and Behaviour

Car exhaust gases also depend on driving conditions and behaviour. It was pointed out previously that a key factor for petrol cars is the temperature of the engine and catalyst (e.g. see Table 4). This is also true for diesel cars, which emit more CO_2, NO_x and PM when cold (**Table 5**).

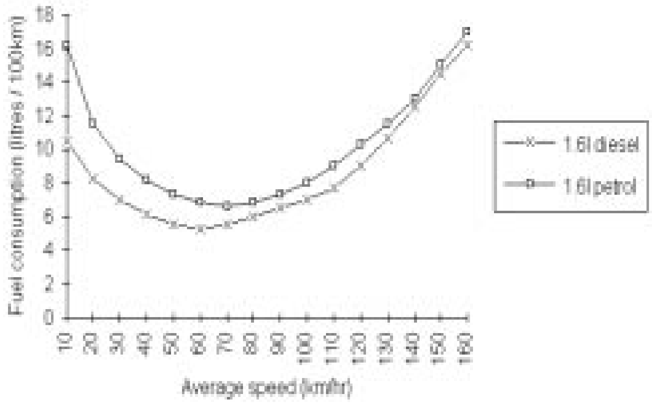
Another major factor is where the car is being driven, since emissions of CO_2 (and NO_x) tend to be highest in urban and motorway driving. This is largely speed related (**Figure 3**). While drivers often have little choice over their speed in urban areas, lower average speeds

TABLE 5 EFFECT OF TEMPERATURE ON DIESEL CAR EMISSIONS

Engine size (l)	Hot /Cold	CO_2 g/km	NO_x g/km	PM g/km
<1.4	Cold	143	0.44	0.24
	Hot	119	0.38	0.12
1.4-2.0	Cold	173	0.72	0.34
	Hot	144	0.63	0.17
>2.0	Cold	234	0.98	0.36
	Hot	195	0.85	0.18

Source: "UK Petrol and Diesel Demand", ETSU, 1994

FIGURE 3 HOW FUEL CONSUMPTION VARIES WITH SPEED



Source: RCEP 18th Report

on motorways would significantly reduce both CO_2 and NO_x emissions. Other aspects of driver behaviour that could improve fuel economy include avoiding sudden acceleration and braking, and ensuring that cars are not loaded with unnecessary weight or aerodynamic drag (e.g. unloaded roof racks).

Overview

As noted previously, the Budget proposals for an environmentally graduated VED have two main environmental justifications. First is reducing CO_2 emissions by lowering fuel consumption, and it is evident from the Sections above that the technology for achieving significant reductions already exists. The RCEP's 18th Report assessed whether current technology could achieve such reductions in the short-term and in the medium to long-term and concluded that it could deliver reductions in fuel consumption of up to 30% in 4-5 years and up to 50% within 10 years. These figures are broadly in line with EU proposals to cut average CO_2 emissions to 120g/km by 2010.

Second is the reduction of emissions of pollutants such as NO_x and PM. Technology has already been applied to reducing emissions of NO_x through EU legislation effectively requiring all petrol vehicles to be fitted with TWCs. However, current TWCs suffer from a number of limitations - they do not work at full efficiency until warm; they increase CO_2 emissions; they are vulnerable to a wide range of damage and they cannot be used with the newer, most efficient (lean burn or direct injection) petrol engines, or with any diesel engine. Further reductions in NO_x emissions will thus depend on the extent to which the new technological developments in catalyst and engine design outlined above find their way onto the market. PM is a problem largely confined to diesel engines, and unlike NO_x , current technology offers little or nothing in the way of 'bolt-on' options for reducing emissions (nor is there much prospect of it doing so in the near future). The outlook here depends more on redesigning diesel engines to incorporate advance direct injection, exhaust gas recycling and turbocharging.

Beyond the current technology reviewed here, are newer approaches aimed at low or zero emission vehicles. These are unlikely to be stimulated by the VED proposals and are not considered in detail in this briefing, but include alternative fuels such as electricity (perhaps hybrid electric/petrol vehicles), hydrogen, fuel cells, solar power, etc. The Government is also providing over £5M for collaborative research to accelerate the exploitation of environmentally friendly car technologies under the **Foresight Vehicle LINK Programme**, and the **Cleaner Vehicle Task Force** is exploring a wide range of issues affecting the development, buying and use of cleaner cars

BOX 1 THE DVLA DATABASE

The Driver and Vehicle Licensing Agency (DVLA) in Swansea is responsible for:

- maintaining the central vehicle record;
- issuing registration documents;
- collecting and enforcing payment of VED;
- paying VED refunds.

The current database contains details on all 25 million cars and light goods vehicles in the country, including:

- engine size (cylinder capacity;
- fuel type (petrol, diesel, CNG, etc.);
- date when first registered.

It does not hold details of emission data from the manufacturers type specification, fuel consumption, or the Euro-status of the car (e.g. whether it conforms to Stage I, II, III, or IV). However, from 1999, DVLA will be operating a new computer database (to ensure Millennium compliance), and this system has been designed to be flexible enough to capture such data if required. Looking further ahead, steps are now being taken to set up an MoT database, which will link all test centres and include details of all cars tested. Once this is established, it could be linked to the new DVLA database, enabling VED to be calculated on the basis of MoT test results (although this would require more sensitive emission tests to be included in the MoT).

ISSUES

Two main questions arise from the budget VED proposals. First, is a graduated VED the best method of achieving the stated environmental objectives (a reduction in emissions of the greenhouse gas CO_2 and in the pollutants PM and NO_x)? Second, if so, what environmental criteria can be used to define the different tax bands?

POSSIBLE ENVIRONMENTAL CRITERIA

As noted in the previous Sections, a range of different factors influences emissions of CO_2, NO_x and PM. These sometimes conflict with each other - for instance, fitting TWCs to petrol engined cars greatly reduces NO_x but causes a slight increase in CO_2 emissions. This means that no single criterion is likely to meet all the stated objectives and that tax bands may thus have to be based on a number of different approaches.

Two main categories of approaches could be used. First are emissions-based criteria, where tax bands are directly defined by the amount of greenhouse gases or pollutants the car emits. This is generally accepted as being the fairest method of graduating VED, but is also likely to be the hardest to implement. It requires accurate information on exhaust emissions from each of the 21 million or so licensed cars in the UK. Second is the use of proxies, where some feature of the car's design (e.g. engine size, or whether or not it is fitted with a TWC) is used to allocate it to a tax band. Proxies may create anomalies, but are much easier to implement, because the information to classify each vehicle is much more readily available. The pros and cons of these approaches to setting tax bands reflecting emissions of CO_2, NO_x and PM are discussed in more detail below.

Criteria for CO_2 Emissions

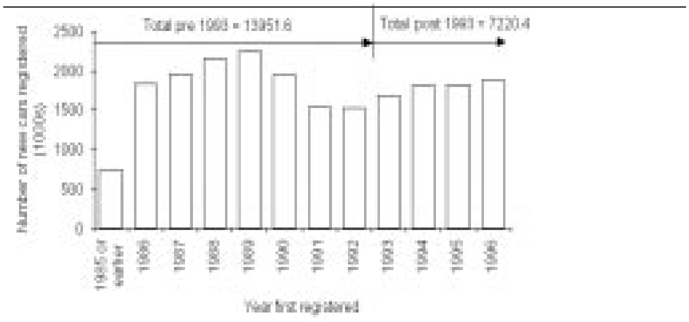
Three main criteria have been suggested as the basis for tax bands to reduce CO_2 emissions from cars:

- New vehicle fuel consumption. This is effectively an emissions-related yardstick, the CO_2 emitted by a car being directly proportional to the amount of fuel it uses. In principle, this information is readily available for cars less than 6 years old (EU legislation has required manufacturers to certify the fuel consumption of all new cars marketed since 1993).
- Engine size (capacity of the cylinders). This is a proxy criterion which assumes that engine size is closely related to fuel consumption. Engine size information is held on the DVLA's computer for each licensed car in the country (see **Box 1**).
- Fuel type - as noted previously, some fuels (diesel, LPG, CNG) give rise to less CO_2 emission per km driven than others (petrol), so VED could be varied according to vehicle fuel .

The RCEP's 18th Report considered options for using a graduated VED to reduce CO_2 emissions from cars and recommended that *"the annual excise duty on cars be steeply graduated, and based on the certified fuel efficiency of a car when new"*. Its 20th Report called for *"substantial variations in VED for cars and light goods vehicles according to their certified fuel consumption"* as an incentive for people to choose more fuel efficient cars.

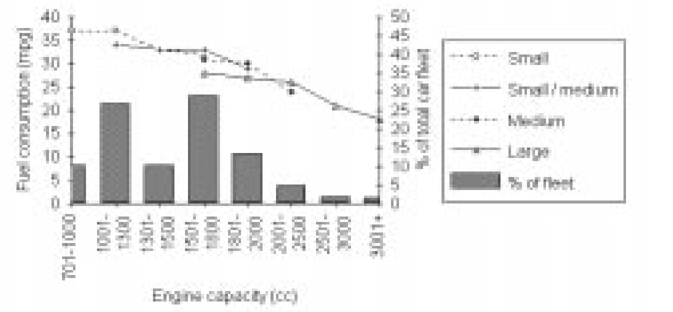
The practicality of this approach is questioned by groups

FIGURE 4
AGE DISTRIBUTION OF THE BRITISH CAR FLEET IN 1996



Source: Transport Statistics Great Britain, 1997, DETR

FIGURE 5 CAR SIZE, ENGINE SIZE AND AVERAGE FUEL CONSUMPTION



Source: National Travel Survey 1992-94, DoT

such as the Society of Motor Manufacturers and Traders (SMMT). SMMT point out that, to be effective, such a system would have to be applied to all cars in the UK fleet, and suggest that there is currently no such mechanism. For instance, according to the most recent vehicle licensing figures (1996), some two thirds of the British car fleet (13.95 million out of 21.17 million) was first registered before 1993 (see **Figure 4**), and was thus not subject to the requirements to provide fuel consumption figures as part of the type approval process. Furthermore, even for those (7.22 million) cars registered since 1993, this information is not available in any readily usable form, because it is not included on the DVLA database of all vehicles registered in this country, used to compute the VED due (see Box 1).

The RCEP recognised this in its 18th Report, stating that *"if the government were to conclude that it is impracticable to base a graduated annual excise duty on certified fuel efficiency, we consider that a graduated duty based on engine size should be introduced"*. It noted that engine size had traditionally been a *"reasonable proxy"* for fuel consumption, but that the relationship had been weakened by recent developments in engine design. **Figure 5** shows that in general, the bigger the car and the bigger the engine, the higher is average fuel consumption. Anomalies nevertheless occur - a medium size car with a 1.9-2.0 litre engine consumes less fuel (30mpg) than a large car (28mpg) with a smaller (1.5-1.8 litre) engine (Figure 5).

There are two main grounds for questioning a graduated VED based on engine size, despite it being relatively easy to implement (because information on engine size is already held on the DVLA computer, see Box 1). First, there are the anomalies mentioned above - the many exceptions to the rule that bigger engines use more fuel. For instance, SMMT point out that a new 2 litre Ford Mondeo averages 34mpg whereas the 1.8 litre version does 30mpg, and suggest that a new VED could actually increase fuel consumption if it encouraged manufacturers to put smaller engines in bigger cars. They are also concerned that a VED based on engine size might discriminate against new generation (e.g. direct injection) petrol and diesel engines, since such designs offer reduced fuel consumption but tend to have a larger capacity than conventional engines.

A second main objection is that linking VED to engine size could distort the car market, with manufacturers switching production to cars with engine sizes just below the tax thresholds. SMMT suggest that this could disadvantage UK-based car manufacturers if their overseas competitors were quicker off the mark in producing such cars. While there is evidence that similar distortions have occurred before (e.g. the emergence of models just below the 1.8 litre threshold for company cars), this generally occurs only where the tax bands are very broad. **One way of minimising potential distortions would be to introduce a system with a large number of narrow bands, perhaps based on increments as small as 100 cc.**

Another way to use VED to minimise CO_2 emissions would be to vary the rate according to the type of fuel used, to provide an incentive for motorists to switch to lower emission fuels such as LPG or CNG. This would be relatively easy to implement since data on vehicle fuel type is currently held on the DVLA database (Box 1). One problem here is that while conversion of petrol engined cars to run on such gases is relatively straightforward (it involves fitting compressed gas tanks, a regulator and a mixer / injector system), most vehicles converted to date have retained the original petrol tank, pump and carburettor / injection system, and are thus able to run using either fuel (so called dual-fuel cars). Any VED-based incentive to encourage conversion would thus probably have to be confined to mono-fuel (gas only) cars.

A factor limiting the take-up of dual-fuelled cars is the lack of a comprehensive fuel supply network. There are currently only 120 LPG and 20 CNG refuelling sites in the whole of Britain, although CNG cars could be refuelled at home from domestic gas, with the appropriate equipment.

Finally, CO_2 emissions could be reduced by using VED as a tool to encourage a switch from petrol to diesel cars, although any such move would also impact on NOx and PM emissions (see later). A study at ETSU for the DTI and DoT in 1994 looked at a number of scenarios where diesel cars represented various proportions (10-40%) of the UK car fleet. It found that the proportion of diesel cars in the fleet had only a relatively small effect on vehicle CO_2 emissions (with 10% of the fleet diesel, CO_2 emissions were projected to rise by 38%, compared with a 35% rise if 40% of the fleet were diesel). In contrast, small but constant improvements in fuel consumption (1% reduction each year) for both petrol and diesel cars were projected to have a much bigger impact on vehicle CO_2 emissions (which would rise by only 26 or 29%, with a fleet consisting of 40 or 10% of diesels respectively).

Criteria for NOx and PM Emissions

Unlike CO_2, where emissions are dictated by the amount of fuel burned, NO_x and PM levels depend on factors such as engine design, the effectiveness of emission control systems (TWCs, particle traps), and fuel type. This means that if VED is to be used on a means of reducing levels of these pollutants, additional environmental criteria will be needed. As noted previously, the fairest way of graduating VED to take account of these pollutants would be to set emissions-based tax bands. Under such a scheme, cars with the highest emissions of NO_x and PM_{10} would be charged a higher VED than those with lower emissions. However, while such approaches are conceptually straightforward, implementing them poses considerable practical difficulties. The main problem is how to obtain detailed information on the actual amount of these pollutants emitted by each licensed car in the country.

Information on total NO_x / hydrocarbons emissions (for both petrol and diesel models) and PM (diesels only) is available for all new cars (through the type approval process) registered since 1993. As outlined previously, new emission limits for NO_x and PM are due in 2001 and 2005 (Stages III and IV respectively) under EU legislation, and one option here would be to base the tax bands on a car's 'Euro-status' (i.e. whether it conforms to Stage I, II, II or IV). Thus, cars meeting the 1993 Stage I specification could be charged a higher rate of VED than those meeting Stage II, which would be charged more than those conforming to Stage III, and so on. Such a system could also be used to provide an incentive for manufacturers to introduce cars conforming to the new Stage III and IV (when agreed) standards before the statutory deadlines.

As noted in Box 1, details of a car's Euro-status are not held on the DVLA database, and so cannot currently be used for calculating VED rates for individual cars. However, the database does contain the date when the vehicle was first registered, and it is often suggested that this information could be used as a proxy for the car's Euro-status. Under such a system, cars first registered in 1993 or later would be assumed to meet Stage I requirements, those registered in 1997 to meet Stage II, etc. However, this system would be far from perfect because some manufacturers were given derogations of up to 18 months to meet the new EC standards, while others anticipated the standards, introducing new models conforming to the requirements well before they became law. Such anomalies may mean that date of first registration is not a reliable proxy for Euro-status.

Any such approach would also mean basing VED on a car's specification when new, rather than reflecting its current level of emissions. As noted previously, this may be more of a problem for NO_x than PM, since the performance of TWCs (the main technology adopted by manufacturers to meet EU NO_x emissions standards) is known to deteriorate with vehicle age (although the introduction of the OBD Directive from 2001 should increase reliability in future). Ultimately, the ideal situation would be to link the VED rate to the MoT test, with a car's tax rating being determined by its emissions in its most recent test. However, this remains a longer term option since it would require more sensitive emissions tests to be conducted as part of the MoT (the current tests are effectively only able to detect whether or not a TWC is working at all, rather than assess its level of performance) as well as the setting up of a database containing details of all MoT test results (see Box 1), and for this to be linked to the DVLA database. While this is all technically feasible, the implications (for cost, the number of test centres, etc.) would need to be carefully assessed.

OTHER MARKET OPTIONS

The previous Sections outlined a number of difficulties in choosing environmental criteria on which to base a graduated VED:

- In order to meet the stated objectives the VED will have to be based on a matrix of at least two different criteria (one for CO_2 and one for NO_x / PM).
- The DVLA database does not currently contain the information needed to set emissions-based criteria (fuel consumption for CO_2, and manufacturer's type specification for NO_x and PM), **although the new DVLA system which will be up and running in 1999 provides an opportunity to start collecting such data.**
- Data currently available through DVLA limit the options open in practice to proxy criteria - notably engine size as a proxy for fuel consumption (and thus CO_2 emissions), and date of first registration as a proxy for Euro-status (and thus NO_x / PM emissions).
- Neither of these proxies is accurate, and both relate to the car only when new, rather than to its current condition.

These difficulties have fuelled the debate as to whether an environmentally graduated VED is the best way of achieving reductions in CO_2, NO_x and PM from cars. The Institute for European Environmental Policy (IEEP) advocates a variable VED based on a matrix of fuel consumption and emissions (the standard to which the car was manufactured) and points out that the UK is the only EU member state currently operating a flat rate on car ownership (**Table 6**). Among the most common approaches in other member states are to vary car tax according engine size, horsepower, the weight of the car or the type of fuel used. Germany has recently (1997) introduced a variable VED along the lines of that advocated by the IEEP.

However, other groups argue that the environmental objectives would be easier to achieve by other methods. For instance SMMT believes that directly taxing car use through fuel duty is a more efficient way of reducing CO_2 emissions, if emissions reductions are sought from the private vehicle sector. One problem here is that increases in diesel duty will also impact upon the freight and public transport sectors. Belgium addressed this problem recently by increasing the fuel duty on petrol, and imposing a supplementary VED on diesel cars and vans (to compensate for the fact that fuel duty on diesel was not raised). The AA has, however, argued that reducing emissions from vehicles through the government's 6% annual real price fuel escalator is a very inefficient route to achieving overall CO_2 reductions. The crux of the AA's argument is that if it is the responsibility of individual persons or families to reduce their CO_2 emissions, they can do this most economically in sectors other than private transport, e.g. through home insulation.

Other options also exist for limiting emissions of NOx and PM from cars. A recent survey conducted by the RAC suggested that only a small proportion of cars accounted for the majority of vehicle emissions (the RAC estimated that 12% of cars were responsible for 55% of emissions) and SMMT have thus recommended an accelerated scrappage scheme, aimed at removing the oldest cars from the UK fleet. They suggest a £500 incentive to owners of cars 10 or more years old to scrap the vehicle and replace it with a new car meeting latest emissions standards. SMMT estimate that such a scheme would result in at least 200,000 additional vehicles being scrapped in the first year, leading to an immediate reduction in emissions of NO_x of around 1.7%. Experience of such schemes in other countries, however, suggests that they cause distortions in the car market and are open to abuse.

Another option for reducing emissions of NO_x and other pollutants would be a scheme that encouraged owners of older cars to retro-fit catalysts. As pointed out earlier, there are an estimated 14 million cars in this country which were first registered before 1993, and which will thus not necessarily be fitted with catalysts. However, such an option is likely to be expensive since fitting a TWC to a pre-1993 car would also require upgrading of the engine and fuel management systems. Less sophisticated (e.g. two-way) catalysts would be fitted more cheaply, but would not remove NO_x from exhaust gases. Finally, the other main market tool suggested is Road Pricing (dealt with in some detail in POSTnote 43 and 112). There are also a wide range of non-market options (restraint on car-use, parking restrictions, etc.), but these are beyond the scope of this briefing.

TABLE 6 APPROACHES TO TAXING CAR OWNERSHIP WITHIN THE EU (1997)

Country	Variable VED	Main Criteria
Austria	Yes	Horsepower
Belgium	Yes	Engine-size
Denmark	Yes	Weight, fuel type (extra for non-petrol)
Finland	Yes	Weight (diesel only)
France	Yes	Horsepower, car age, type of fuel (discount for diesel)
Germany	Yes	Engine size, fuel type (extra for diesel), discount for 'clean cars'
Greece	Yes	Engine size, 'clean-cars' exempt for 5 years (if they replace scapped old car)
Ireland	Yes	Engine size
Italy	Yes	Horsepower
Luxembourg	Yes	Engine size
Netherlands	Yes	Weight, fuel type (extra for diesel, discount for electric)
Portugal	Yes	Engine size, fuel type
Spain	Yes	Engine size
Sweden	Yes	Weight, fuel type (extra for diesel), 'clean cars' exempt for 5 years
UK	No	Flat rate

Source: "Vehicle Taxation in the EU, 1997", EC DG XXI

IN CONCLUSION

Overall, practical considerations - most notably the data available on the DVLA computer - appear to limit the environmental criteria for a graduated VED. More detailed information on the proposed criteria are expected shortly in the form of the joint DETR / Treasury consultation paper in June 1998. Whichever criteria are selected, whether or not the graduated VED approach achieves the stated environmental objectives will depend on the extent to which it influences the purchasing habits of the general public.

A key factor will thus be the size of the differential between the lowest and highest tax bands - the bigger the gap, the bigger the impact on car buyers is likely to be. However, VED is just one of many potential routes by which the Government could achieve its environmental objectives and further information on these other options, and the wider context in which they could be used, will be available when the White Paper on an Integrated Transport Policy is published.