



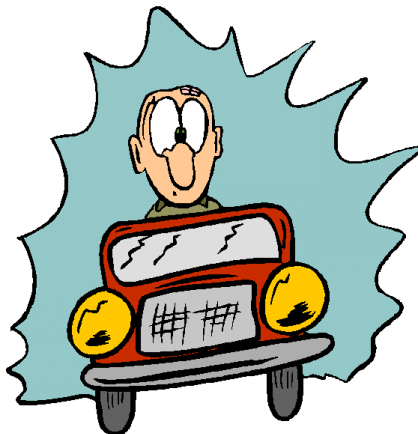
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# TRANSPORT

## Fact Sheet Series for Key Stage 4 and A-Level

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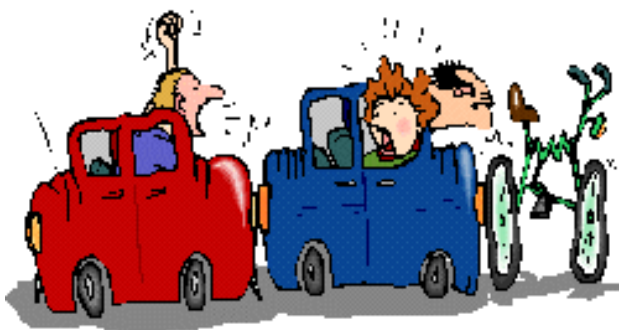
# 1. What is Sustainable Transport?

An effective transport system is vital for economic well-being and good quality of life. However, there is widespread concern that the continuing growth of transport is damaging our environment. Transport is responsible for emissions of many harmful **pollutants** that lead to:



- **acid deposition;**
- human health effects and
- **global climate change.**

To maintain the standard of transport that is required for society and the economy to function efficiently, without placing too much pressure on the environment, it is necessary for governments to devise a policy that will take these factors into account. This can be done through a sustainable transport policy. “Sustainable” in this context means meeting the needs of the present without compromising the ability of future generations to meet their own needs.



In the Sustainable Development Strategy for the UK, the government has acknowledged that it will need to take action to control the rate of traffic growth, improve the performance of vehicles and initiate public awareness about the environmental impacts of polluting emissions from transport. People

need to be encouraged to reduce their dependency on cars, but affordable alternatives must be available to allow them to do this.

Sustainable transport policies will involve more than traffic reduction. New technology is required to increase vehicle efficiency and investment in other modes of transport, e.g. public transport. Cycling and walking incentives will be needed to encourage people to leave their cars behind.

## 2. Road Traffic in the UK

There are currently about 29 million vehicles on Britain's roads, 24 million of which are cars. This means that of all road traffic, cars account for 82%. The additional 5 million range from motor cycles to heavy goods vehicles.

In the past, a large proportion of UK freight was moved by train. However, in the last 50 years there has been increasing movement away from rail onto roads. In 1999, 64% of freight was moved by road compared to 53% in 1980 and 35% in 1950.

Vehicle density, and therefore motor vehicle pollution, tends to be greatest in urban areas. Between 8-9 am, and 5-6 pm, there is a peak in the amount of cars on Britain's roads and hence a peak in pollutant emissions.

People are becoming more and more dependent on the motor car, and today almost 15% of the average family's expenditure goes towards motoring.



Expenditure on the maintenance and construction of roads has not grown as fast as the increase in road traffic. This has resulted in an increase in necessary road repairs and more traffic delays. In Britain, motorways are the most heavily used type of road. They carry 20% of total traffic, yet only constitute less than 1% of Britain's total length of roads.

Transport is the fastest growing energy-consumption sector in the UK and the **Department for Transport** projects that the number of cars on the road will increase by 17% by 2010.

## 3. Fuel Types and Emissions

### **Introduction**

In recent years, concern about exhaust emissions from motor vehicles has been increasing. To combat this, the motor industry has been promoting the diesel car as 'cleaner' than petrol cars due to their greater fuel economy and reduced maintenance requirements. However, diesel cars have very different emission characteristics. An increase in diesel cars at the expense of petrol cars could have important implications on urban air quality, smog formation, global warming and other environmental issues.

Emissions of lead have fallen due to the banning of lead in petrol in the UK from 2000. Recently, there has been much debate about which fuel, petrol or diesel, is the cleanest in terms of exhaust emissions.

### **Emissions from Petrol Vehicles**

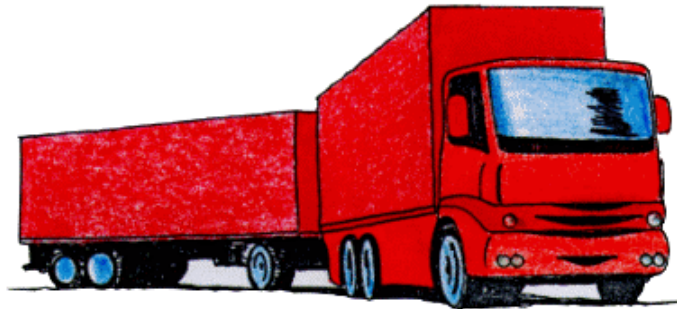
Emissions from petrol cars have been dramatically reduced by the introduction of the **catalytic converter**. These lower **carbon monoxide (CO)**, **hydrocarbon (HC)** and **oxides of nitrogen (NOx)** emissions.



**Particulate** and **NOx** exhaust emissions are much lower from petrol cars than diesel. However, they slightly increase emissions of **carbon dioxide (CO<sub>2</sub>)** due to the **oxidation** of CO to CO<sub>2</sub>. Also, despite the improvements made by catalysts, petrol cars fitted with catalysts still produce more CO and HC than diesel cars.

## ***Emissions from Diesel Vehicles***

Diesel engines are more efficient than petrol engines and therefore use less fuel. Also, diesel fuel contains more energy per litre than petrol, which adds to its efficiency. Diesel contains no lead, and levels of CO, HC or NOx are lower than those from petrol cars without catalysts. However, diesel vehicles have higher emissions of NOx and particulate matter than petrol cars with a catalyst.



***Table illustrating emissions from road vehicles  
(per vehicle kilometre)***

<b>Vehicles</b>	<b>Carbon Monoxide</b>	<b>Hydro-carbons</b>	<b>Oxides of Nitrogen</b>	<b>Particulate Matter</b>	<b>Carbon Dioxide</b>
<b>*Petrol car without catalyst</b>	100	100	100	-	100
<b>Petrol car with catalyst</b>	42	19	23	-	100
<b>Diesel car without catalyst</b>	2	3	31	100	85

\*Petrol cars without catalysts have been given a relative value of 100 for comparison.

Petrol is the major fuel type used for cars and light vans, constituting 95%, with diesel making up 4% and other fuel sources the remaining 1%. Heavy Goods Vehicles (HGVs) and passenger service vehicles are mainly diesel fuelled.

## 4. Impacts of Road Traffic

### ***Introduction***

Since 1975/6, there has been an increase in the proportion of journeys travelled by car and the distance that people travel. Associated with these rising figures has been an increase in the pressures due to transport placed upon the environment and society.

### ***Congestion***

Congestion in cities is acknowledged as a major problem throughout the world. No large city seems to have escaped peak period congestion. It is a problem in countries with generous road systems and low resident densities like the US, as well as in countries like Turkey and Poland, with relatively low levels of car ownership, but poor road infrastructure.



### ***Stress***

Stress due to traffic congestion has now taken on the name “road rage”, and has become an increasing social problem. It has been the cause of many attacks on car drivers and has even resulted in several deaths. Stress can also be caused by the amount of traffic on the roads and is a factor in work related sickness leave.

## ***Work and Economic Loss***

Rising volumes of road traffic have caused a decrease in the efficiency of delivery services that depend on transport. There is also the problem of rising transportation costs due to increased journey times and hence higher payments for drivers.

## ***Local Air Quality***

Transport is becoming an increasing source of air pollution. The transport related problems experienced now are likely to worsen according to the projected increase in UK traffic. The Department for Transport predicts an increase in vehicle traffic of between 17 and 22% by the year 2010, depending on the success of the Government's 10 Year Plan.

The motor vehicle engine emits many types of pollutants including nitrogen oxides (NO<sub>x</sub>), ***volatile organic compounds (VOCs)***, carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), particulates, sulphur dioxide (SO<sub>2</sub>) and lead. The table below shows the UK emissions of these pollutants in 1995. Individually, a vehicle engine is not a particularly important source of pollution. Collectively however, vehicles represent a major source of air pollution in the UK.

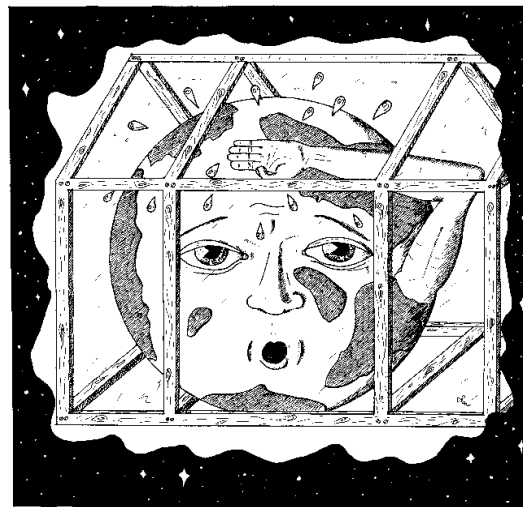
***Emissions from road traffic in the UK, 1999***

<b>Pollutant</b>	<b>Emissions (000 tonnes)</b>	<b>% of total UK emissions</b>
CO	3,293	69
Black Smoke	130	48
NO <sub>x</sub>	714	44
VOCs	473	27
CO <sub>2</sub>	31,200	22
SO <sub>2</sub>	12	1

Emissions are related to the use of the engine, mainly the fuel type and the temperature of combustion. If the engine is 100% efficient, then the products of combustion will be CO<sub>2</sub> and water (H<sub>2</sub>O). Impacts of transport on the environment include acid deposition (acid rain), human health effects, global climate change and noise pollution.

### ***Carbon Dioxide and Global Warming***

Carbon dioxide (CO<sub>2</sub>) is a greenhouse gas that is produced naturally through respiration, decay of plant and animal matter and natural forest fires. Man made sources of CO<sub>2</sub> include fossil fuel combustion, ***deforestation*** and the manufacture of cement. The main removal processes for CO<sub>2</sub> include its absorption by the oceans and photosynthesis by plants.



Since the ***Industrial Revolution***, ***concentrations*** of CO<sub>2</sub> have largely increased. They are higher now than at any other time in the last 160,000 years. The extra amounts of CO<sub>2</sub> in the atmosphere enhance the Earth's natural greenhouse effect, contributing towards global warming.

Of the United Kingdom's total man-made carbon dioxide output, transport accounts for almost a quarter. The UK is responsible for about 3% of the total CO<sub>2</sub> output world-wide, and it is believed that motor vehicles contribute between 14 and 17% of the world's total CO<sub>2</sub> emissions. This figure is likely to increase in the coming years.

The focuses of efforts to reduce CO<sub>2</sub> are on road transport, as it constitutes the main share of the transport market. Other forms of transport, such as aviation, are also considered to represent a growing contribution to the problem of CO<sub>2</sub> emissions and global warming.

Any action that governments may take to decrease the problem of CO<sub>2</sub> emissions from road transport will inevitably lead to some conflicts of interest. For example, the building and use of a new town by-pass may cause considerable environmental damage, but can alleviate town centre congestion.

Some environmental objectives may also have conflicting effects. For example, air pollution is reduced by the use of catalytic converters, but these devices also slightly decrease the efficiency of fuel, thereby increasing the emissions of carbon dioxide.

The best way to reduce the threat of global warming is to use less fuel, and consequently governments are promoting better fuel efficiency. A large amount of transportation takes place on roads, and so this will be the target of most policies. In addition, individual car users have control of how fuel is used. Individuals, therefore, can make a large contribution to the attempts to decrease the man-made enhancement of the greenhouse effect.

If the present rise in the global population is accompanied by economic growth and increased personal income, the total number of motor vehicles could be set to rise beyond 1 billion by 2025, discharging as much as 1,800 million tonnes of carbon into the atmosphere per year. This would be the equivalent over one quarter of the 6,800 million tonnes of carbon emissions from all sources today. Without a major improvement in fuel efficiency, a considerable increase in fuel consumption, and consequently greenhouse emissions, will occur.

## Accidents

Although traffic has grown substantially in recent years, the number of road casualties is declining. In 1998, 3,421 people were killed on roads in Britain, compared to 5,526 in 1955 and nearly 8,000 in 1972.

Each year in the **European Union (EU)** 50,000 people are killed on the roads. Casualty rates vary from country to country for a variety of reasons. There is a tendency for countries with low car ownership to have high death rates per vehicle.

It is also a fact that walking and cycling are less safe forms of transport than cars and buses.

In relation to the amount of time spent travelling, the risk of having a fatal or serious accident is approximately twice as likely on a bicycle as in a car. However, in the majority of cases, injuries or deaths to cyclists are caused by accidents involving cars.



Whilst road death rates are unacceptably high, particularly for pedestrians in urban areas, they are declining in most Western industrialised countries.

Countries like Denmark and the Netherlands make better provisions for cyclists and walkers, which serves to decrease the risk of accidents due to vehicles and cyclists sharing the same road space. Cyclists should also be encouraged to wear a helmet at all times to decrease the severity of any accident that they may be involved in.

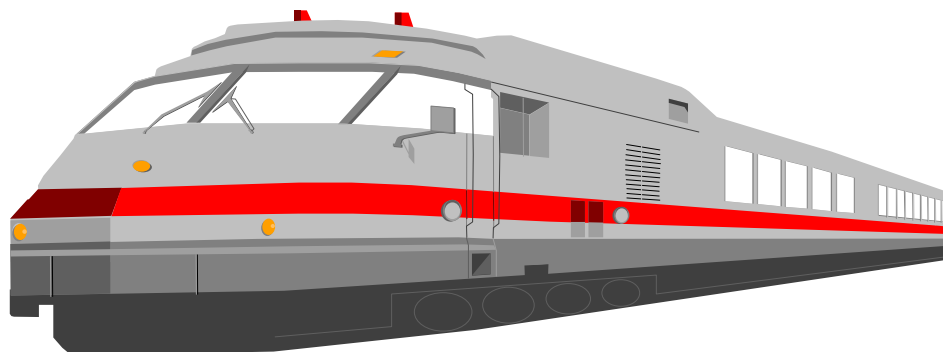
## ***5. Other Modes of Transport***

### ***Public Transport***

The use of public transport must be encouraged if a sustainable transport policy is to be developed. A decrease in the use of personal vehicles would be beneficial to the environment both in terms of land use pressure and air quality.

### ***Trains***

Railways are efficient forms of transport that use existing tracks, and therefore use less land than roads. Some of them, however, utilise diesel as their fuel, which has been found to produce a large amount of particulates when burnt.



### ***Light Rail (Including Trams)***

There has been a resurgence in the use of transport such as trams, which have a lower environmental impact than buses. Trams use smaller vehicles and tighter rail tracks than conventional trains, which enables them to be constructed within existing built-up areas. They also run at a lower cost than trains, and they can easily be expanded to accommodate increases in passengers.



An example of a successful light rail transport scheme is the Metrolink, developed in Manchester in 1991. Sections of the Metrolink run parallel to other vehicles in the existing road network. Since its successful instalment, many additional

extensions have been developed or planned to surrounding suburbs.

### **Buses**

Buses are generally recognised as an environmentally friendly form of transport, particularly in relation to the number of car journeys needed to carry the same number of passengers. A bus uses less fuel per person carried, and hence less fuel than the number of cars needed to replace it. However, buses do contribute to air quality problems, particularly in cities.



Buses in the UK are mainly powered by diesel engines, with a handful of alternative fuels under trial. Improvements in the emission performance of buses are likely to be needed in the future. In 1996 the first purpose built gas bus in the UK began operating. This was part of a trial, with a range of alternative fuels, to overcome the public's perception that buses contribute significantly to environmental pollution. The aim of the experiment was to encourage the public to see them as part of the solution instead of the problem.

Public transport is beginning to become more attractive due to improved transport information and the introduction of bus lanes, which decrease journey times. The cost of public transport needs to

be lowered to encourage people to use this as an alternative to personal vehicles.

## ***Cycling***

Cycling is often the quickest way to make short journeys. At present, there are some cycle tracks in British towns and cities, but the improvement and expansion of these routes could encourage more people to cycle. Improving cycle parking facilities at convenient locations could assist this.



## ***Walking***



Walking is a sustainable mode of transport that is available to all at no cost. The safer the walking environment the better, and hence the introduction of pedestrianisation to city centres has increased the number of people that travel on foot. York is a good example of a city where improved conditions for pedestrians has brought an increase in pedestrian traffic.

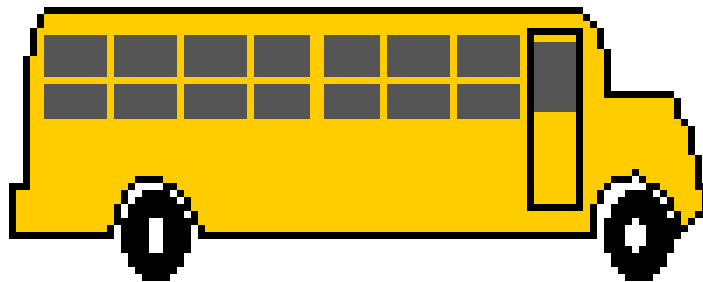
In the UK it has been found that 50% of all journeys are less than two miles, and therefore are ideal for cycling or walking. Walking and cycling are also extremely healthy modes of transport, as they increase physical fitness.

It has been suggested that walking and cycling should be given a much more prominent role in transport policy formulation throughout the developed world. Not only do these modes cause the least damage to other road users, but they also incur a much lower social, economical and environmental cost than motorised ones.

## ***Park and Ride Schemes***

Park and ride facilities have been introduced in many districts during the last decade. They are often found in rural areas, small communities and cities where traffic congestion is a major problem.

Park and ride facilities aim to provide a car park where people can transfer from a few people in each car to a large number of people together on a bus or train. This has the effect of reducing the amount of traffic in problem areas, particularly urban centres. The parking facilities are often located around bus or rail stations, and car parking is often available free of charge as an incentive for their use.



A survey showed that in Britain a third of the population had used a park and ride scheme, and 9 out of 10 of these people were satisfied. Park and ride schemes could become even more attractive if restrictions were placed on city centre roads to reduce traffic. Cheaper fares would also make the services more attractive.

Supporting services and facilities could be used to reinforce the overall efficiency and effectiveness of park and ride facilities. These would prioritise transit services, giving them right of way.

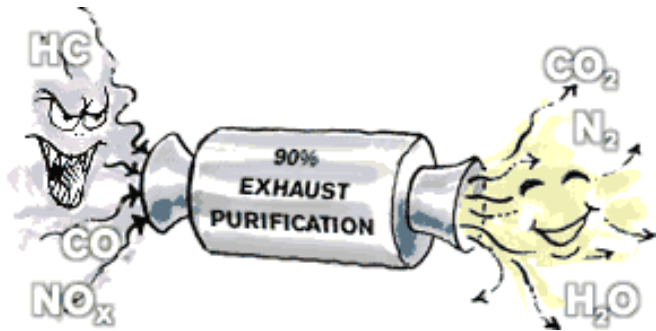
## 6. Reducing Emissions from Road Traffic

### Introduction

With a large rise in traffic numbers, it becomes increasingly important to keep polluting emissions to a minimum. There are presently a number of ways in which road traffic pollution can be reduced, including the use of technological solutions.

### Catalytic Converters

Since January 1993 all cars sold in the European Union (EU) have been fitted with a catalytic converter (CAT). This is made of a thin layer of platinum group metals on a honeycomb structure. The surface area of a typical three-way catalyst covers the equivalent of two football pitches. As exhaust gases pass through the catalyst a chemical reaction occurs which converts carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NO<sub>x</sub>) to less harmful compounds (water, nitrogen and carbon dioxide).



The surface area of a typical three-way catalyst covers the equivalent of two football pitches. As exhaust gases pass through the catalyst a chemical reaction occurs which converts carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NO<sub>x</sub>) to less harmful compounds (water, nitrogen and carbon dioxide).

To work most effectively, a catalytic converter needs to reach an optimum temperature. It may not reach this in a short journey. Devices to pre-warm the catalyst are being developed which improve the overall performance of catalytic converters.

The use of catalytic converters leads to a dramatic reduction in the emissions of CO, HC and NO<sub>x</sub>. However, they also result in an increase in CO<sub>2</sub> emissions, which do not cause a problem for urban

air quality, but may contribute to global warming. The efficiency of a CAT can be as high as 90%.

### ***Oxidation Catalysts***

***Oxidation*** catalysts may be fitted to either petrol or diesel cars. The catalyst oxidises the pollutants formed by incomplete combustion of fuel to CO<sub>2</sub> and water. It is also effective for HCs, ***aldehydes*** and CO. However, they do not reduce NOx emissions.

### ***Carbon Canisters***

Carbon canisters are being fitted to petrol tanks to reduce evaporative emissions of petrol. Vapour rises into the carbon canister, which then returns the petrol to the tank hence avoiding a loss due to evaporation.

### ***Lean Burn Engines***

Lean burn engines are more fuel-efficient than other engines and produce less NOx and CO, but they do emit higher levels of HC. Currently they are still under development and have not yet been able to meet EU emissions standards, especially at high speeds.

### ***Exhaust Gas Recirculation***

This involves returning exhaust air to the fuel inlet, which results in a reduction in peak engine temperatures and emissions of NOx from petrol vehicles. Levels of CO and HC are also reduced.



The technical fixes outlined above will reduce pollution to some degree, but combined with the introduction of alternative fuels, further reductions may be found.

# 7. Alternative Fuels

## ***Introduction***

To replace pollutant fuels (petrol and diesel), alternative fuels are currently being developed. Those presently put forward as alternatives include: compressed natural gas (CNG); liquefied petroleum gas (LPG); city diesel; hydrogen; alcohol fuels and battery operated vehicles.

## ***Electric Vehicles***

Milk floats and some other vehicles are powered by electricity using a rechargeable battery, which does not produce pollution when they are used. However, electrical cars can only be considered to be truly non-polluting if the electricity generated for their use comes from renewable sources like the Sun, wind and water. Researchers are currently developing cars that have both combustion engines for long journeys and electrical batteries for shorter ones.

## ***City diesel***

City diesel is a petroleum based lower emission diesel developed in Sweden but now available in many other countries, including the UK. The main benefit with city diesel is that its combustion reduces particulate emissions by 34 - 84% depending on engine type, duty cycle, test basis and type of particulate measured.

To produce a cleaner environment for all to live and work in, the development of alternative, cleaner fuels is essential. To encourage the use of new fuels, competitive prices combined with good marketing techniques are required.

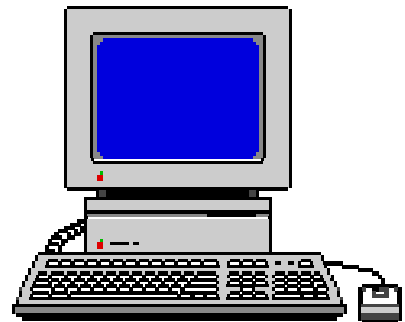
## ***8. Reducing the Need to Travel***

### ***Introduction***

Since the introduction of the motor car, the population has slowly spread outwards from major urban centres. Dispersal occurred as people looked for cleaner environments to live and work in, away from busy town centres. As cars became more affordable, people were able to travel out of town easily. This in turn led to an increase in the length of journey that people made, and an increase in the number of cars on the road.

### ***Working from Home***

With the introduction and expansion of the Internet, it has become possible for many people to work from home. Work processed on a computer can be electronically mailed across the globe within seconds, making it possible for people to work for companies on the opposite side of the world.



### ***Car Sharing***

The vast majority of journeys made to and from work by car take place with only one person in a vehicle. If people making regular car journeys could share them between a group of drivers, then congestion and hence pollution would be kept to a minimum. There would also be a reduction in the number of cars in city centres, and commuters' petrol and parking costs would be greatly reduced.

## **9. Make Travelling by Car Less Attractive**

### ***Introduction***

At present, travelling by car is the most attractive form of transport, due to its convenience. To encourage people to use other modes of transport we need to make travelling by car seem less attractive.

### ***Road Pricing***



This provides a way of charging motorists for some of the social and environmental costs of cars that are not reflected in petrol or maintenance expenses. Charges can be varied according to whether cars are used during peak times. Unfortunately, government legislation is required before such a road pricing scheme can be introduced. It is possible, however, that such legislation may be made available to local authorities in the next few years.

### ***Parking Charges***

Higher parking charges in cities may deter people from using private cars, and make public transport seem more attractive. For this to be successful, parking charges must exceed the cost of public transport.



## ***10. Land Use Planning and Transport***

To relieve the pressure of transport on society and the environment, emphasis needs to be placed on reversing the trend of population dispersal outwards from urban areas. By effective land use planning, activities including work, shopping and leisure are brought closer together. This would reduce journey distance to a level where travel on foot and by bicycle becomes more popular. To facilitate this, urban centres need to be made more attractive and the quality of urban living improved.



The sort of journey that a person is required to make, either for work or leisure activities, is directly influenced by land use policies. Land use planning, if correctly devised, could lead to a reduction in the need to travel. This could be achieved by locating housing, employment and other facilities in close proximity.

# Glossary

**Acid Deposition:** Acidic air pollution that falls to the ground as either particles (dry deposition) or as a solution in rain (wet deposition). The latter is commonly known as “acid rain”. Produced from the atmospheric build up of NO<sub>x</sub> and SO<sub>2</sub>.

**Aldehydes:** An organic compound containing carbon, hydrogen and oxygen.

**Carbon Dioxide (CO<sub>2</sub>):** A molecule formed from one atom of carbon and two of oxygen. It is mainly emitted through the burning of fossil fuels and deforestation.

**Carbon Monoxide (CO):** A colourless, odourless, poisonous gas.

**Catalytic Converter:** A device fitted to the exhaust system of a vehicle, which converts the majority of harmful exhaust pollutants, such as hydrocarbons, into less harmful ones.

**Concentration:** A measure of the atmospheric content of a gas, defined in terms of the proportion of the total volume that it accounts for. Trace gases in the atmosphere are usually measured in parts per million by volume (ppmv), parts per billion by volume (ppbv) or parts per trillion (one million million) by volume (pptv).

**Deforestation:** Those practices that result in a long-term change of land-use from forest to non-forest uses.

**Department for Transport:** The British Government agency in charge of transport issues.

**European Union:** A union of countries in Europe, known as Member States, which try to work together to achieve economic and social equality.

**Global Climate Change:** A theory that increased concentrations of greenhouse gases are causing an elevation in the temperature of the Earth's atmosphere.

**Hydrocarbons (HC):** Any organic compound that contains only carbon and hydrogen.

**Industrial Revolution:** The rapid growth of industry which began in the late 18<sup>th</sup> Century and was made possible by the harnessing of energy from fossil fuels.

**Nitrogen Oxides (NO<sub>x</sub>):** The collective term for nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>)

**Oxidation:** The process by which something undergoes a chemical reaction with oxygen.

**Particulate:** A particle of an organic or inorganic substance present in the atmosphere that is less than 10 microns (µm) in diameter.

**Pollutants:** Substances that are damaging to the environment.

**Volatile Organic Compounds (VOCs):** Carbon-containing organic compounds present in the atmosphere as gases. They are an important class of air pollutants found in the atmosphere, occurring mainly at ground level in urban and industrialised centres.

## Further Reading

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