

Energy Issues	Relevant Factors/ Evidence	Some Implications
DEPLETION OF FOSSIL FUELS	<p>Fossil fuels are finite, and ultimately exhaustible, energy resources. In 1998, fossil fuels met 90% of global commercial energy demand. Crude oil accounts for over 98% of transport consumption.</p> <p>World oil production will soon peak¹. Thereafter oil production will continue for many decades, though at a declining rate. Thereafter, coal, tar sands, heavy oil and oil shales could be used to produce liquid or gaseous substitutes for crude oil.</p> <p>Demand for energy is strongly correlated with GDP and climate. If oil demand was held constant to postpone the decline - the greatest burden would fall on the non-OECD countries where per capita oil use today is only 14% that of the OECD countries.</p> <p>Demand for aviation fuel is growing at about 5% per year ².</p> <p>Energy consumption in transport is growing at a faster rate than for other sectors – people are buying larger cars, car ownership is increasing.</p>	<p>Unless growth in world oil demand is sharply lower than generally predicted, world oil production will begin its long-term decline soon – and certainly within the next 2 decades.</p> <p>Demand for energy is likely to continue to rise in line with growth in GDP so unrestrained demand for energy is unlikely to be sustainable in the long run.</p> <p>Expected growth in traffic volumes is likely to more than offset the expected efficiency gains in vehicle performance.</p> <p>Need to find ways of using less fossil fuels:</p> <ul style="list-style-type: none"> • reduce demand for travel; particularly society's dependence on the car. • promote non-motorised modes • encourage switch to more energy efficient modes (HOVs, collective transport); • use fossil fuels more efficiently • develop alternative fuels • develop alternative vehicle technologies • enhance public awareness of energy issues through media campaigns etc.
CLIMATIC CHANGE	<p>Transport accounts for 25% of UK's CO₂ emissions. 4/5ths are produced by road vehicles³. Further growth in road traffic will hinder attempts to reduce CO₂ emissions.</p> <p>Emissions of CO₂ and most other pollutants are generally lower per occupant for bus and rail travel. Rail freight tends to be more environmentally friendly than road freight.</p>	<p>Decrease overall energy use – restrain road traffic growth.</p> <p>Reduce use of non-renewable energy.</p> <p>Ensure environmental impacts taken into account in investment decisions and the price of transport.</p> <p>Encourage switch to more environmentally friendly modes.</p>
INTERNAL COMBUSTION ENGINES	<p>The development of conventional ICEs is far from fully exploited⁴. Direct fuel injection could result in cars running on fuel mixtures nearly twice as lean as conventional engines. But these require low sulphur petrol which is currently unavailable in the US. Ford is working on a hydrogen powered ICE.</p>	<p>Promote further developments of ICE technologies.</p>
Energy efficiency	<p>The EC has proposed a Community strategy to reduce CO₂ emissions and improve fuel economy⁵. EC Directive 99/94/EC commits car manufacturers to attain a CO₂ emission target of 120g/km CO₂ on average for newly registered passenger cars by 2005, and at the latest 2010. This Directive is part of a trio of policy approaches, which includes fiscal measures, and an agreement by the motor manufacturers in Europe (ACEA) to reduce emissions of CO₂ by technical improvements to new cars. The Directive allows each Member State to introduce its own schemes (labels, guides, posters) and stipulates a minimum amount of information that is required on each.</p>	<p>Economic incentives such as “feebates” could encourage the use of more energy-efficient vehicles.</p> <p>Without fiscal measures, regulation will be necessary to achieve improvements in fuel efficiency.</p> <p>Improved energy efficiency induces reduction in overall driving costs, which in turn could lead to increased mileages and car purchases. This “rebound” effect could offset any gains in energy efficiency.</p> <p>Develop smaller/ lighter cars.</p>

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	<p>In the UK fiscal measures have been introduced to encourage people to buy cars with lower CO₂ emissions, including differential rates of Vehicle Excise Duty and company car allowances. Similarly “Feebates” are being introduced in Austria and Canada. This concept taxes vehicles with high fuel consumption and compensates vehicles which use less fuel.</p> <p>Pollution emission regulations have speeded up progress in engine design, but have hindered improvements in energy efficiency.</p>	<p>Increase the recyclable content of vehicles.</p>
Cleaner fuels	<p>Cleaner fuels are marketed on the basis that they are more environmentally friendly than existing alternatives e.g. “City Diesel”. Compressed natural gas (CNG) and LPG are alternative fuels that could have a role in improving air quality now. Low sulphur petrol is a prerequisite for improving conventional ICEs.</p>	<p>Greater use of cleaner fuels would reduce emissions.</p> <p>The advent of low sulphur fuels would advance ICE technology leading to efficiency gains.</p> <p>Fiscal and/or regulatory policies would speed up the introduction of cleaner fuels.</p>
Alternative/ renewable energy sources	<p>Many promising prototype technologies exist to use alternative fuels. Most are at an early concept stage. They have strong environmental advantages over conventional fuels – lower emissions and noise.</p> <p>For the introduction of new fuels, a new fuelling infrastructure, parallel to existing ones may become a necessity. A cheaper alternative is to blend conventional and alternative fuels e.g. in France about 5% RME is added to diesel fuel. Similarly methanol or ethanol can be added to conventional gasoline, and state-of-the-art Otto engines can operate on such blends without any problem.</p> <p>EU has set a target of 12% for the contribution of renewable sources to energy consumption by 2010⁶. In the UK in 1997 renewable energy only contributed to 0.5% of consumption - the lowest in the EU.</p>	<p>The challenge of developing alternative fuel vehicles lies in making them affordable.</p> <p>Regulation could be an important agent of change – in particular strict emission requirements and restriction of “heavy polluting” propulsion systems in city centres.</p> <p>Perhaps economically more promising and less risky to use blends of conventional and alternative fuels.</p> <p>User attitudes are likely to be difficult to change.</p> <p>Need strong commitment and favourable economic regime to develop renewable energy sources.</p> <p>Renewable sources could make an important contribution to energy supplies.</p> <p>Renewables are an essential component of any cost-effective climate change strategy.</p>
Natural gas/ Liquefied petroleum gas (LPG)	<p>Compressed natural gas and LPG are alternatives to petrol and diesel. In 1997 they accounted for only 0.1% of final UK energy consumption. They are attractive for motor vehicle use because they are stored in liquid state and used in gaseous state, making it possible to obtain a high-energy storage density and achieve cleaner and quieter combustion. However LPG/CNG require better storage and handling facilities than conventional fuels.</p> <p>Some adaptation of existing fuel system technology is required to enable vehicles to run on these gases. Bi-fuelling designs are available, allowing cars to use both conventional and gaseous fuels.</p> <p>In some countries there are networks of local filling stations providing these fuels and these are developing in the UK</p>	<p>CNG and LPG are current alternatives to diesel and petrol.</p> <p>Bi-fuelling designs offer greater flexibility. Although engines designed specifically for gaseous fuels are available, vehicles are normally adapted to use gaseous fuels as an after market conversion.</p> <p>LPG/CNG fuel would need to be widely available for high market penetration.</p>
“Energy crops” -	<p>Biofuels are renewable energy sources derived from vegetable products.</p>	<p>Energy crops are the only renewable energy resource with the potential to be</p>

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Biofuels	<p>Biofuels require relatively undeveloped technology and can be stored for future use e.g. to meet peak demand.</p> <p>Biodiesel is derived from vegetable oils – rapeseed, sunflower etc. It can replace diesel entirely without engine modification.</p> <p>Bioethanol and its derivative ETBE are oxygenated products produced from a range of agricultural feedstocks, e.g. starch and sugar crops. It can be used in existing, slightly modified petrol engines.</p> <p>Biomethanol can be produced from wood, and used in the same way as ethanol.</p>	<p>expanded by man.</p> <p>The use of biofuels in engines is not subject to any technical limitations. No significant engine modifications are required.</p> <p>The production of liquid bio-fuels is not yet economic without substantial subsidies.</p> <p>Ethanol and methanol have stringent safety and handling concerns. These fuels are corrosive, colourless and burn with a clear flame. They require special fuel systems on vehicles and better storage facilities at depots.</p>
Hydrogen	<p>Hydrogen (H₂) has often been called the perfect fuel. Its major reserve on earth (water) is inexhaustible. The only emission from an H₂ fuel cell is water.</p> <p>Renewable energy sources can produce hydrogen by electrolysis. Solar power is attracting a lot of attention.</p> <p>Disadvantage of H₂ is that it is a very diffuse gas that is difficult to store and transport. Liquid H₂ is more compact but must be kept at -250°C which is energy consuming and somewhat dangerous. Hydrides are a solid state storage system - H₂ atoms are bound to metal alloys which can be stored more safely.</p> <p>Several prototype hydrogen vehicles using fuel cells are under development. Japan is leading the commercial market with a small fleet of delivery trucks. BMW is developing vehicles which run on solar gathered pure liquid H₂, a process that is completely neutral to the earth's environment.</p> <p>At present no major infrastructure exists to deliver H₂. Ford has built a pilot H₂ refuelling station to analyse the benefits of liquid vs. gaseous refuelling. Japan also has some H₂ filling stations.</p>	<p>Hydrogen as a fuel has considerable potential. Technically it could replace oil.</p> <p>Hydrogen powered vehicles have zero emissions and H₂ can be produced from renewable sources.</p> <p>There are safety and handling concerns to be overcome with hydrogen as a fuel.</p> <p>Hydrogen is still very expensive to both produce and deliver.</p> <p>Standardising hydrogen production would make it cheaper.</p>
Electric and hybrid vehicles	<p>There are 3 types of electric vehicles (EVs) – the pure EV, powered only by rechargeable battery; the series hybrid EV, which uses electricity from a small diesel generator to power the vehicle at low speed with additional power for starting and accelerating provided by batteries; and the parallel hybrid EV, which employs a combination of battery driven electrical and combustion driven mechanical drives. Toyota's hybrid gas/electric vehicle "Prius" already available in Japan gets 66 mpg in stop-and-go traffic. GM will unveil demonstrator models of full size hybrid pickups this year⁷.</p> <p>Practically all manufacturers are developing electric vehicles whose driving ranges are 2-3 times higher than earlier EVs. These are starting to capture a small part of the passenger and urban car market.</p> <p>The key technological issue regarding EVs is batteries. With the exception of lead and NI-Cad batteries, all other systems are prototypes.</p>	<p>EVs are the most familiar of the alternative fuel set. Although they have been around for years they are limited by short range and long charge time.</p> <p>EVs make most sense as fleet vehicles or in-town runabouts.</p> <p>City deliveries and urban public transportation are well suited for electric drive in view of environmental advantages.</p>

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	Electric propulsion systems have been used for decades in mass transit.	
Fuel cells	<p>Use of fuel cells in cars appears promising. Fuel cells convert the “free” energy of a chemical reaction, typically between hydrogen and oxygen (generally from air), directly into low voltage direct current electricity and heat. They are similar in principle to batteries.</p> <p>Fuel cells can be designed to run on a variety of fuels.</p> <p>Hydrogen is not likely to be a practical fuel until the advent of hydrogen supplied filling stations. Interim solutions involve “reforming” hydrogen from another substance using other fuels such as methanol or natural gas.</p> <p>Truly commercially competitive products are not yet available - widespread uptake is unlikely before 2010⁸. For the transport sector, capital cost projections for volume manufacture of fuel cell systems compare favourably with internal combustion engines.</p>	<p>Fuel-cell vehicles perhaps hold the greatest promise for the clean car of the future.</p> <p>Fuel flexibility offers great advantages.</p> <p>There is likely to be an increasing demand for the high efficiency, low (even zero) emissions features offered by fuel cells. This could help offset the greenhouse effect.</p> <p>Obstacles remain in fuel cell technology – particularly on-board hydrogen storage.</p>
ENCOURAGING ALTERNATIVE MODES	Largest gains in energy efficiency can be obtained by switching as many trips as possible from cars to public transport, or even better, to cycling or walking trips.	
Bicycles	<p>The bicycle is probably the ultimate clean transport technology.</p> <p>Human powered vehicles (e.g. bicycles) could account for a considerable proportion of inner city trips. A fleet of bicycle rickshaws is used for tourism in Berlin.</p> <p>Conventional policies are provision of physical measures - cycleways and cycle lanes e.g. National Cycling Network. Newer ideas include automated smart-card operated bike pools.</p>	<p>Main technological challenge is devising ways that bike use can be expanded.</p> <p>Widespread use of bicycles is unlikely to be a panacea for all urban transport problems! However bicycle travel could make a big impact in a small area.</p> <p>A significant barrier to cycle use is the danger of traffic. Road accidents might increase if cycling increased – need to promote safer cycling conditions.</p> <p>Adapt existing road space to provide more cycle facilities. Incorporate cycling facilities in land-use design.</p> <p>Increase provision of secure parking for cycles. Improve interchange facilities with other modes.</p>
Walking	<p>Walking has a major role in transport (more than an 25% of all journeys) particularly for short journeys.</p> <p>Walking has declined over past years because more people have cars and walking is unpleasant in congested streets. Also there are security issues.</p> <p>There are a number of practical actions that local authorities can take to promote walking⁹ such as reallocating road space to pedestrians. Pedestrian crossings are important to ensure people can cross roads safely. In urban areas pedestrian schemes have helped to make the environment more pedestrian friendly.</p>	<p>Need to improve conditions for walking such as “Safe Routes to schools”.</p> <p>There are road safety implications from promoting walking.</p> <p>Reassess how urban centres are designed making them more attractive for walking.</p> <p>Tackle fear of crime – e.g. CCTV in town centres.</p> <p>There are health benefits from walking more.</p> <p>Encouraging more people to walk will not have much impact on levels of congestion or global warming etc, although there could be local benefits e.g. around schools.</p>
TRANSPORT AND TRAFFIC	Traffic and transport management techniques aim to improve the efficiency (achieve energy savings) and environmental impact of road traffic and public	Most methods and techniques for transport and traffic management are well known. At local levels there is a need to disseminate good practice.

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MANAGEMENT TECHNOLOGIES	<p>transport primarily in urban areas. Present systems rely heavily on advanced transport telematics (ATT). The THERMIE projects ENTIRE¹⁰ and ENTRANCE¹¹ provide some good examples of innovative schemes. The aims are to achieve energy savings through a reduction in veh-km, greater fuel economy, and use of alternative fuels.</p> <p>ATT traffic control and management systems include for example;</p> <ul style="list-style-type: none"> • Road and congestion pricing, • Adaptive traffic light systems e.g. for bus priority • Advanced systems for traffic management on motorways • Dynamic traffic guidance systems • Real-time Parking information systems – to help reduce city centre car traffic searching for spaces etc. <p>ATT technologies for public transport management include:</p> <ul style="list-style-type: none"> • Operational control systems for fleet management • Communication systems for services on demand e.g. in rural areas • Real time advanced traveller information systems • Advanced payment systems <p>Increased efficiency in freight transport relies on better fleet management through technologies such as computerised vehicle routing, scheduling and electronic data interchange etc.</p> <p>The important new technologies in rail systems involve more efficient traction equipment and applications incorporated into new operating systems.</p>	<p>Efficiency gains will quickly be eroded by traffic growth unless other policies are implemented.</p> <p>Although the individual ATT technologies are well developed, current problems are system integration and interoperability. Communication protocols and standards are the main technical barriers to deployment of these technologies.</p> <p>Regions/ cities need to develop an overall blueprint for a sustainable transport system. ATT applications cannot be developed in isolation and must be form an integral part of the urban planning process.</p> <p>Integrated quality is only achieved at a city level by collateral/collective effect from packages of different measures.</p> <p>High level political support is necessary to see projects through. Public acceptance is also essential.</p>

Other relevant factsheets

Environmental concerns

Vehicle design and technology

Emerging concepts and technologies

References

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- ⁹ DETR. “Encouraging walking: advice to local authorities”. Mar 2000.
- ¹⁰ EC ENTIRE Project. “European Network for Innovative Transport Technologies for the Rational Use of Energy”.
- ¹¹ EC ENTRANCE Project. “Systems for more efficient use of Urban Transport”.