TRANSPORT AND ENERGY IN BRITAIN AND HUNGARY–A COMPARISON

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Summary

Global oil reserves are projected to be exhausted during the next century and are distributed unevenly. Economies which are heavily dependent upon oil will face severe disruption before then, as prices rise. Transport systems are heavily dependent upon oil.

Britain and Hungary face this future problem from initially different but converging positions. At present Britain produces enough oil for home consumption but has a high level of car ownership and use. Hungary has a lower level of car ownership but is rapidly catching up with Britain. Hungary also has to import over 80% of its oil needs. By the turn of the century both Britain and Hungary will have to import their oil from a volatile and competitive world market.

The paper explores ways in which transport systems can be made more energy efficient and less oil dependent. It identifies a limited scope for improving the energy efficiency of cars and concludes that oil demand will increase because the number of cars and car traffic will rise faster. It proposes that incremental policies be introduced to switch traffic from energy inefficient modes of transport to efficient ones and to invest in oil independent technologies. The paper recommends a switch to electrified public transport for passenger traffic, and to rail or water transport for long distance freight traffic, with local distribution by electric road vehicles.

Introduction

One of the most important economic and political problems today is to create an efficient strategy to control long-term energy consumption. A significant part of this consumption occurs in the transport sector which is heavily dependent upon oil. Therefore an analysis of the relationship between energy consumption and the structure of the national transport system will help to establish a reliable decision making process to guide long-term planning and investment in the transport system and its infrastructure.

Although the British and Hungarian energy situations seem at first sight to be very different there are some important similarities and analogies. For the present Britain is fortunate in being self-sufficient in oil but has a high level of car ownership and use. British oil reserves will be exhausted by the turn of the century. On the other hand Hungary has to import over 80% of its oil demands but has a relatively lower level of car ownership and use.

This paper shows how, on the one hand, today Hungary is close to Britain in the past, and on the other that traditional Hungarian aims for

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urban transport may be good examples for British policy makers for the future development of cities. Finally, from different sides, Britain and Hungary face identical future problems and shared experiences may be of mutual benefit.

We hope that the recommendations originating from this analysis, of the similarities and dissimilarities, of the relationship between energy and transport, will be useful to transport engineers and planners, transport policy makers and vehicle manufacturers in both countries.

Traffic and the Growth of Mobility

Britain

Car Ownership

Car ownership began to grow strongly from 1930 and by 1950 there were two million cars, or 4 cars per 100 people. From 1950 to 1960 the number of cars in Britain doubled to four million and then again to 8 million by 1970. Since 1970 the growth of ownership has been slower but none the less stood at 14 million, or 25 cars per 100 people, in 1982. Some 56% of British households have at least one car but ownership is not uniform, with higher levels in the south of England and rural areas where the average is 33 cars per 100 people, with 80% of rural households having a car. Car ownership is lower in the north of Britain and in the large cities of Edinburgh, Glasgow, Leeds, Liverpool, Manchester and Newcastle upon Tyne, averaging only 12 cars per 100 people, with less than 40% of households having a car.

Car use

Accompanying the growth of car ownership has been a sevenfold increase in car use. In 1950 public transport was more important for passenger traffic than private cars, with 130 and/or 50 giga passenger km per annum. By 1960 private car traffic had overtaken public transport with 150 and/or 120 giga passenger km pa. Since then private cars have been the most important transporters of people. In 1983 public transport carried 100 giga passenger km, while private cars carried 350 giga passenger km.

Role of cars

The growth in the ownership of cars has taken place at the same time when the average journey length and the annual average distance travelled by cars has also increased, standing in 1982 at 16,000 km pa. The private car has enabled people to increase their travel speed, so that journeys can be made more quickly and a larger area opened up for shopping, social, leisure and other activities. Car have also enabled people to live at locations independent of their work. The growth in car ownership has meant a change in the method of travel to work, and now the national average of all journeys to work by car is over 60%. In Britain, for journeys over 2 km in length cars are the dominant method of transport, accounting for 85% of all travels. Buses carry 8% and railways 7%.

Road Network

The growth of car ownership has been instrumental in the construction of new roads, including a motorway network covering the centre of Britain with a total length of 2500 km. First class roads have also been improved to dual carriageway standard, with a total length of 90 000 km, complementing the motorway network by acting as its feeder and distributor. In 1950 there was a total road length of 270 000 km, or 135 metres per car. By 1982 the road network had grown to 300 000 km but the length of road per car had fallen to 21 metres. High standard roads are only 30% of the length of the whole road network but carry 70% of the total traffic.

Road Freight Transport

Parallel to the growth of car ownership there has been a growth in road freight haulage. In 1950 railways carried about 250 million tons pa., a total higher than the freight transported by road. In 1982 railways carried only 140 million tons, 10% of the national total, while about 1250 million went by road. Because the average rail transit is nearly twice as long as by road, rail carried 20% of the total freight ton-km, with roads carrying about 80%. To carry this increasing freight by road there has been a growth of the commercial vehicle road fleet, with the fastest growth being in heavy goods vehicles of over 20 tons gross weight. The present maximum weight is 38 tons on five axles. There are 3 million commercial vehicles of which about 500 000 are over 30 ton gross weight. The growth in road freight traffic, which has been made possible by the improvement of the strategic road network, has led many industries to close branch factories and branch out nationally from single plants near the centre of England.

Traffic Congestion

The growth of the total road fleet to 17 million vehicles, or 18 metre of read per vehicle, has created considerable congestion problems, both in urban areas where there is a concentration of activity but also on the inter urban motorway network, where 3 traffic lanes in each direction are not enough to meet the weekday demand. Steps are being taken to increase the capacity of motorways further and to construct by-pass motorways. The worst affected motorways are: M1 London to Birmingham, M4 London to Cardiff, M5 Bristol to Birmingham and M6 Birmingham to Preston. This does not take into consideration seasonal congestion due to holiday traffic which affects the M5 south of Bristol and the M6 north of Preston.

In urban areas there have been road improvements and construction of motorways to increase capacity. However, the construction of motorways is very disruptive to the urban fabric. Most of the traffic growth has been accommodated by traffic management techniques, with networks of computer controlled traffic signals, parking controls with space limitations and parking tariffs to discourage peak period use. [Department of Transport 1983.] [3]

Hungary

Car Ownership

Car ownership did not begin to grow strongly in Hungary until after 1960 when there were only 20 000 cars, or about 0.2 per 100 people. By 1970 the car fleet has grown to 250 000 or 2.1 per 100 people. Between 1970 and 1980 there was a rapid and consistent rise in car ownership of about 83 000 new cars per year, so that in 1980 there were over one million cars, or 9 per 100 people. In 1983 there were 1,258 million cars in Hungary, 11.6 per 100 people, and 35% of households had a car.

A recently announced forecast (Forró, 1984) [5] is that car ownership will rise to 1775 million by 1990, which is an annual growth rate of about 82 000, only a little below that enjoyed during the 1970s. By 1990 43% of households will have a car.

Car Use

Although relative to income the price of petrol in Hungary is higher than in Britain (1 litre is 0.41% of the average monthly wage in Hungary and 0.08% in Britain), it is clear that car use has been rising at least as fast as car ownership, with an annual average use of 12 500 km per car in both 1981 and 1983. This gives a national total use of 13.82 giga km in 1981 and 15.73 in 1983. Assuming an average of two persons in each car, 31.46 giga passenger km were transported by private car in 1983, compared to 40 giga passenger km by public transport. Therefore in terms of the balance between public and private transport, Hungary is in a similar position to Britain in 1950.

Role of cars

There is no available data over a long time scale to indicate how car use has changed, although for the past four years, the annual use per car has remained static. It is difficult therefore to determine whether this will continue, and how much it will depend upon the real price of petrol and the perceived cost of alternative methods of transport.

For families with a car, it confers considerable benefits; increased journey opportunities, the ability to carry heavy loads easily and to be able to go when and where public transport does not conveniently go. These are real benefits and ignoring the economic and social status that car ownership confers, it means that car users will be 10th to give up using their cars, unless the alternatives are very much better.

If the experience of Britain is a guide, car use will not decrease significantly should petrol prices rise. Car owners will forego or defer other expenditure in order to retain the benefits of car use. This points is very important when considering ways to affect the balance between public and private transport.

Road Network

During the decade of rapid growth in car ownership from 1970, a network of motorway roads has been constructed. In 1970 there were 8 km of motorways. In 1980 130 km and by 1983 167 km had been built. There were also 79 km of other high standard roads. Over and above these there are 1934 km of other first class and 4438 km of second class roads. Thus there are 2180 km first class roads, 7% of the national road network of 29 684 km. First and second class roads form 22% of the total. Inspite of the construction of motorways, the national road network grew by only 144 km, 0.5%, between 1970 and 1983.

In terms of capacity there were 124 metres of road per car in 1970 but only 29 metres in 1980. In 1983 this figure has declined further, to 24 metres. Therefore comparing the road networks and private car fleets, Britain and Hungary have an almost identical traffic density.

Road Freight Transport

Side by side with the growth of car ownership there has been a rise in the importance of road freight transport. During the decade between 1970—1980, road transport became dominant, from carrying 54% of the freight in 1970 (152 million tons), to 60.5% in 1980 and nearly 62% in 1983 (235 million tons). At the same time rail freight has fallen from 42% to 32.5%, with a total of 124 million tons, about half the freight carried by road.

The average rail freight transit is over 6 times as long as that by road, 186 km and/or 28 km by road in 1983. Rail was therefore more important in terms of ton/km, with 56% of the total in 1983 (23.1 giga ton/km). However this is a substantial drop from 75% of the total in 1970. This decline has been consistent. By comparison, road freight traffic has increased threefold to 6.5 giga ton/km in 1983. This was a steady rise.

To carry this increased road freight traffic, the goods vehicle fleet has nearly doubled: from 74 487 vehicles in 1970 to 129 605 in 1983. The majority of this increase has been in trucks, since dumpers, road tractors and special purpose vehicles declined from 74 000 in 1970 to 44 000 in 1983. Should this trend continue, by 1990 Hungary will have a freight transport system nearly as heavily dependent upon roads as Britain.

Traffic Congestion

The growth of the total Hungarian road vehicle fleet to 1,668 million in 1983, with 18 metre of road per vehicle, represents a density which is the same as in Britain. However, the ownership and use of cars is concentrated in the main towns and cities, and here there is already widespread congestion during work days. Measures to accommodate increased car traffic, principally traffic management have barely coped and in future only increasing road capacity can prevent more worsening congestion. Parking also creates problems since in most places, demand exceeds supply and some congestion is caused by cars seeking parking space, and by parking which partly blocks the highway. The provision of off-street car parking would help to reduce this problem and release road capacity for the flow of traffic [7, 10].

Comments

Starting from a lower base, Hungary is rapidly catching up Britain in terms of vehicle ownership and use. For passenger travel, cars will soon carry more traffic than public transport in both Britain and Hungary. In terms of freight, rail is still more important than road in Hungary but there has been a steady decline in rail use and an increase in road freight traffic. If this trend continues road freight may be more important than rail before the end of the century, as it already is in Britain.

Energy use in Transport

Transport is an energy intensive sector of the economy, both for infrastructure construction and vehicle operation. Oil is the dominant energy source. The prospects of alternatives to be available do not seem advantageous

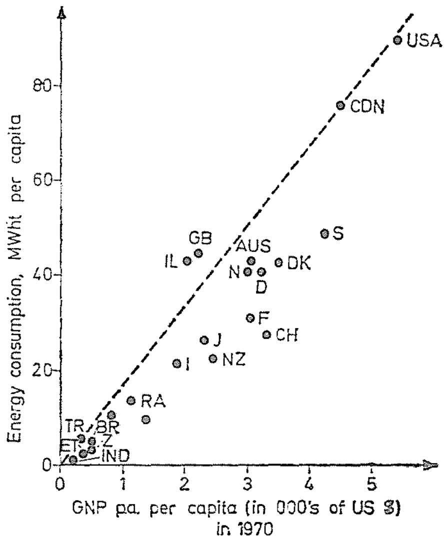

Fig. 1. International comparison between energy consumption and G.N.P. in 1970

before the turn of the century. One report suggests that global oil reserves may be exhausted by 2005 (Ford 1982). [4]

Britain and Hungary have advanced economies highly dependent upon transport. By the turn of the century there could be serious problems due to the availability of oil. As national output rises, energy consumption can also be expected to rise (Fig. 1).

Energy in Britain

Britain is fortunate in producing more oil from the North Sea fields than is consumed by its economy. Oil production began in 1973 and grew quickly so that the output exceeded the demand of the transport sector by 1975. Oil production is anticipated to reach its peak in 1985 and by 1998 be insufficient to supply an increased demand from the transport sector (Fig. 2).

At present transport is heavily dependent upon oil, which supplies over 99% of the energy consumed. Electricity supplies the rest, for use on railways and special road delivery vehicles. The energy efficiency of the transport sector is low, 77% of the energy consumed is wasted (Fig. 3). This compares with a 25% waste in industry and a 40% waste in the domestic and commercial sectors. However the highest absolute waster is in electricity generation.

With a growing demand for energy, particularly oil, and the decline of oil production from the North Sea, projections have been made for the British energy gap which will appear after the turn of the century (Fig. 4). Various

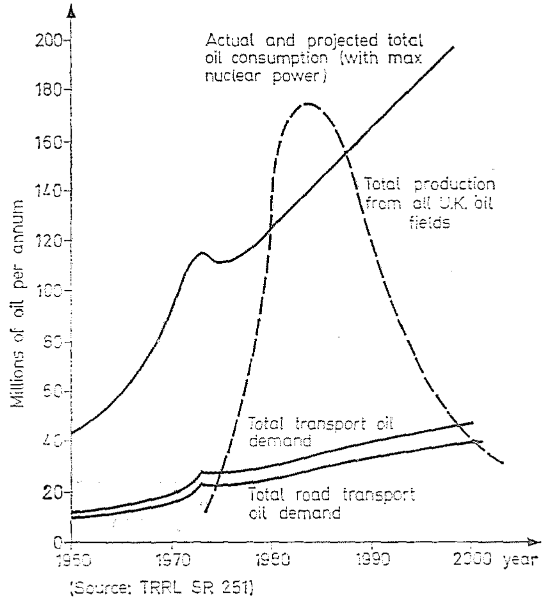

Fig. 2. Oil production and consumption in Britain

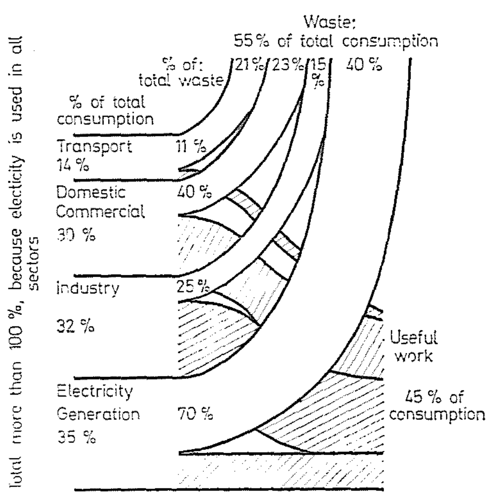

Fig. 3. Energy efficiency in the British economy

proposals were put forward to fill this gap, including the importation of energy. The British Government plans to increase the production of electricity through Atomic Power Stations by eight times. However, more electricity will not help the transport sector unless it can be used to release oil, presently consumed in other sectors.

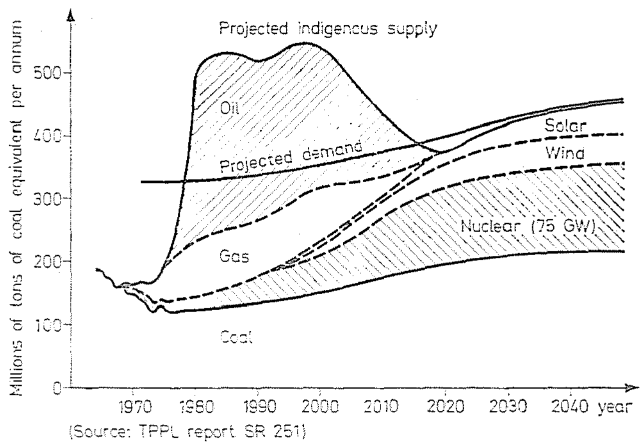

Fig. 4. Projection of future energy demand and supplies from indigenous British sources

Another proposal (Chapman 1976), [1] based on the principles of conservation, seeks to waste less energy by the better insulation of buildings, new technologies and in transport by more efficient engines, etc. Such a strategy would allow the G. N. P. to rise by 50% in the year 2000, with no increase in energy consumption. Two sectors are particularly energy wasteful; transport and electricity generation. It may be possible to improve the efficiency of electricity generation by using the waste heat from Power Stations to heat buildings presently using natural gas, which could then be used to power transport.

The road sector uses 90% of all the energy consumed by all forms of transport in Britain, and virtually all was provided by oil. Cars use 70% of the energy consumed by the road sector, and 60% of the total. In 1980 the car fleet averaged 9.4 L of petrol per 100 km. Vehicle manufacturers aim to improve this 5.6 L per 100 km by the turn of the century. However, an improvement in vehicle efficiency will be counteracted by the projected increase in the size and use of the vehicle fleet. Thus the demand for oil for road transport will continue to rise, although more slowly than earlier. At present there is no convenient alternative fuel to oil which can be used in internal combustion engines. Nor does there seem to be any other system available which is not oil dependent. It may be possible to electrify transport but for this to be practical for road vehicles new, higher capacity batteries are needed.

Energy in Hungary

Hungarian oil fields produce 17% of the internal demand for oil. The other 83% is imported. At present the car fleet consumes annually some 1.2 million tons of oil, or 60% of domestic production. In total oil represents only

18% of the total Hungarian energy consumption but of the oil, petrol is 47%, diesel 24% and heating oil 30% of the total.

About the entire energy consumption — management industry uses 44%, agriculture, forestry and water 8%, the general public 28% — some of which is petrol to power cars, and transport, postal and telecommunications: 6%. The Hungarian economy is much less dependent on oil than Britain, where oil provides nearly half the energy consumed. However, the major proportion of oil consumption in Hungary, over 70%, goes into the transport sector, compared to only one third in Britain.

Given the projected rise in car ownership and anticipated usage, oil consumption in the transport sector will continue to rise and by 1990 cars may consume 20% more than can be produced from Hungarian oil fields. Because of the relative youth of the Hungarian car fleet new, more energy efficient cars are unlikely to reduce significantly the energy consumed at a short term. So, the prospects to the end of the century are for oil consumption in transport to continue to rise, then plateaux and possibly, decline slowly.

Discussion

Global oil reserves

By the turn of the decade Britain will no longer be able to produce enough oil indigenously to meet demand, and by 1998 oil production will not even meet the demand of the transport sector. This is the position Hungary currently faces, having to important over 80% of its oil needs. Oil reserves globally are not distributed uniformly and as the world economy grows the demand for oil will increase more quickly in the developing countries than in the industrialised ones. A quarter of the global oil reserves are in the Middle East, an area which is politically unstable. Therefore before the turn of the century Britain and Hungary will both need to buy oil from a very competitive market.

This pessimistic picture could be brightened by the discovery of further oil fieds, like Alaska in the 1950s and the North Sea in the 1970s. However, any new fields will be more expensive to exploit than existing or exhausted fields. So even if global supplies can be increased to provide oil further into the 21st century, the real price of oil will increase to cover the cost of extraction from more difficult and isolated locations. This prognosis was discussed by Meadows et al. in 1971. Their conclusion was that oil will rapidly become both more difficult to obtain and expensive, that oil reserves will be exhausted before the middle of the next century by the most optimistic forecast of reserves, and that this process will be progressive.

Alternative energy sources

Work is in progress to find substitutes for oil. It is generally easier to find replacements for stationary than for mobile uses of oil. For example the heating of buildings can be converted from oil to gas, coal or electricity. Of the known alternative fuel sources, coal and nuclear power seem at present the most practical. Coal represents 60% of known and 80% of probable global fuel reserves. Nuclear power has considerable environmental problems in containing radioactivity and is also limited to only three fuel suppliers: Canada, Namibia and the U.S.S.R. Unless fusion reactors, which convert hydrogen into helium like the process that heats the sun, can become practical, fission reactors which burn uranium are likely to be difficult to exploit further.

Oil substitution

Most of the practical energy sources are suitable only for generating electricity which cannot at present be used in most of the transport sector. There are developed processes for producing oil-like liquid fuels from coal, wood, rubbish and plant materials, or methanol by the fermentation and distillation of carbo-hydrates. However, these processes have conversion efficiencies of less than 50%, would require a high investment in refining capacity, would be more expensive than oil for the medium term future and when used in internal combustion engines would significantly reduce overall fuel efficiency.

Electricity is an alternative energy source for transport (Chapman et al. 1977) [2]. The overall energy efficiency is twice as good as potential oil substitutes, it will make use of existing electricity generating capacity and will improve overall generating efficiency both on a daily and yearly basis by increasing the proportion of base load to peak. Electric vehicles are quiet and non-polluting. Unfortunately, the biggest users of oil in transport are cars. The equivalent range of a tank of petrol needs a battery system that is not yet available.

The Ford Energy Report identifies that for the American market, presently available battery technology could provide acceptable electric cars to replace the second car, and would meet 90% of all journeys made by all cars. It is however the 10% of journeys longer than present battery range which makes the electric car unattractive.

The position of goods vehicles is similar, with a substantial proportion of present haulage suitable for electric operation. Indeed in Britain there are over 60 000 battery electric vehicles used for the local delivery of goods. Long distance road haulage will for the foreseeable future be based on oil.

For public transport electrification is at present practical for most operations, but not necessarily economic, as fuel in only about 10% of total costs. However Harrison, in 1983, found that under British conditions, urban bus routes with a frequency of more than 6 per hour, are already economical to be converted to trolleybus operation, with reduced maintenance costs and increased vehicle life. Hybrid buses could be used to extend the range of operations from a trolleybus network. For railways, electrification is proven, well developed and requires but investment funds for implementation.

Other approaches

The problems of the transport sector, faced with declining oil availability and higher prices, can be considered from three other perspectives:

First. Technical development in the design and construction of engines will improve overall fuel efficiency by burning more of the input fuel or being able to use lower grades. However, the ultimate theoretical efficiency of internal combustion engines is only 35% and approaching it will at best reduce energy consumption by no more than 10%. Investments to develop more fuel efficient internal combustion engines is likely to delay the development of other energy systems.

Second. Other aspects of vehicle design and use can also be improved. For example, new gearboxes and transmission systems, wheel and tyre design, an aerodynamic shape and reducing vehicle weight would all help to improve energy efficiency. One of the more elusive methods would be to re-use some of the energy that is presently lost during braking. This is especially important in urban areas where vehicles frequently have stop and start. Electronics can be used to ensure that engines work in their optimum speed range and guide the driver to improve his practice. Drivers affect fuel consumption and better driving techniques would reduce fuel use. Altogether these could save between 20—30% of the total energy used.

Third. The operating environment and traffic organisation can be altered to reduce energy consumption. Better road traffic control will ensure the smoother running of vehicles and less fuel will be wasted in stopping and starting. Priority can be given to modes of transport that are fuel efficient, e.g. bus over car. Fiscal policies may be put to encourage the use of energy efficient modes and discourage inefficient ones. Better organisation in the freight sector could improve the load factor of goods vehicles, presently under 50%, and so reduce the number of journeys where goods vehicles are partly or completely empty. Where rail is available the transfer of freight from road would improve energy efficiency, since rails is twice as energy efficient as roads. And lastly a long term investment strategy should be aimed at improving energy efficiency and reducing oil dependence. The total savings from these approaches could be up to 40%.

Conclusion

For at least the following decade Britain and Hungary will have transport systems that are heavily dependent upon oil. Decisions made now on investment and fiscal policy will have a profound effect upon energy demands, especially for oil, at the turn of the century, when oil supplies are likely to be rather poor. The best strategy would appear to be to encourage transport systems that are or can easily be made independent on oil.

Implications for vehicle manufacturers

Private Cars

Given the global reserves of oil, the internal combustion engine car is likely to be obsolete by early in the next century. Car builders are looking for a substantial improvement in the performance of batteries to make the alternative electric car practical. The lead-acid battery is likely to be developed with double the present performance but that would still be less than the range of a petrol tank. The most promising new battery system seems to be the sodium-sulphur battery with a performance at least six times that of present lead-acid batteries (Lafferty 1982) [8]. In the meanwhile, manufacturers should reduce the deadweight of cars as an effective way of improving fuel efficiency.

Goods Vehicles

Goods moved by road are presently less energy efficient than by rail or water transport. Energy consumption could be reduced by transferring freight from road transport. However a substantial proportion of freight will continue to be distributed and collected by road. These are essentially short journeys and should be within the capability of battery electric vehicles. In urban areas and for servicing rail heads and water ports, electric goods vehicles are likely to become important. The financial penalty represented by the cost of the batteries, which makes the purchase price of electric vehicles higher than oil engined ones, could be solved for example by leasing or hire purchase arrangements.

Public Transport

For railways only funds are needed to convert to electric operation, the technology is well tested. For buses the picture is different. It is likely that when oil nears exhaustion public transport will be a priority user. However, as the discussion above indicated, the price of oil will increase substantially in real terms before then and will become a significant cost item in the near future. Therefore bus operators will want more fuel efficient buses. These need to be lighter, and have better engines and transmissions. On intensive urban services trolleybuses may already be economically viable and perhaps operators should begin programmes of conversion. There should be no reason why a mass produced trolleybus should cost more than a diesel bus. But there does remain the cost of the power supply system. Here perhaps new institutional arrangements may be needed, with electricity generating undertakers providing the overhead system and reflecting the capital cost in the electricity tariff. This would be the equivalent to the Highway Authority providing the roads that buses run on.

Lastly if passengers must be transferred from cars in order to reduce oil consumption, then public transport vehicles must be attractive, comfortable, easier to get on and off, more quite and with a good chance of getting a seat. The introduction of bus priorities and good management should ensure that buses are frequent and reliable.

Conclusion and Recommendations

The paper has shown that the future availability of oil will be crucially important to the continued operation of the transport system. However, before oil nears exhaustion, transport operators will face significant cost increases. Unless transport systems can reduce their dependence upon oil both Britain and Hungary will need to import substantial quantities before the turn of the century. This oil will need to be bought from a volatile and competitive world market. A transport system dependent upon oil will cause serious distortions to the domestic economy both because of the cost and balance of payment problems, but also because of the vulnerability of the economy to a disruption of oil supplies.

It would seem sensible to encourage and invest in technologies which make vehicles generally more energy efficient and less dependent on oil. Also people should be persuaded to make some or all of their journeys by public transport instead of using cars. Freight should be switched from road to rail or water transport. If this is begun now and continuously extended it would cause little disruption to the economy and have significant long term benefits by reducing total oil consumption in the transport sector.

Another policy must be to develop oil-independent power systems and methods of transport. In this the electrification of railways and urban public services seems practical and realized over a certain period would have a low capital requirement.

Bus and goods vehicle manufacturers must develop electric vehicles for urban use, since well before oil is exhausted its price will have risen to a level preventing its use in large areas of transport. Urban transport can easily be electrified. For many goods vehicles existing battery technology is adequate and in some areas it might even be possible to use it in the electricity supply of trolleybuses.

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