Melbourne suburbs sprawling into the distance from the central Royal Botanic Gardens.

Saving fuel in cities

With the price of petrol and other liquid fuels rising inexorably and the possibility of future shortages looming, the search has begun in earnest for ways to cut down on consumption.

Cars are among the biggest consumers, and people can save a lot of fuel by choosing models with the smallest thirsts. City planners can help by locating houses, shops, factories, and so on in ways that reduce the need for long car trips, and by designing road systems that do not produce petrol-guzzling, stop–start motoring.

The need to conserve liquid fuel is becoming increasingly clear. Australia's degree of self-sufficiency in petroleum supplies is falling, having peaked at about 70% a few years ago. By the end of the century — just 22 years away — we will probably be totally dependent on imports, and petroleum may well be in short supply throughout the world. Alternative liquid fuels, notably oil made from coal, may help meet the demand, but they will not be cheap or available in unlimited quantities.

According to the latest statistics, just over half of Australia's oil-derived energy powers road transport. Vehicles that move people — mainly cars — account for about 70% of that energy, and about 70% of the energy used in passenger vehicles is consumed in our cities and suburbs.

The biggest users of fuel are potentially the biggest conservers. So, much attention is being given around the world to prospects for reducing the amount of energy used by city road transport.

Two CSIRO groups in Melbourne are among the research teams looking at aspects of the problem. At the Division of Building Research, Dr Ron Sharpe, Dr John Brotchie, and Dr Ray Toakley have used computer-modelling techniques to look at the effects of possible future development patterns on the amount of energy used for transportation in Melbourne. The other group — Mr Mike Wooldridge, Dr Ron Johnston, and Mr Ros Trayford, of the Division of Mechanical Engineering — has begun a project aimed at assessing the possibility of using traffic management techniques such as linked traffic lights and priority lanes to save fuel.

Despite its convenience, the private car is a most inefficient means of transport.

Cars inefficient

Figures gathered by the Building Research scientists illustrate the dominant role of private vehicles as energy consumers in city transport. In Melbourne in 1976, trains, trams, and buses used an estimated 16 TJ (terajoules, or 10^{12} joules) per day — less than 5% of the scientists' estimate of total energy consumption by transport in the city (396 TJ per day).

Dr Sharpe and his colleagues point out that, despite its convenience, the private car is a most inefficient means of transport. The average car spends only about 3% of its life in motion, and when it moves it expends much more energy on moving its own bulk (averaging about 1500 kg) than on moving its payload (averaging about 1·5 people weighing perhaps 100 kg).

Cars also take up a lot of space; in fact the scientists estimate that as much as 35–45% of urban land is devoted to them. This is land used for roads and driveways, parking areas, car-associated industries, and petrol and service stations. If less land were devoted to the car, the scatter of houses, shops, work places, and schools could be reduced. This would lessen the distances people need to travel.

However, there is no question that travel by private car has many advantages that people would not readily forgo — like being able to go directly where they want when they want to go there. The scientists assumed an important continuing role for the car in their modelling exercise, which looks at various scenarios for the development of Melbourne up to the year 2000.

Alternatives

The model they used is TOPAZ, developed nearly 10 years ago by Dr Brotchie and Dr Sharpe and since used in many planning exercises. One of the most important was a study of alternative corridor growth patterns for Melbourne, done in collaboration with the Melbourne and Metropolitan Board of Works (MMBW). The scientists used information gathered for that study, which sought to identify the most economically favourable development plan, in their energy study.

What TOPAZ provides is a broad picture of the costs and benefits of alternative development strategies. These can be expressed not only in terms of economic factors such as construction and operating costs, but also in terms of pollution emissions, traffic energy consumption, and other variables.

The scientists first divide the area being modelled, in this case the Melbourne metropolitan area and the corridors designated by the MMBW as future growth areas, into zones. Then they feed into the computer data on such matters as the present and expected future development of housing, employment, shops, and schools. Data on transport patterns and aspects of the urban infrastructure such as road systems and water supply networks are also fed in.

The model is concerned with interactions; it shows, in broad terms, what effects particular developments will have elsewhere. For example, it can be used to compare the likely costs of providing electricity, roads, and public transport to serve different areas being considered for housing developments.

Dr Sharpe, Dr Brotchie, and Dr Toakley used the model, primed with data gathered for the earlier Melbourne study, to estimate energy consumption by private transport in the area in 1976. They were able to make a rough check of the figure produced (380 TJ per day) using statistics on annual petroleum consumption in Victoria. Starting with the assumption that *per capita* petroleum consumption is the same in Melbourne as in Victoria as a whole — as about 70% of Victorians live in the Melbourne area this should not be too wide of the mark — they came up with a figure of 330 TJ per day. They regard this as giving reasonable credence to the figure produced by the model.

Increases expected

Then they used the model to look at what might happen to transport energy use by the year 2000 if various developments occurred.

The first scenario they examined had the population remaining at the 1976 level of about 2·6 million and no further development occurring. However, present trends towards increased individual mobility were assumed to continue. The result was a quite substantial increase in energy use by private transport (from 380 to 460 TJ per day) and public transport (16 to 22 TJ per day). Part of the reason for the expected rise is the increasing average age of the population, putting a larger proportion in the car-driving age group.

The impact of any town planning decisions on transport-energy use will inevitably be slow and unspectacular.

Next they looked at various development patterns designed to cater for a population of 4 million at the turn of the century. Although a projection made as recently as 1971 put Melbourne's population in 2000 at about 4·5 million, 4 million is now seen as an upper limit that will probably not be reached.

The study predicts that if low-density development (detached housing on the normal suburban block) continues at the fringe of today's outer suburbs, energy use by private transport will rise to 700 TJ per day and that by public transport to 33 TJ per day. This represents an increase of 85% on the 1976 total. If new development is restricted to one sector of the outer fringe, the increase is still greater.

The study indicates that redeveloping the inner suburbs to cater for the increased population would be a better alternative in terms of conserving energy. The scientists looked at what would happen if the population density in these suburbs averaged 125 people per hectare, compared with the present average for the metropolitan area of about 25 per hectare. Private transport energy consumption came out at 680 TJ per day, 20 TJ less than the estimate for fringe development.

Incentives

The model indicates that considerably bigger energy savings could be achieved by adopting measures aimed at encouraging people to use public transport. Making public transport free would reduce energy use by private transport in the year 2000 to 640 TJ per day, if the assumptions fed into the model were borne out. Public transport would use 43 TJ per day, compared with 31–34 TJ per day in the absence of this incentive for people to leave their cars at home.

If a quadrupling of petrol prices were adopted as the incentive, energy use by private transport would fall to 620 TJ per day, according to the model. Public transport


A familiar Melbourne scene: cars use much more energy than public transport.

would use 52 TJ per day. The impact of introducing both free travel by public transport and a quadrupled petrol price would be quite substantial — the energy use estimates are then 560 TJ per day for private and 60 TJ per day for public transport.

The scientists looked at the effects of building satellite cities at the ends of the proposed development corridors to cater for the population increase. They assumed that, because the satellites would lack the diversity of an established city, especially in their early years, much travel would take place to and from Melbourne. This would occur despite efforts to make the satellites self-contained. The model's figure for energy use by private transport is 780 TJ per day, the highest for any of the alternatives considered.

In assessing the implications of these figures, it should be borne in mind that the model gives only an initial broad-brush picture of the likely effects of different development strategies on Melbourne's transport energy consumption. The model and data used embody many assumptions about the future that will need reviewing as more information becomes available.

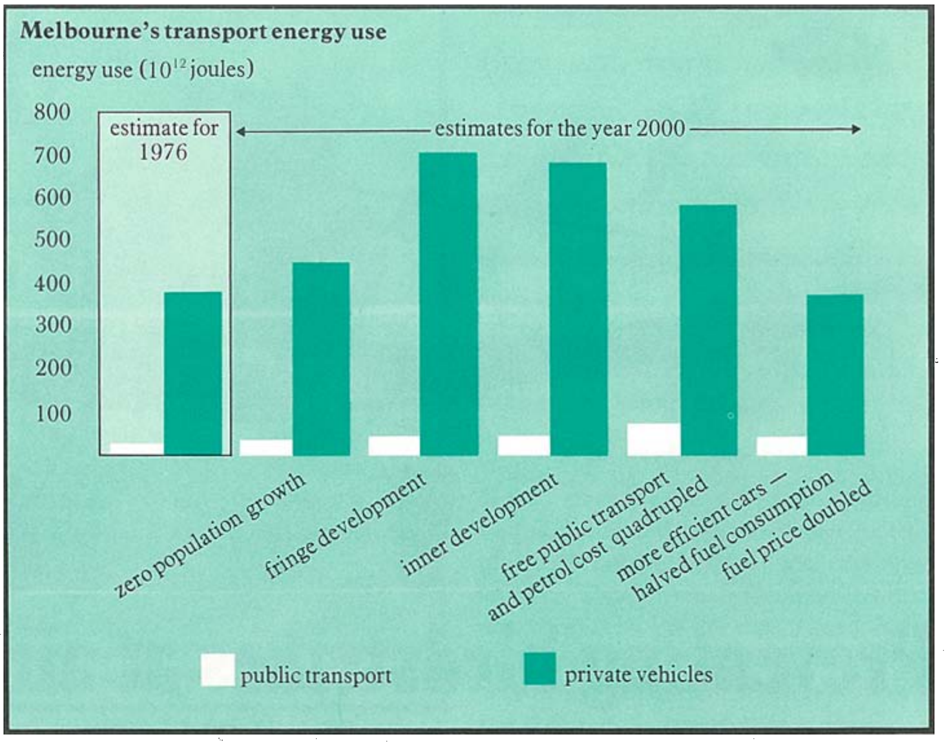
Unspectacular

The scientists point out that planning decisions at a local level, as well as major decisions on how a city should develop, can influence energy consumption. For example, savings should flow from siting high-density housing near railway stations and other public transport terminals.

However, the impact of any town planning decisions on transport-energy use will inevitably be slow and unspectacular. A city's transport system and housing are not things that can be altered radically in a year or two; the average life of a house at present is 40–50 years.

Changes in people's life styles could have a much more rapid effect. Between 1964 and 1972, the number of car trips the average Melbournian took per year to and from work remained virtually constant. But the average number of shopping and social trips almost doubled. If we went back to 1964 habits, much petrol would be saved.

Changes in car design and people's choice of models could produce even bigger savings. A United States study quoted by the Building Research scientists indicates that a combination of quite simple changes — including reductions in vehicle size, weight, and aerodynamic drag, and the use of gear boxes with infinite speed variations — could reduce fuel consumption by about half. But replacing the cars now on the road also takes time; in Australia the average life of a motor vehicle is 10–15 years.



Traffic engineering

Meanwhile, the Division of Mechanical Engineering scientists, in conjunction with the New South Wales Department of Motor Transport, have begun a project that they hope will enable them to recommend ways to reduce energy use by existing cars on existing city roads. They are concerned with the major arterial roads that carry most traffic; a recent Commonwealth Bureau of Roads study shows that just over one-fifth of Australia's city road length carries three-quarters of the traffic.

In an initial experiment with a specially instrumented car, the scientists found that the stops and starts of city driving can raise fuel consumption to as much as double that recorded when the car runs evenly. They also found a correlation between fuel consumption and a measure they term the 'acceleration index'. This is the number of times per kilometre that a car's changes in speed cause it to accelerate through any of a number of equally spaced constant speed levels such as 0, 10, 20, 30, etc. km per hour.

The scientists suggest that this index could be used to predict fuel consumption by vehicles in various city traffic situations. They plan to check the correlation between fuel consumption and acceleration index for common types of vehicle such as four-, six-, and eight-cylinder cars, and trucks and buses. They will also gather information on the numbers of vehicles in each category using one of Sydney's arterial roads.

With this information, they hope to be able to estimate the effects that possible traffic engineering changes would have on fuel consumption, as these changes would influence the average acceleration index for a stretch of road. Coordinated traffic lights reduce numbers of stops and starts; the research should show how significant this can be in terms of fuel conservation. It should also show what impact priority lanes — reserved for buses or fully occupied cars — can have on fuel consumption. In some situations they may increase it, because the setting-aside of a priority lane may mean that traffic will flow less smoothly in the remaining lanes.

More about the topic

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