ENERGY AND PUBLIC TRANSPORT - ARE POPULAR BELIEFS A MYTH?

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ABSTRACT: *In recent years there has been a popular belief that considerable savings of energy can be achieved by increasing patronage on public transport. However, because of the spatial development of Australian cities, public transport cannot be expected to increase its share of the passenger transport task to an extent likely to alter significantly current energy consumption levels.*

On the other hand, worthwhile savings can be achieved through such measures as improving the efficiency of the existing vehicle and the traffic system.

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ENERGY AND PUBLIC TRANSPORT

INTRODUCTION

In 1973/74 the Organisation of Petroleum Exporting Countries (OPEC) increased the price of crude oil by a factor of four and restricted exports. Other countries immediately became painfully aware of the extent to which they depended on oil and its derivatives in maintaining their standard of living and their life styles.

In Australia, transport is a major consumer of petroleum (57% of total consumption) and indeed of all primary energy (27%). Transport is almost totally dependent on petroleum fuel and while about 70% of needs are currently met from indigenous sources, this situation will change in the 1980's without substantial new discoveries to compensate for the drain on existing local wells. (Commonwealth/State Transport Secretariat-1978; Clark-1975; The Institution of Engineers, Australia-1977a; OECD-1978).

In common with other advanced countries, Australia has an urgent need to identify ways in which it can reduce its dependence on petroleum. There are a number of ways in which this might be possible (OECD 1978):

1. reducing the number of trips;
2. reducing the amount of travel for certain trips;
3. reducing vehicle trips without reducing the number of person trips or shipments;
4. improving the fuel efficiency of existing vehicles;
5. transferring travel to vehicles or modes which are more petroleum efficient;
6. transferring travel to non-petroleum modes.

Because public transport vehicles can carry many more passengers than are normally carried by private cars, it would appear to be a simple matter to reduce consumption of automotive fuels by transferring people from private cars to bus or tram/train services, and particularly to tram or train as these are powered by electricity.

Assuming an average fuel consumption of 12 litres/100 km for a private car and 35 litres/100 km for a 50 seat bus and assuming one person travels in the car and 50 travel in the bus, the respective fuel used per passenger-km is 0.12 and 0.007 litres.

However, there are a number of factors which reduce the apparent energy saving of energy strategies based on public transport. For example:

1. trains and buses are fully laden only for part of the journey in the direction of peak travel and carry less than full loads on the return journey and at other times of the day;

2. the total door-to-door journey is more circuitous when public transport is used;

3. the distance travelled on train or bus by individuals is only part of the total journey;

4. no allowance is made for empty running of trains and buses to or from depots;

5. the energy consumed in constructing the facilities and vehicles, maintaining lighting at stations, etc., can also have a marked impact on the energy equation;

6. public transport is unsuited for a large proportion of urban trips and many people cannot reasonably alter their travel habits to use public transport;

7. new or altered transport services can attract additional trip-making thus reducing the energy saving that might otherwise be achieved;

8. new rail systems can attract passengers from other modes which are more energy efficient, e.g., buses.

Many large cities have expanded their public transport systems or built new ones in recent years and as would be expected, the energy-saving potential of such systems has been examined closely in a number of countries.

ENERGY AND PUBLIC TRANSPORT

This paper refers to a number of reports, prepared in U.S.A., Sweden and Australia, and examines available travel data for Sydney to gauge the extent of likely transfers of trips from private to public vehicles.

UNITED STATES

U.S. Senate: A study prepared by the Congressional Budget Office for the Committee on Environment and Public Works, September 1977 concluded that for 'typical' conditions, rail rapid transit offered little aid to the nation's efforts to save fuel - *"the expenditure of federal funds on these systems for purposes of energy conservation appears to be misguided and possibly even counter-productive."*

Buses appeared to offer the greatest fuel savings, especially express buses and those services given priority in traffic (but see reference to Sydney's transit lane, page 12).

Automobiles were judged to require about twice as much energy per mile as do new rail rapid transit systems. However, the gap between automobile energy requirements and those of other modes will shrink as automobiles become more fuel-efficient under measures already introduced or under consideration. (Cars in Australia already consume far less fuel per kilometre on average than those in the U.S.).

Van pooling and car pooling hold the greatest prospects for reducing fuel consumption per passenger kilometre, provided the passengers are attracted from other cars and not from public transport. But experience to date suggests that these prospects will not be achieved and there will be relatively little energy saved at the national level.

Dial-A-Ride is the least efficient of all modes.

U.S. Department of Transportation: A study by the Transportation System Centre (1973) commissioned by the Department of Transportation examined the potential energy savings possible from different transport strategies, the time needed to achieve them and the investment capital needed. The saving achieved by shifting trips from car to public transport was only between 1.0 and 1.8% of total transport fuel (Table 1) and would require an investment of US$6,200 million - 1000% increase on the investment in existing facilities.

TABLE 1.

TRANSPORT ENERGY CONSERVATION OPTIONS

ACTION TO BE TAKEN	FUEL SAVINGS AS A PER CENT OF TOTAL TRANSPORT FUEL			ACHIEVEMENT TIME TO MAXIMUM SAVINGS	COST DIFFERENTIAL TOTAL INVESTMENT	
	Ultimate	In 15 Years	In 5 Years		$'s bil.	%
Increase car efficiency	20+	15.3	4.0	20 years	10	+20
Truck efficiency	5.4	5.4	2.2	15	3	+20
Reduce speeds	2.9	2.9	2.9	3	0.2	N/A
Carpooling to work	10.0	6.0	3.0	2+	N/A	N/A
Shift from car to urban transit	1.8	1.7	1.0	10	6.2	1000
Shift from car to inter-city bus/rail	2.9	1.3	0.5	15	6	600
Shift to bikes and walking	1.8	0.9	0.5	10	2	N/A
Shift from trucks to rail	1.6	0.6	0.3	15	15	50
Increase allowable truck loads	4.4	4.4	3.9	10	Negligible	N/A

N/A = Not available

SWEDEN

A study by the Royal Academy of Engineering Sciences (1977) examined the likely consequences for motor vehicles of different levels of growth in the national economy, shares available for private consumption and future supplies of petroleum.

In 1975, 12% of Sweden's total consumption of petroleum products was used for driving cars. Reducing this consumption by 10% - a considerable saving to achieve - would reduce total consumption by only 1%.

With long distances and a widely dispersed population, the conditions for profitable operation of public transport are worse in Sweden than in the more densely populated parts of Europe.

> *"The pattern of travel appears to be developing in the direction of a greater need for individual transport. Among the likely causes are residential sprawl, family members living and working at different places during the week, more women at work, increasing part-time work, and more individuals working at hours that suit them personally. Neither the present types of car nor the present systems of public transport appear particularly well fitted to such a development.*

One possibility assumed in the scenarios is therefore that the active members of the population will go in for more but smaller cars, while public transport (outside the central areas of the cities) will be developed to suit the needs of carless persons, such as the retired, whose numbers are increasing and who ought to have better opportunities for getting about and pursuing their activities.

"No matter whether it is regarded as good or bad, the trend therefore seems to be towards a state where car owning will still be a necessity, and where no real breakthrough for public transportation can be expected before the end of the century."

As far as freight was concerned, the study concluded that no other forms of transport could be substituted to any great extent for the highway truck.

AUSTRALIA

The Institution of Engineers, Australia: Investigations by the Task Force on Energy (1977) indicated that the potential energy savings appeared to be modest and capital expenditure substantial:

"A reduction of 50 per cent in consumption of oil-based fuels in private urban car usage alone has been estimated to reduce total oil energy consumption by only 8.5 per cent. A reduction in vehicle use of this magnitude is not likely to take place in the foreseeable future. Moreover, it is in the highly dispersed pattern of house to house visiting that public transport has the greatest difficulty in providing an acceptable level of service, at reasonable social cost, as an alternative to the private vehicle. If therefore, by some means (e.g., petrol rationing) the quantity of leisure motoring were reduced, the proportion of trips transferred to public transport would probably be relatively small, although shorter trips might be substituted. There is also some irony in this, since the private vehicle operates most efficiently under leisure motoring conditions of relatively low congestion and high vehicle occupancy. Furthermore, since about half of the vehicle mileage is described as being for leisure or personal social reasons, it may be assumed that this kind of automobile usage has a significant social value."

In the Institution's "Recommendations for an Energy Policy for Australia" (1977b) it was indicated that, in time, a 30% saving could be achieved in transport energy consumption without serious inconvenience to transport users.

In the immediate term, effort should be directed primarily at improving the energy efficiency of private motor cars by such measures as fuel economy standards, better traffic management, appropriate traffic planning and construction, car pooling, encouragement of alternative fuels or power sources.

Commonwealth Bureau of Roads: The Economic Research Unit (1975) in a report commissioned by the Commonwealth Bureau of Roads found that, even using optimistic assumptions, public transport could increase its share of the urban passenger transport task from 15% in 1975 to only 23% in 2005.

Based on current fuel efficiencies, the fuel saving would amount in 2005 to only 2% of the fuel consumed in the urban passenger task or less than 1% of total energy.

In its 'Report on Roads in Australia 1975', the Commonwealth Bureau of Roads (1975) provides the following information on the proportions of the land passenger transport task performed by private and public transport vehicles in Australia in 1973/74:

TABLE 2.

	MILLION PASSENGER KILOMETRES	%
Cars & station waggons	153,800	92.2
Road public transport	3,400	2.0
Rail	9,700	5.8
TOTAL	166,900	100.0

As can be seen from the magnitude of these figures, a very large percentage increase in public transport patronage would be needed to produce even a small reduction in use of private vehicles.

Australian Transport Advisory Council: The Commonwealth/State Transport Secretariat (1978) report "Transport and Energy Overview" prepared for Australian Transport Advisory Council lists a number of reasons why in Australia public transport cannot substitute for many trips now performed by private vehicles:

- 21% of daily vehicular passenger trips are either business trips or 'paid' work trips which involve company cars;
- a further 57% of vehicular passenger trips are for personal business, shopping or social purposes and in Sydney over half of these are less than 5 km in length;
- public transport is likely to provide an alternative to private vehicles only to major centres - in Sydney only 14% of work trips and 3% of total trips by private vehicle (including company cars) are to major centres (Sydney C.B.D., North Sydney, Chatswood, Parramatta);
- a heavy capital investment in rolling stock and infrastruction would be needed to provide the capacity to allow people the choice of transferring to public transport;
- rural areas account for more than half the passenger kilometres travelled and in these areas there is little choice of mode other than private vehicle.

The study concluded that:

"Investment in public transport facilities, particularly in urban areas, is not likely to be cost effective as a fuel conservation measure - major investment by the private sector will be needed for the development of more fuel efficient cars and alternative fuel production facilities."

SYDNEY'S TRAVEL PATTERN

Because of planning policies adopted in past years, the preference for single dwellings and the progressive increase in car ownership since the 1940's residential development in the Sydney region is widely dispersed at relatively low density. The planned decentralisation of employment growth away from the city centre to the suburbs has also had a major influence on daily travel patterns.

The development patterns reflect a wide range of underlying forces such as the preference for single-family dwellings and open space; lower land costs in suburban fringes; the availability of cars and roads; and many other social and economic trends that have brought about our existing life-styles.

Unfortunately these employment and housing development patterns are far from the optimum as far as transportation energy requirements are concerned.

The most comprehensive published information on the pattern of trips made by Sydney residents is found in the Sydney Area Transportation Study (1971). The Study found that on a normal weekday in 1971 almost 6 million trips were made by residents of Sydney and another 1 million by commercial vehicles.

In describing the pattern of residents' trips in a form which can be readily understood, it is convenient to consider it in three basic parts, namely, trips within the central business district, trips between the C.B.D. and suburbs, and the remaining trips made between suburbs.

Table 3 sets out the number of trips included in these three categories on a normal week-day, determined by the Sydney Area Transportation Study:

TABLE 3.

DAILY JOURNEYS BY SYDNEY RESIDENTS IN 1971 – S.A.T.S.

	NUMBER	%
Trips within C.B.D.	52,000	0.9
Trips to and from C.B.D.	585,500	9.8
Remaining (cross-regional) trips	5,317,800	89.3
TOTAL	5,955,300	100.00

Trips Within The C.B.D: Because there are so few people resident within the C.B.D., there are few trips which lie entirely within the C.B.D. The Sydney Area Transportation Study showed that the number of daily trips which lie entirely within the C.B.D. amounted to less than 1% of the total in the region.

It will be appreciated that if more people in the work force lived within the C.B.D., the demand for transport facilities would be reduced. Those working in the C.B.D. would generally be within walking distance of their jobs; those working in the suburbs could be using otherwise empty seats available on trains and buses returning after their trip to the C.B.D.

Trips To And From The C.B.D: Because of their concentration, trips starting or finishing within the C.B.D. are most likely to be satisfied by public transport.

Of the total daily trips by Sydney residents, only 585,500 or 9.8% are between a suburb and the C.B.D. Of the total number of trips associated with the C.B.D. throughout the day (including the 52,000 within the C.B.D) 62% are carried on public transport while 20% comprise car drivers and 8% car passengers.

However in the morning peak hour between 8 and 9 a.m., about 83% travel by public transport and less than 11% drive a car (Table 4).

TABLE 4.

PERSON TRIPS TO SYDNEY C.B.D., 8–9 A.M. – S.A.T.S.

	NUMBER	%
Train passengers	66,640	54.7
Bus passengers	26,981	22.2
Ferry passengers	6,743	5.5
Taxi passengers	345	0.3
SUB-TOTAL	100,709	82.7
Car (etc.) drivers	12,849	10.6
Car (etc.) passengers	6,178	5.1
Walk and other	1,969	1.6
TOTAL	121,705	100.0

This situation occurs largely because of the concentration of workplaces in the C.B.D. and the entensive radial railway system which has been in existence in Sydney since last century.

Cox and Fleming (1976) surveyed a sample of those commuters who drive to work in the C.B.D. (the 10.6%) and showed that there was very little scope for inducing such people to transfer to public transport, mainly because the car used is a business vehicle. In fact, it was concluded from the survey that 83% of the drivers had compelling reasons for using the car and were unlikely to transfer to public transport irrespective of any improvements which could realistically be expected in the public transport service (Table 5).

TABLE 5.

N.R M.A. SURVEY – USE OF CAR BY SYDNEY C.B.D. COMMUTERS

Drivers with "Compelling" Reasons for Using Car:

	PERCENTAGE
a. Car used during day	59.2
b. Subsidised cars not included in "a"	11.5
c. Public transport inadequate outside peak hours	4.1
d. No public transport in area or several transfers needed	4.2
e. Health and other reasons	4.4
TOTAL	83.4

In brief, then, the significant characteristics of this part of the daily transport task in Sydney, viz., the movement to and from the C.B.D., are that it amounts to only a relatively small proportion of the total task and most of it is already performed by public transport.

Trips Between Suburbs: These comprise almost 90% of the total daily journeys made by Sydney residents.

Because of the dispersed nature of their origins and destinations throughout the suburbs, they are not generally suited to public transport, particularly existing radial railway services, and as a result most of them are now carried by road vehicles (Table 6)

TABLE 6.

NON-C.B.D. DAILY TRIPS IN SYDNEY - S.A.T.S.

	NUMBER	%
Roads:		
Car drivers	2,392,500	45.0
Car passengers	976,500	18.4
Bus passengers	645,600	12.1
SUB-TOTAL	4,014,600	75.5
Other:		
Train passengers	340,400	6.4
Ferry passengers	13,100	0.2
Walk and other	949,700	17.9
TOTAL	5,317,800	100.0

A recent survey by Cox and Fleming (1978) showed that in comparison with C.B.D. car commuters, those driving their cars to work in the suburbs were less likely to be driving business vehicles and hence were less 'captive' to their cars. They were more likely to be using the car because of the absence of a public transport service sufficiently direct for their needs (Table 7).

TABLE 7.

N.R.M.A. SURVEY - USE OF CAR BY SUBURBAN COMMUTERS

Drivers with "Compelling" Reasons for Using Car:

	PERCENTAGE
a. Car used during day	28.0
b. Subsidised cars not included in "a"	2.9
c. No public transport	17.3
d. Public transport services inadequate	37.0
e. Other reasons	2.9
TOTAL	88.1

Commercial Traffic: In addition to the 6 million daily trips made by Sydney residents, about one million trips are made by commercial vehicles (Table 8)

TABLE 8.

	NUMBER OF TRIPS	%
Station sedan	276,000	30
Utility/panel van	432,000	46
2/3 Axle truck	186,000	20
Combination truck	10,000	1
Other vehicles	27,000	3
TOTAL	931,000	100

ENERGY SAVING STRATEGIES FOR SYDNEY

Because of their structure, some cities are better adapted for the efficient use of public transport than others - this applies particularly to European cities which have high-density residential development, highly centralised employment and a large proportion of the population living in the C.B.D. (Huxtable 1978).

But on the basis of the Sydney travel patterns outlined in this section there appears to be little scope for transferring a greater share of the passenger transport task to public transport, even if it were clear that this was desirable for energy conservation, environmental or other reasons.

Experience in Sydney with lanes reserved for high-occupancy vehicles (Cox and Sealres 1978) has not been such as to encourage their use as energy conservation measures (or for that matter as a measure aimed at reducing peak-hour time wastage on arterial roads). Nor have schemes for encouraging car pooling on a geographical basis been accredited with even modest success. (Traffic Authority of N.S.W. 1977).

And, as Jay (1978) has pointed out, only a tiny fraction of a city's fabric is being changed in any one year, and there are difficulties in developing new transport corridors in heavily built-up existing areas.

More detailed examination of travel patterns in Sydney, of planning policies and the likelihood of success of any change in direction may point the way to greater use of public transport in the future. In the meantime it appears that the main, if not the only, measures likely to achieve a worthwhile reduction in energy use are those which make the operation of motor vehicles more energy efficient.

CONCLUSIONS

The scope for attracting people out of cars into public transport will vary for different cities, for different parts of each city, for trips of different purpose, etc. Whether such a transfer of trips between modes will achieve any worthwhile savings in energy consumption will need to be examined closely in each case.

Investigations referred to in this report indicate that the scope for energy reduction by greater use of public transport is far less than is sometimes predicted on the basis of specific energy efficiency of cars and public vehicles. To cater for any substantial reduction in car use would, moreover, require investment in public transport services many times existing levels, even if the transfer could be achieved without drastic effects on existing life-styles.

On the other hand, considerable savings in energy use are possible by making motor vehicles more energy efficient. This can be achieved by further reducing average fuel consumption, for example, by reducing the weight of vehicles, improving engine design, reducing aerodynamic drag, using steel-belted radial types, installing manual in place of automatic transmissions and omitting accessories such as air conditioning and power steering.

There is also much scope for energy conservation by making the operation of vehicular traffic more efficient, by established traffic-management techniques such as clear-ways, priority roads and signal co-ordination. However, at least in Sydney, it appears there is relatively little scope left for achieving major improvements by these measures and urgent action is needed to transfer major flows of 'through' traffic to a network of new roads (albeit roads of lesser design standard than the freeways initially proposed by the Department of Main Roads).

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