Cycling and urban travel:

How much society could save by substituting bicycle trips for short car trips

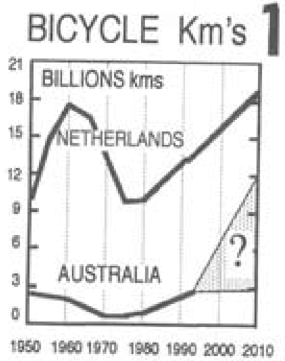
Alan A Parker

URBAN passenger transport is a very expensive activity that generates a lot of hidden costs as a result of accidents, pollution, noise, congestion and greenhouse gas emissions. This article quantifies the potential social cost savings of increased bicycle use.

In Australia funding to build bicycle infrastructure has always been inadequate and always will be unless the costs are known and the economic benefits proven to politicians. In the past, the benefits of cycling could not be established because the social costs of urban car use were not reliably quantified. A welcome new development is that the health costs of air pollution, costs of time lost through road congestion, the costs of noise effects and even some provisional costs for greenhouse gas emissions have been quantified in reputable studies. Furthermore, the British Medical Association has established that the health benefits of cycling are greater than the accident costs. These numbers are crunched in this article.

The hidden (or external) costs of driving in Sydney, Melbourne and Brisbane, will average out at $4000 per motorist per year at 1993 prices. In Adelaide and Perth it will be around $2500 so the cost savings to society of substituting bicycle trips for short car trips are high (59c/km). The net benefit of substituting one billion single occupant car-km with one billion bicycle-km could therefore be around $600 million a year.

Unfortunately, there has never been an assured funding mechanism for bicycle facilities and the needs of urban cyclists (Canberra excepted) have been neglected for 30 years. There is an urgent need to bring the inadequate bicycle infrastructure in urban areas up to a reasonable standard for a decade at least and an economic case for the Commonwealth Government to invest $1 billion in a catch-up funding program over ten years. The Netherlands national government had to do this to maintain high levels of bicycle use (see Figure 1) from 1977, and any other government in the developed world that seriously intends to encourage bicycle use will have to do the same.



World best practice: The Dutch generate bicycle travel

A cautious comparison with the Netherlands is useful because it shows just how the unsustainable trends are being confronted creatively to tackle the kind of problems that Australia also faces. Millions of Dutch householders use bicycles to stretch the usefulness of the family car and avoid the purchase of second or third cars and, if without a car, are better able to get by with no car at all. Although the Netherlands as a whole is very different from our continent, which is mostly farmland and desert where very few people live, the urban areas of both countries, where most people live, have many features in common.

Some useful comparisons can be made between urban Australia where 83 per cent of Australians live and the whole of the Netherlands (Parker 1994a). Our capital cities cover 34,700 square km and the Netherlands covers 37,000 square km; the urban population of Australia and the total population of the Netherlands will both be about 16 million in the year 1998. There are large accessible national parks and a large length of coastal recreational sites in both these areas. This is a comparison of areas that are easily accessible and of similar population. The importance of high density housing developments is understood but there other important factors.

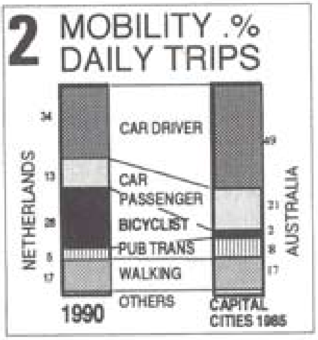
In both countries suburbanisation is considered a problem, but it is far worse in Australia. In the Netherlands it is mostly 2 storey housing clustered close together with open space around the cities and villages; in Australia mostly single storey housing sprawls everywhere, leaving little open space or farmland in between but the overall population density of the two areas is similar.

There are high levels of commuting to CBDs from rural areas, or from towns and villages that are up to 80 km away. The growth rate in vehicle km travelled has been high in the Netherlands partly because there is nearly twice the length of motorways than in urban Australia (OECD 1992). Motorways have generated much suburbanisation and overuse of the car. However, the price of petrol is $1.45 cents per litre, so the car user pays for a larger proportion of the hidden costs of motoring.

In the Netherlands the national government made a $1.5 billion investment – 10 per cent of the roads budget – on bicycle infrastructure over many years in response to the 1974 oil crisis and a decline in bicycle use (Parker 1994). This investment was timely as the bicycle travel trends shown in Figure 1 indicate. The reduced transport costs achieved by improving the bicycle infrastructure come mostly from reduced car travel in urban areas and the reduction of short car trips with cold engines that waste fuel and are extremely polluting.

After the decline in bicycle use had been arrested by the national government, local and regional governments are now maintaining and expanding the bicycle infrastructure. The national government continues to fund bicycle related research, pilot programmes and to coordinate the implementation of the Netherlands Master Bicycle Plan, which is an integral part of the national greenhouse gas reduction strategy (CROW 1991). The Dutch bicycle infrastructure consists of urban bikeway networks of finer mesh than the arterial road network, main road cycle crossings, secure bicycle storage and safe routes to railway stations.

The role of the bicycle in the Netherlands is to satisfy a very large niche market for urban transport for trips of between 0.5 and 5 kilometres. Some 28 per cent of all trips are now made by bicycle, as is shown in Figure 2, and more bicycle trips are made by women



than men (Pravetz 1992); it is planned to increase bicycle use further. For the same effort as walking the bicycle provides access to ten times the catchment area (Parker 1989), and it is recognised that the bicycle can also greatly improve access to railways (Replogle and Purcells 1992, and see Figure 3). There are already 160,000 bike/rail patrons, and there is a national plan to increase rail use by 15 per cent (CROW 1991) by using bicycles as a feeder to railway stations.

Perhaps the most important difference is in government policy towards sustainable development and reducing greenhouse gas emissions. The inter-

Bicycles make better use of road space. Great Victoria bike ride coming down the Tullamarine Freeway in Melbourne.

esting feature of the Netherlands approach is that they do not want technical improvements in vehicle design, fuel efficiency and cleaner combustion to

FIGURE **3**

Station catchment area data for walking & cycling with the same physical effort (75 watts for 7.6 minutes, within a rectangular street grid)

Effort advantage	1.0	3.1	3.8
Speed km/hr	6.1	20.0	23.0
Distance km.	0.8	2.5	3.0
Catchment area sq Km	1.3	12.4	19.0

SOURCE: PARKER A.A. 1989

be wasted and swallowed up by a large increase in car use. They also want to reduce congestion costs for the commercial vehicles, truck and bus fleets by getting more single occupant cars off the roads and by making better use of existing road assets. The key objective in their national environment/transport plan (VROM 1992) reflects this approach and states that there will be **"no increase in per capita car km travelled by the year 2010".**

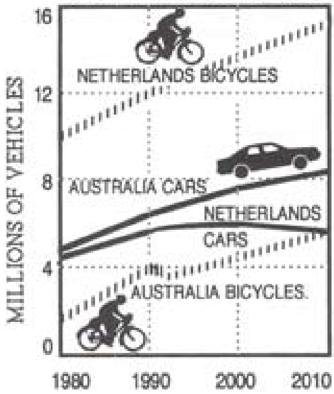
The Groningen study

One of the most interesting studies of both the hidden (external) cost of motoring and the hidden benefits of bicycling was an evaluation in 1988 of urban policies practised in the Dutch city of Groningen (Krommendijk 1988). Groningen has 240,000 inhabitants and has for 20 years given priority to public transport and cycling; more recently the city has banned cars from the central area. It also restricts long term car parking and suburbanisation while at the same time concentrating employment near public transport interchanges.

Per capita greenhouse gas emissions from transport are only a third of what they are in Australian capital cities. The 1988 study estimates that persons who used the bicycle as a means of replacing short car trips to the city save the city $405 each year. The cost savings where the result of measuring the hidden (external) costs.

Today 50 per cent of Groningen commuters cycle to work. People not only enjoy cycling but they understand that it adds to the quality of urban life (Johan 1993). For example, greater use of bicycles permitted a giant car parking lot to be turned into a town square. A traffic jammed street was transformed into

4 CAR AND BICYCLE FLEETS NETHERLANDS & URBAN AUSTRALIA. 1980 TO 2010



a highly successful open air street market. High quality apartments in traffic-free precincts have been built on former highways. Speed limits of 30 km/hr in residential streets make cyclists of all ages and both sexes feel very secure when sharing road space with cars. In 1994 there were 3000 bicycles securely parked at Groningen central railway station, most of which belonged to students and white collar workers commuting to other cities.

All over the Netherlands (CROW 1991 & 1992) authorities are trying successfully to follow the Groningen example. The most important lesson to be learnt is that great changes are possible with patient and persistent planning.

Making better use of the urban car fleet

The Australian urban car fleet uses nearly twice the resources and produces nearly twice the pollution and greenhouse gas emissions per person than in the Netherlands. The problem in Australia is that, while most new small cars are fuel efficient and less polluting than ever before, this fine engineering is being wasted because we choose use to bigger, older and dirty cars and use them to much in the wrong places at the wrong time.

By the year 2005 around 30 per cent of all car trips are likely to be of less than 5 minutes duration (VATS 1995), and these short car trips with cold engines and cold catalytic converters waste fuel and are extremely polluting, so the volume and the toxicity of emissions will increase. The average urban motorist produces 4.9 tonnes of carbon dioxide a year, one of the highest per capita emission rates in the world. The trends and planned growth of the bicycle and car fleets in Australia and the Netherlands are shown on Figure 4.

Yesterday's health problem was airborne lead; tomorrow's problem is microscopic airborne particles from three sources: the exhaust pipe, the friction of tyres on the road and brake wear. These particles will be carrying hydrocarbons, cancer-inducing chemicals and asbestos deep into people's lungs (*New Scientist* 1994). By 2005 the volume of these small particles will have increased greatly. Most worrying of all is what new research is beginning to uncover.

The most recent estimates made in the US by the EPA (*New Scientist* 1994) this year show that 60,000 people die prematurely each year in the USA as a result of small airborne particles. On a pro rata basis that would be around 4000 premature deaths each year in Australian, but this is only a guess as the research has not been done to find out the real number of deaths. The weight of the combustion excreta from the average car over the 12 years of its life is shown in Figure 5.

Sydney is the worst environmentally affected city in Australia. When viewed from Manly on many days it is shrouded in a brown cloud of filthy air from car exhausts. Air pollution in Sydney's west and south west regularly exceed World Health Organisation limits, and photochemical smog levels are likely to exceed the levels of Los Angeles within 10 years. Other cities are spending billions on traffic-generating road works in their rush to catch up with Sydney.

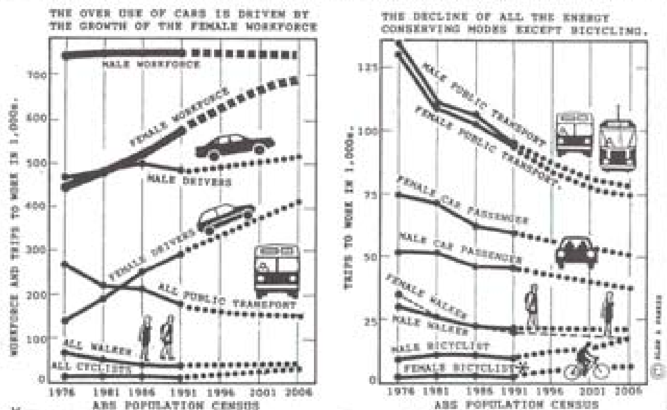
A refreshing proposal to go in the other direction is the Integrated Transport Plan for South East Queensland – the Brisbane/Gold Coast conurbation. However, the data in this plan shows the unsustainability of current trends in this, the fastest growing urban area in Australia. The plan states that "half a million extra vehicles will be registered by 2011 .... Daily vehicle trips will trips will increase from 5.7 million to 10.5

FIGURE 5
THE AVERAGE CAR EXHAUST EXCRETA (12 YEARS)

Carbon dioxide. (GHG)	53.3 tonnes
Carbon monoxide	3.3 tonnes
Hydrocarbons	450 kg
Nitrogen oxides	351 kg
Methane (GHG)	47 kg
Particulates	26 kg
Lead	17 kg
Sulphur dioxide	11 kg
Nitrous oxide (GHG)	7 kg

Note: GHG = greenhouse gas.

6 ECOLOGICALLY UNSUSTAINABLE COMMUTING TRENDS
MELBOURNE TRIPS TO WORK 1976 TO 2006. TAXIS AND MOTOR CYCLES OMITTED FOR CLARITY. SOURCE: ABS POPULATION CENSUS 1976 to 1991.



*On Census day 8mm of rain fell before 9am and it was windy with showers the rest of the day are other costs associated with the complete life cycle of the car from its manufacture to its final disposal.

The average car produces 70.1 tonnes of carbon dioxide over its entire life, which is 16.8 tonnes more than the 53.3 tonnes coming out of the exhaust pipe shown in Figure 4. Before a car is manufactured extracting the ore, smelting and refining the 880 kg of metals produces 400 million cubic metres of polluted air and 30 tonnes of solid waste. Before a car is used 10.8 tonnes of carbon dioxide and 1.5 tonnes of factory waste are produced from its manufacture and the processing of over a tonne of metal, plastic and glass in each car.

In its working life the average car has to be serviced, which produces 6 tonnes of carbon dioxide in repairing and disposing of it. This is such a large amount because 35 per cent of cars are damaged in road accidents. Indeed, in Victoria one in every 267 cars kills a human being, one in every 60 cars permanently handicaps a person and one in every 7.3 cars causes a personal injury. The indirect costs of educating and training doctors and other personnel, providing ambulance and hospitals services to road accident victims all have to be met from taxes. No estimates exist for greenhouse gas and pollutant emissions from road building and maintenance, but they must be considerable.

Oil drilling and extraction, and the refining and distribution of the petrol to motorists produce oil and gas leakage, evaporation and energy use at every stage from sinking an oil well to spillage at the petrol pump that are responsible for at least 3 million tonnes of carbon dioxide emissions in Australia. Imported oil, brought in by a leaky fleet of tankers, many of which are potential environmental time bombs, incur more hidden costs. There are also emissions of methane and benzene from local refineries which add to urban air pollution.

During its brief life the car will produce hundreds of litres of waste oil and brake fluids and great volumes of contaminated water from car washes. Disposing of cars is no easy task before it finally rusts away or the metals are melted down: scrap tires, batteries, plastic residues, contaminated exhaust systems and engine oil break up and may then contaminate ground water.

Vehicle-related services funded out of general taxation include traffic controls, policing, emergency services, and street lighting. The average urban car demands about 800 square metres of land under tarmac or concrete for roads and parking, four times more than in Europe; around one eighth of Australia's best agricultural land is buried under roads.

In estimating the external pollution costs of car travel per km I have used the average figure for urban driving: this underestimates the costs because bicycle trips can replace short car trips, many of which would be with a cold engine. The correct figure is likely to be 0.5c per km higher, and further research is needed to determine this. If all the indirect costs not included in the estimates of external costs (VTES 1994) are taken into account, the estimate of the bicycle-use cost saving in Figure 8 is conservative.

FIGURE 8
Social cost savings of bike trips replacing driver-only car trips
Costs, 1994 year, in cents/km

Car external costs	25.9
Car running costs	47.5
Total social cost	**73.4**
Bicycle depreciation	5.2
Bicycle repairs, etc	8.6
Health benefits less costs	0.0
Bike total cost	**13.8**
SOCIAL COST SAVINGS	**59.6**

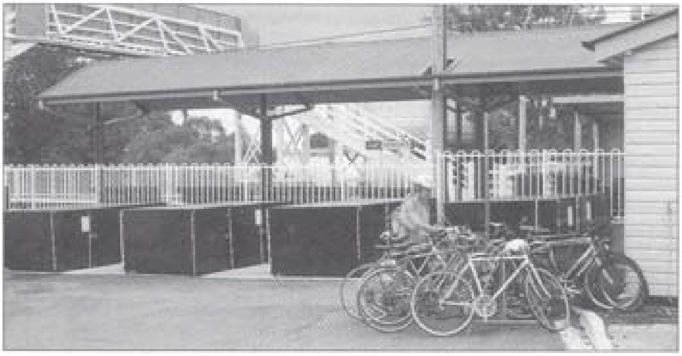
Note: Assumes 1,500 bicycle km per year, & that the use of the bicycle enables a car to be dispensed with in a multi-car household

The hidden social and health benefits of cycling

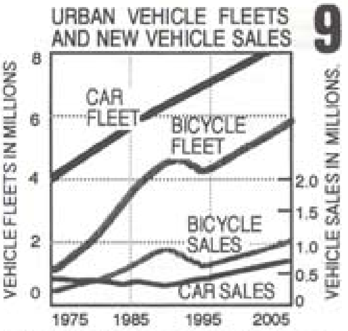
In 1992 the personal health costs of a motorised and sedentary lifestyle were analysed and health benefits of regular cycling were reliably estimated by the British Medical Association. Regular cycling, even at low to moderate exercise levels, can reduce the risk of coronary heart disease, stroke and other chronic diseases. The BMA found that the life years gained from the health effects of bicycle exercise were greater than the life years lost as a result of road accident injuries or fatalities (BMA 1992).

In another study (CTC 1993) the key finding on health benefits were that, if Dutch levels of bicycle use were reached, heart disease rates would fall by 15 per cent, the individual risk of a heart attack would fall by up to one half, there would be an increase in life expectancy, and business costs would be reduced through lower levels of absenteeism. The cyclist death rate per 100,000 km ridden in the UK was 3.7 in 1992 and 1.8 in Australia in 1993. Whatever the health benefits in the UK it could be argued that there will be twice the health benefits in Australia. However, I have conservatively costed the health benefits as merely cancelling out the accident costs in line with the BMA findings.

There are other external health benefits due to reduced health care costs and a contribution towards greater functional independence in later life.



Free bicycle lockers at Sandgate Station, Brisbane. 540 bicycles are stored in lockers 20% to 30% of these cyclists previously parked their cars at the station.



Replacing short and very polluting cars trips saves more than the 0.5 cents/km health costs shown on Figure 8: the real cost saving is probably about 2c/km for short trips on a cold engine.

Bicycle economics is about the health benefits for cyclists and the social benefits of using bicycles to make better use of the car fleet and reduce its size. The size of the urban bicycle and car fleets is shown on Figure 9; it can clearly be seen that, if we assume a bicycle to have half the life of a car, the size the bicycle fleet is at least two thirds that of the car fleet. The opportunity is there for many people to choose to ride a bicycle if they wish.

Figure 10 shows the number of households in Melbourne and the growing proportion with two or three cars. This trend continues despite the reduction in average household size from 3.47 persons in 1966 to 2.81 persons in 1991, and similar trends can be seen in other cities. Nearly half of all households consist of only one or two people (Melbourne Strategy Plan 1994).

The proportion of households without a car will increase as a result of the increase in the proportion of old people in the Australian population who cease to drive because of health or road safety regulations and will thus need an alternative means of transport. Current trends will restrict old people's mobility and their access to basic services. In the Netherlands the old have the option of riding a bicycle in comparative safety, and that is going to be a more important consideration in the future: by 2030 there will be 5 million Australians over 65 years of age compared with 2 million today (Housing and Regional Development 1994). Declining eye sight will prevent a growing proportion of older people from driving, but most of them will have eyesight good enough to continue cycling. The same applies to many other ailments of the aged. It is noteworthy that many Dutch people are still cycling in their eighties, which reinforces the case for separate bicycle facilities on main roads and low speed limits on residential streets.

Figure 8 shows that when bicycle trips replace car trips it can save society 59.5 cents per kilometre. The assumption is that that nearly all the cost savings come from car owning households. For example, in Melbourne, 11 per cent of households have three or more cars, 35 per cent of households have two cars and 38 per cent have one car and only 13 per cent of house holds have no car. The current trends for multiple car ownership are shown in Figure 10.

The social cost savings will mostly result from 84 per cent of the car owning households using bicycles to stretch the usefulness of the motor vehicles they own to avoid the purchase of another car. (In this there may be a time-lag as a result of people who already own several vehicles continuing to use them until they need a new one.)

Only a small proportion of the cost saving will come from the 13 per cent of households without cars who use bikes by choice or out necessity to avoid the personal costs of owning a car. If one person in a household cycles it is often enough avoid the purchase of another household car, especially if it is a commuter trip direct to work or to a railway station. If children cycle to school and most of the other places they want to go to, a vehicle for chauffeuring is not needed by the parents. There will also be cost saving due to the adoption of a more bicycle orientated lifestyle that results in people gradually choosing to do more things within bicycle range because they like cycling.

The 59.5c/km cost saving can be best realised by learning from the Netherlands where behavioural studies of motorists have found that 41 per cent of car trips of ten minutes or less can be replaced by bicycle; the Dutch authorities intend to greatly increase the substitution of car trips by bicycle trips (Louisse 1992). Figure 11 shows my estimate of the potential for substituting car trips of different durations in Melbourne; the story should be similar in other big cities.

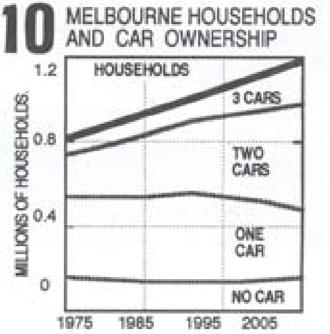
Cities are changing from essentially single centred cities to multi-centred cities with multi-directional transport flows. These trends are likely to increase the dominance of the motor car in moving people around cities. Bicycles can be used most productively to do the following:

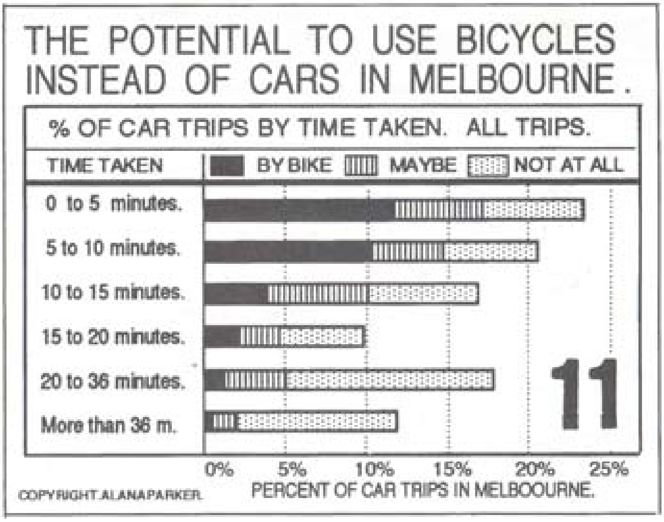
1. Replace 40 per cent of short, single-occupant car trips of less than 3 km with cold engines that are very polluting and wasteful of fuel.
2. Replace around 20 per cent of single occupant car trips of less than 6 km.
3. Replace some long urban commuting trips of 10 to 60 km in length with a bike-rail (or other mode) trip and increasing urban rail patronage in the process by around 20 per cent (Parker 1989 & 1992).

User pays: The polluter must pay for building up bicycle infrastructure

The low level of bicycle facility funding, fuel pricing policy and the separation of transport planning from land-use planning greatly encourages wasteful transport behaviour by able bodied motorists and discourages cycling. Traffic conditions grow more stressful for cyclists in the bigger cities, where bicycle-safe main roads are few and far between.

The benefits of building up the bicycle infrastructure so that by the year 2010 there would be several billion more bicycle kilometres ridden each year would be in the order of $600,000 per billion bicycle kilometres. The potential cost saving runs into billions. Clearly





allocating the equivalent of 10 per cent of the urban roads budget to building up a close-knit and continuous network of bikeways as was done in the Netherlands would be a very profitable investment. In Australia there is no way of increasing bicycle use to levels in the Netherlands today, but we could increase bicycle use to around 20 per cent of all trips and could double public transport patronage. Urban cycling was at this level during the Second World War and late 1940s. Today Australians have the freedom to choose to use the most environmentally friendly vehicle ever invented but are constrained by infrastructure deficiencies and traffic stress. The Commonwealth Government has a legitimate role in accelerating the provision of necessary physical infrastructure and encouraging more bicycle friendly traffic behaviour by other road users.

As the level of government to which people tend to look when they want reform, innovation or forward thinking, the Commonwealth should establish a national bicycle planning group to ensure that the states spend the funds available, carry out the necessary research and develop nationally significant pilot programs and coordinate a national bicycle strategy, as is being done by the national government in the Netherlands. The existing bicycle strategy does not reflect world best practice and is in need of revision. What is proposed here would be the best way to implement the bicycle related recommendations in the report issued by the Australian Urban and Regional Development Review, *Timetabling for tomorrow: An agenda for public transport in Australia* (Housing and Regional Development 1995). Australian cyclists, through their state organisations and national journal, have been saying this for some time. The cycling movement knows what it wants and what is needed; will the Commonwealth Government act? (Salomon 1995; Parker 1994 & 1995).

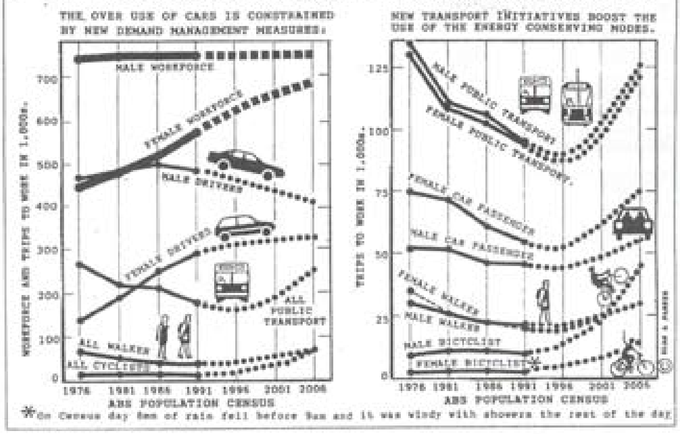
A basic principle in environmental economics is that the polluter should pay for both the costs of pollution and the means of preventing future pollution. To apply this principal the Commonwealth Government should put a levy of 2c on every litre of petrol, with the specific purpose of encouraging bicycles to be used instead of cars for short trips. This levy would raise $205 million a year for urban bicycle facilities and programs. To do anything else is to regard the bicycle as a toy in a world where twice as many bicycles are sold than cars and the non-polluting bicycle is the principal form of transport for millions of people. Now is the time to recognise that petrol heads in the transport power elite, who have regarded the bicycle as a toy for the last 30 years, have cost their country dearly. The Commonwealth Government has the means to rectify that mistake and should do so.

In the broader context of achieving ecologically sustainable development Australian governments need petrol, electricity and land pricing policies that give people sensible price signals so as to encourage them to consume less car kilometres, buy more energy efficient cars and to conserve and make better use of land, fossil fuels and appliances. The kind of changes required in transport behaviour are easy enough to visualise. Figure 12 shows the changes in commuting travel patterns required to move towards a more sustainable future. Urban consolidation will help, but without supporting de-

Turning a "RatRun" into a bicycle route. One way for cars, two way for bicycles. Alternate one way direction for cars to create discontinuity. Richmond, Melbourne.

12 ECOLOGICALLY SUSTAINABLE COMMUTING TRENDS

MELBOURNE TRIPS TO WORK 1976 TO 2006. TAXIS AND MOTOR CYCLES OMITTED FOR CLARITY. SOURCE: ABS POPULATION CENSUS 1976 to 1991.



mand management measures, including doubling the price of petrol, car pooling and building up the cycling and public transport infrastructure, little will be achieved.

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Note: This is a revised version of an article originally published in *Australian Cyclist* (February-March 1995).

Urban Futures is grateful to the editors of that journal for their kind permission to reprint this article.