STUDY ON POTENTIAL TO IMPROVE FUEL ECONOMY OF PASSENGER MOTOR VEHICLES

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NOTES

1. This Study comprises two parts :

Part 1 - Study Part 2 - Working Papers

The Working Papers may be obtained by contacting the Road Safety Division, Department of Transport and Communications, GPO Box 594, Canberra ACT 2600. Telephone 06 2747621.

2. The views expressed in this Study are those of the author and do not necessarily represent those of the Commonwealth Government.

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PRINCIPAL FINDINGS AND CONCLUSIONS

Passenger car sales will grow to 498,000 by 2005, including up to 18 percent commercial vehicle derivatives. Companies buy just over half the new cars sold, and individuals make 65 percent of the choices of company cars.

Neither the public nor manufacturers actively seek fuel economy, and many cars made in Australia are not fuel efficient by world standards.

To improve new car fuel economy, over 20 technical devices were identified, plus controls on speed and acceleration. Diesel engines would help, but there would be more noxious emissions. Technology can deliver a 20 percent reduction in National Average Fuel Consumption by 2005, and up to \$3.4 billion increase to national social welfare. New safety and emission standards involve a 3 percent penalty on fuel economy.

The foreign owned Plan Producers are under pressure from imports, which are favoured by current tariff reductions. Australia may lose two firms and local production may fall 25 percent by year 2000.

By bringing forward their investment programmes, Plan Producers can deliver even more fuel economy than they now propose. But if Government insists on fuel economy targets beyond the limits of technology, it will further assist importers and accelerate the loss of Australia's productive capacity while still not meeting the Government's Interim Target on Greenhouse.

The market based policy instruments listed in the Brief could be used in conjunction with other marketing techniques to deliver a technical fix while keeping a balance between environmental and economic concerns. These instruments were assembled in the form of:

- a Technology Delivery Programme which creates a positive encouragement for consumers to purchase and manufacturers to sell clean and fuel efficient cars;
- a Prescriptive Fuel Consumption Programme which provides a more aggressive and interventionist approach that would be available as a backup if necessary, or if targets were set so low that they could not be delivered by technology alone.

A Fuel Economy Support Programme would undertake a lengthy public awareness campaign, prescribe achievable Fuel Consumption Targets, vehicle testing procedures and establish fuel consumption certification procedures including mandatory vehicle labelling.

The Technology Delivery Programme would eliminate the 20 percent wholesale sales tax, introduce a 'Fee-bate' scheme to rebate a variable sales tax to buyers of fuel efficient cars, eliminate company tax deductions on cars to downsize company car choices, and maintain revenue neutrality as necessary by varying the fuel tax. This will promote competition among Plan Producers and importers, and fuel consumption targets down to 6.5 litres/100km are contemplated. Buyers would accept the programme and pay the technology costs. Increases to welfare would rise to around \$5 billion.

The Prescribed Fuel Consumption Programme is much more aggressive and involves a Gas Guzzler Tax, a substantial rise in fuel taxation and, as a last resort, mandatory fuel consumption standards. The welfare losses would wipe out the potential gains from technology and exceed potential revenue gains, but fuel consumption targets below 6.0 litres/100km would not be achieved unless Government were to legislate most large and medium cars off the road.

This vision is not prescriptive, and there may be other options. Despite likely consumer and industry acceptance:

"It must be considered that there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things".

Machiavelli, The Prince

EXECUTIVE SUMMARY

This Report provides information about the factors affecting the fuel economy of new passenger cars sold in Australia, and the potential for reducing fuel consumption up to 2005. It does not explicitly consider commercial vehicle derivatives nor does it make recommendations. Qualifying comments are included where appropriate.

Australian Automotive Manufacturing

The industry rose at the end of World War II out of the ashes of the world industry, which could not then produce cars for Australian requirements. The 'Australian Car' was built to carry families with children and serve the rural community on a largely unsealed road system. Many of the original requirements are no longer applicable.

Production is small by world standards. The five Plan Producers (Ford, GMH, Mitsubishi, Nissan and Toyota) invest around \$500m annually, and in 1988 built 332,337 cars for local consumption and export (1921 cars) against a capacity of about 400,000 units in six plants in New South Wales, Victoria and South Australia. They imported 26,372 vehicles.

These firms commanded 80 percent of the total market in 1988, which sold 410,000 passenger motor vehicles (PMVs) into a total car parc of about 7.14 million cars and station wagons. By 2005, it is estimated that sales of new PMVs will grow to about 498,000, when Australia will contain nearly 10.3 million cars.

Factors Affecting Fuel Efficiency of Australian Cars

Australia's overall fuel economy record is one of the worst in OECD countries. Over half the models sold here are between 10 and 15 percent less fuel efficient than equivalent models sold in the US. Our 1988 NAFC of 9.10 litres/100km compares poorly with Italy (6.80 litres/100km) or the United Kingdom (7.40 litres/100km); our (on road) fleet average of 11.80 litres/100km in 1988 is 39 percent higher than New Zealand or Denmark (8.50 litres/100km).

Most Australians do not actively seek fuel economy. Consumers rank it not higher than sixth behind attributes such as price, size, appearance and reliability; cars offered by Plan Producers and importers (quite reasonably) feature these requirements. Manufacturers do not calibrate engine management and transmission systems to optimise fuel efficiency, and this culture will not be easy to change.

Although companies and Government operate less than 10 percent of the total fleet, they buy over 50 percent of all new cars. More than 95 percent are luxury (LTD/Statesman/BMW /Mercedes), upper medium or medium class cars. Employees use about 65 percent privately, and 24 percent are used in home occupation or very small firms. Individual preferences dominate vehicle choice.

As Australian car ownership rises from 0.44 cars per person in

1988 toward an estimated 0.5 around 2005, sales of commercial vehicle derivatives could reach 18 percent. World wide, these are favoured for recreational use and as a second vehicle. This trend may prejudice future fuel economy outcomes.

Even if the fuel economy of new cars were improved, it would not greatly affect overall fuel consumption. The average age of the car parc is nearly 9 years and rising, and it now takes 25 to 30 years to replace the fleet. Many drivers are leadfoots, and there are no plans to retrain them. Present urban population trends cause fuel use to grow faster than population.

It is thus not surprising that Australia's expectation for National Average Fuel Consumption (NAFC) is also poor, being 8.0 litres/100km in 2005, or 13 percent above that for Germany.

Fuel Economy Policy Overseas

Except for Japan, where voluntary fuel consumption targets were established by the 1979 Rationalisation of Use of Energy Act, most countries set voluntary targets by agreement between Government and manufacturers. Results have been mixed. In Australia, the 1979 agreement has not been as effective as in those countries which also brought in high fuel prices. 1.4

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Some observers argue that mandatory fuel consumption standards would correct Australia's poor fuel economy. The US Corporate Average Fuel Economy (CAFE) legislation provided a basis for testing this view.

CAFE sought maximum improvement in fuel efficient technology, while leaving the mix of vehicle sizes to be determined largely by the market. It also considered economic practicability and protection of the US domestic industry against imports.

There is a major distinction between this objective and one which seeks to reduce total fuel consumption or greenhouse gas emissions, as might flow from the Government's Interim Planning Target on Greenhouse emissions. The latter admits use of policy to encourage the sale of smaller vehicles, whereas CAFE does not.

However CAFE did impact on vehicle size, and importers obtained commercial advantages over domestic producers. Both importers and US manufacturers indulged in bizarre 'games' to circumvent model classifications. Some US administrators view these outcomes and the downsizing of the fleet as unintended, even embarrassing consequences of a bad law.

Further, the early effectiveness of CAFE stalled in the mid 1980s. The current CAFE standard is at the 1985 level, US manufacturers are trading on credits achieved around 1986, and fuel economy for light trucks has been constant for 10 years. Even the strongest proponents of CAFE would agree that results would have been better if the regulation was supported by higher fuel taxes, but these are politically unacceptable in the US.

Proponents of new US energy policies are considering better ways to improve fuel economy, including alternative types of fuel consumption targets. The Administration accepts that fuel economy needs to be improved as a matter of policy, but also has concerns about industry viability and excessive downsizing. The cost to manufacturers, consumers and political process is seen as a price to be paid for fuel conservation.

Maximum Technology Scenario

Evidence from overseas test results, international comparisons, an OECD/IEA Conference in Berlin and other international reports on manufacturers' global strategies all show scope for fuel efficient technology in Australia beyond current industry plans.

A "steady as she goes' scenario or "Product Plan" was prepared, which generally conforms to industry expectations. It assumes no new Government fuel economy policy, but expects competition to continue on the basis of model size and performance in line with the global strategies of manufacturers.

The "Maximum Technology Scenario" (MTS) holds interior volume and performance constant at Product Plan levels, but assumes increased penetration of some 21 applicable technical devices already available in Australia or elsewhere. It includes:

- improvements to bodywork such as weight reduction due to use of (especially) aluminium and plastics; reduced drag through improved streamlining and assembly techniques; and greater penetration of front wheel drive;
- modifications to engines including advanced valve technology, advanced friction reduction, modified two stroke (Sarich) engines and improved fuel injection;
- transmission improvements such as torque converter lockup; additional gears in both automatic and manual transmissions, and continuously variable transmission where applicable. Electronic transmission control is also anticipated;
- accessory improvements such as electric power steering; low viscosity lubricating oils; low resistance tyres; and evolutionary improvements to alternator, water pump, etc.

The MTS vision conforms to international best practice and:

- argues that a 9 percent gain in fuel economy could be achieved by 1995, mostly by recalibrating engine management and transmission systems;
- assumes that equivalent US1994 emission controls and occupant safety devices will be mandated before 2000, including a penalty of 3 percent on NAFC.

Discussions with Plan Producers indicate that it is feasible to implement the MTS without major change to manufacturing or service infrastructure. No significant change was assumed for 5 years, after which manufacturers would bring forward development programmes valued at \$1700m in 1988 dollars. The present value at 1988 of the additional costs was estimated to be about \$200m.

Benefits of the Maximum Technology Scenario

In the right circumstances, the MTS could bring NAFC levels down to 6.5 litres/100 km, or even lower. This is nearly 20 percent below Federal Chamber of Automotive Industries expectations. Other expectations are given in the report.

If implemented, the Maximum Technology Scenario would benefit Plan Producers, car users and all Australians generally. Subject to uncertainties of interpretation, the present value of benefits to national social welfare could exceed \$3.4 billion.

The estimated benefits to consumers are so great that they become central to the public policy arguments surrounding motor fuel conservation. In particular, the evidence suggests that a technological solution to fuel economy goals would be better than any other approach.

How to Make It Happen?

The question then remains, what should the Government do to encourage consumer and industry participation in a vigorous fuel economy programme, which delivers improved technology?

There is already a great deal of Government intervention. Taxes and charges raise about \$12 billion annually, and the plethora of regulations constrain manufacturers, distributors, owners and users. Most but not all intervention favours fuel economy.

In considering what Governments should do, it is relevant that:

- there is strong competition among manufacturers and distributors of cars, with over 300 models on offer. They compete on the basis of interior volume, price, style/luxury and power, but rarely on fuel economy;
- individuals' preferences are very important for cars sold to businesses, Government and individuals, but fuel economy does not rank highly among those preferences;
- consumers will pay the additional three percent or so to gain the benefits associated with fuel efficient technology;
- production levels of Plan Producers need to be kept above some critical size to encourage competitive manufacturing in Australia. Plan Producers have in recent years lost market share to smaller, more fuel efficient imports;
- the Maximum Technology Scenario offers a major improvement to fuel efficiency and some recovery of Plan Producers' market share.
- o many buyers see second hand cars as a reasonable option to new ones, thus a 10 percent fall in price results in a 6 percent increase in the total volume of cars sold, and a 6.6 percent increase in the number of cars scrapped;
- price effects of new cars flow through to the second hand market and can discourage the use of the very old cars.

The Consultant considered that the high level of competition between manufacturers, combined with the lack of market focus on fuel economy and the benefits available from encouraging a higher

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turnover of vehicles, provide an opening for Government to restructure the existing market, and exploit the available synergy between technology and policy.

It suggested that Government might opt for marketing techniques plus market based policy instruments to manipulate sales outcomes in the direction of fuel conservation. This would be preferable to more regulation of manufacturing, unless Governments are looking for fuel consumption targets below technology limits.

Others claimed that regulation brings lower and more certain fuel economy, but US and other evidence shows that this is false; coercion often produces perverse outcomes, imposes costs and other disincentives on industry and opens the door to compliance problems and even corruption. Manufacturers' creativity should be used to improve technology rather than avoid bad laws.

In particular, Governments should learn from previous Australian and overseas experience where policies tried to legislate technical solutions. Rather, policies and programmes should recognise manufacturers' expertise, but place them under competitive pressures to deliver fuel efficient vehicles or lose market share.

A Policy Framework

Candidate policy instruments listed in the Brief were ranked on the basis of criteria which are meaningful to the players, and a concern to minimise unintended consequences. The preferred ranking included ties between candidates, as follows:

- Public awareness programmes (including vehicle labelling).
- Changes to the Sales Tax regime;
- Changes to company income tax arrangements;
- Fuel Excise;
- Business Franchise Fee;
- Fringe Benefits Tax and Annual Registration Charges;
- Mandatory Fuel Consumption Standards.

It was concluded that the policy framework should:

- clearly articulate the objectives of its fuel economy policy in specific terms which are meaningful to manufacturers, distributors and users;
- pursue fuel economy goals by encouraging technology rather than command and control over vehicle size and performance;
- influence public attitudes in terms of the key marketing issues relevant to users and manufacturers;
- choose policy instruments according to this ranking, as it will make the difference between efficient and effective energy outcomes and perverse or unintended consequences;
- keep stringent and potentially risky policy instruments in reserve.

In the Consultant's view, it is not possible to overstate the need for a public education campaign of the scale of 'Life. Be in It.'; 'Quit' or 'Drink. Drive. Bloody Idiot,' to make the community value clean and fuel efficient cars.

Towards Fuel Economy

Accordingly, it was decided that the report would present:

- a Technology Delivery Programme which creates a positive encouragement for consumers to purchase and manufacturers to sell clean and fuel efficient cars;
- a Prescriptive Fuel Consumption Programme which provides a more aggressive and interventionist approach that would be available as a backup if necessary, or if targets were set so low that they could not be delivered by technology alone.

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It was assumed that Government purchasing policies would be changed to conform to whatever programme(s) mix was selected.

These programmes would be supported by a **Fuel Economy Policy Support Programme** which delivers required administrative arrangements, a strong and carefully oriented public awareness campaign to promote values of fuel economy among consumers, and provides all car owners with the means to readily identify and compare the fuel economy attributes of product offerings.

The Technology Delivery Programme involves:

- (a) eliminating the 20 percent wholesale sales tax;
- (b) introducing a 'Fee-Bate' system which applies marketable rebates or tax penalties to product offerings depending on their fuel efficiency;
- (c) eliminating or substantially reducing income tax deductions on company cars;
- (d) compensating for losses to Government revenue arising from changes to sales tax and company income tax collections, including a rise in the fuel tax if necessary.

The analyses of effects on national social welfare (1988 dollars) indicated that significant synergy can arise between carefully chosen technology and policy instruments. The present value of national social welfare falls from \$3.4 billion under the MTS alone to about \$2.5 billion under (a), but a rise to about \$5.5 billion is estimated if a fuel tax is used to achieve revenue neutrality under (d).

Eliminating the sales tax would increase the size of the market by up to 60,000 cars per year and increase the share of upper medium and medium class cars sold. Plan Producers would be better off and the cost of accelerating the technology investment programmes would be only \$200m.

The Fee-Bate system gives sellers a wholesale or retail tax credit if they sell a vehicle with certified fuel consumption below a Target set by Government. Penalties would apply to the less fuel efficient vehicles. Manufacturers who cannot meet Fuel Consumption Targets set by Government would be allowed to buy credits from those who can, and offset them against the penalty.

Under Fee-Bate, penalties fall on the manufacturer rather than consumers, whose benefits are not compromised by the removal of choice. The tax credits and penalties would be a powerful incentive for manufacturers to introduce fuel efficient technology which retains market share; failure to provide fuel efficiency would allow 10 or so fuel efficient models to dominate the market, and those manufacturers would make extraordinary profits. The least fuel efficient models would be forced off the market.

Penalties should be significant and large enough so that their effect cannot be negated by sales discounts which otherwise might be used to encourage consumers to buy less fuel efficient models.

Eliminating company tax deductions on cars may seem aggressive; and the political impact may be greater than that which followed abolition of company entertainment deductions. But it is the only way to encourage companies to downsize significantly from the upper medium and luxury classes; otherwise, they will remain a feature of company and Government purchases for many years, especially while the differential between FBT and personal income tax represents a legitimate tax avoidance measure for employees.

Eliminating tax deductibility of company cars represents a revenue gain of perhaps \$2.3 billion annually, which is more than the revenue likely to be lost from eliminating the sales tax.

If revenue neutrality were required, changes to the fuel tax or company tax rates could be considered. If the fuel tax were used alone, it would have to rise by 12 to 18 cents per litre over the planning period.

If Government requires further improvements in fuel consumption beyond what is offered by Technology Improvement Programme, it would have to consider a **Prescribed Fuel Consumption Programme** comprising:

- a Gas Guzzler Tax, which consists of a wholesale or retail sales tax, about 80 percent higher than the existing wholesale sales tax, applied to the luxury and upper medium classes only;
- a rise in fuel taxes (say) to the average of OECD countries (i.e. an additional 50 cents/litre in 1988 dollars);
- mandatory fuel consumption standards.

These imply much more stringent taxation and/or regulation than the Technology Delivery Programme. The taxes cause downsizing which can lead to unacceptably large losses to national social welfare. Only the Gas Guzzler tax will not eliminate all the gains that consumers obtain from the Maximum Technology Scenario. The loss of welfare under the fuel tax rise is so great because it affects all 7.4 million cars in Australia.

Further, large fuel taxes appear to generate disbenefits faster than they generate revenue which might be used to compensate the disadvantaged, who are certain to include the poor and people who live on the fringes of urban areas.

This Programme will give a competitive advantage to importers of small and mini vehicles (i.e. Japanese plants offshore) as tariffs fall through to 2000. Very low targets could cost Australia its automotive manufacturing industry, because there is no reason why overseas parents would convert Australian plants to manufacture small and mini cars. There may be a number of unintended consequences as well.

Consumers and manufacturers will do everything possible to prevent downsizing, because it preempts the considerable benefits of car use, which are real albeit controversial among proponents of fuel conservation.

The Gas Guzzle: tax is not particularly effective in fuel economy terms; it would reduce NAFC by only about 0.3 litre/100km at 2005, below the Maximum Technology Scenario.

A fuel tax rise of 50 cents/litre will deliver a 20 percent drop in Fleet Average Fuel Consumption from a 1988 base, if used in conjunction with a technological fix. This meets the Government's Interim Planning Target on Greenhouse emissions.

If a fuel tax becomes necessary, it probably should be imposed via a Business Franchise Fee rather than a fuel excise, so that regional differences could be taken into account.

There appears to be little to gain from considering mandatory fuel economy standards as a way to achieve fuel economy goals. They:

- will assuredly cause losses to the welfare gains available from technology, although there is no way currently available to assess the magnitudes of loss;
- will not necessarily achieve a 20 percent reduction in fuel use below 1988 levels. Not only does it take too long for new vehicles to feed through the total fleet, but political action by manufacturers may frustrate progress, as has happened in the US;
- are likely to divert manufacturers from technological advance and into avoidance of the regulations.

However, the report comments on how one might introduce mandatory fuel consumption standards, in the event that the Government wishes to explore the option further.

The Fuel Economy Support Programme would:

- undertake a lengthy public awareness campaign including media advertising;
- disseminate relevant information about fuel efficiency, including the <u>Australian Fuel Consumption Guide for New Car</u> <u>Buyers</u>.;
- prescribe achievable Fuel Consumption Targets and related regulations;
- prescribe useful procedures for vehicle testing including provision of test infrastructure if necessary;
- establish fuel consumption certification procedures including mandatory vehicle labelling.

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It is considered that there would be considerable synergy between the Fuel Economy Support Programme and the Technology Delivery Programme.

The public awareness programme is essential to any fuel economy programme and should:

- provide the vehicle for initial announcement(s) by Government;
- present the goals, objectives and targets of fuel economy policy in a credible and understandable way;

- convince the public and manufacturers that Government policies on fuel economy are necessary and desirable, thereby duplicating the success of public health and drink driving campaigns cited above;
- disseminate reliable information for buyers about Fuel Consumption Targets and vehicle performance;
- include sufficient budget for media advertising, preparation and distribution of literature, vehicle labelling and like actions.

The Report contains advice about targeting the information programme, a communications strategy and budget.

The technology based fuel consumption forecasts by class given in the Report provide a suitable basis for choosing Fuel Consumption Targets. Further consideration of the structure of Targets is required, including vehicle class definitions, weighting fuel consumption with measures of consumer utility, and penalty structures.

Targets will be required for commercial vehicle derivatives and should be consistent across Plan Producers and importers.

Improved test procedures and practices are required to enable the lay public to verify the fuel consumption of cars and to manage them for optimal fuel economy. The Report contains further detail on vehicle testing procedures and establishing fuel consumption certification.

Some Ineffective Policy Instruments

A number of other policy instruments were identified by the Brief or proposed by others during the course of the Study. These were considered for various reasons to be less effective than the ones cited above. They included:

- increased annual registration charges;
- abolition of depreciation from company tax deductions;
- a weighting system for company tax deductions, with the weights varying with certified fuel consumption;
- o increase in FBT;
- imputing to personal income tax returns an amount related to the extent of company car use;
- introducing a stringent system of motor vehicle testing for older cars.

Doubtless many other possibilities will emerge as the information in this report is considered by others.

The first four of these would not impact sufficiently on vehicle choice. The fifth can be observed in Britain and the last would impose significant costs on the economy as well as consumers.

Expectations for Various Levels of Intervention

Little, if any, Government intervention is required to deliver an NAFC target of 8.0 litres/100km by 2005. Government can confidently assume that competition between manufacturers and designs inherited from overseas parents will deliver this target. However, the Fuel Economy Support Programme could be worthwhile, and may induce further gains, perhaps down to a Target of 7.5

litres/100km.

Depending on how aggressively the Technology Delivery Programme is pursued (in conjunction with the Fuel Economy Support Programme), the Government could achieve any chosen Fuel Consumption Target within the limits of technology. This was estimated at 6.0 litres/100km, provided new safety and emission standards are not adopted and limits over acceleration performance are mandated.

However, new safety and emissions standards are expected around year 2000, and limits on performance will be strongly resisted by manufacturers and consumers alike. Thus the most realistic expectation under the Technology Delivery Programme is about 6.5 litres/100km.

The Prescribed Fuel Consumption Programme could deliver Targets below 6.5 litres/100km, by downsizing the mix of vehicles sold. Fuel Consumption Targets below 6.0 litres/100km will not be achieved without very aggressive policy action.

A Target of 5.0 litres/100km virtually requires Government to legislate all except mini and small class cars off the road.

Conclusion

The above vision of a technology fix plus Government intervention is not, and should not be construed to be, prescriptive, or even well defined; any education or legislative programmes will require considerable consultation and negotiation with a range of interested parties, especially the automotive industry, user representatives, and government bodies responsible for the administration of safety, emissions and the consequences of climate change.

It should not be forgotten that other avenues exist for reducing Australia's overall fuel consumption, particularly influence over urban structure and the way people use existing vehicles. Whatever policy intervention emerges, it should be applied equally to Plan Producers and importers.

A need for customer acceptance is paramount. Once achieved, the industry will probably be much more accepting of change than appears to be the case at present. But even then:

"It must be considered that there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things."

Machiavelli, The Prince.

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INTRODUCTION

1.1 CONTEXT

Within the context of developing a comprehensive policy response to the Government's planning target to reduce greenhouse gas emissions, the Department of Transport and Communications acting in concert with the Department of the Arts, Sport, the Environment, Tourism and Territories; the Department of Primary Industries and Energy; and the Department of Industry, Technology and Commerce commissioned Nelson English, Loxton and Andrews Pty. Ltd. (NELA) to assess the potential to reduce fuel consumption by new passenger cars sold in Australia. The Greenhouse Unit of the Victorian Department of Conservation and Environment also agreed to participate in the Study.

1.2 OBJECTIVES

The aim of the Study was to assess the potential to reduce fuel consumption by new passenger cars sold in Australia.

The scope of the work required:

- an examination of the experience in Australia and overseas with fuel consumption standards;
- an assessment of the technical capacity for improved fuel economy in motor vehicles over the period to 2005;
- an assessment of the economic implications of meeting fuel economy targets for new motor vehicles of 8, 7, 6, and 5 1/100km by 2005;
- an analysis of possible options for improving fuel economy of new passenger cars sold in Australia.

Commercial vehicle derivatives such as 4 wheel drive vehicles and panel van conversions used for passenger purposes were deemed outside the Terms of Reference.

1.3 APPROACE

The Study was not required to make recommendations. Rather, it was envisaged that the information would be used by Client Departments and perhaps others as a source of information on which they might devise policies and programmes to accelerate fuel economy of the new passenger car fleet in Australia, as measured by the National Average Fuel Consumption (NAFC).

On this basis, the approach envisaged a framework for a possible Government programme(s) of legislation/regulation which can deliver NAFC targets down towards 5 1/100km. Information and analyses were designed to be used within this framework.

There are some constraints on such a programme:

- DOTC is already exploring additional safety controls which may put upward pressure on future NAFC;
- o the Government has a long term commitment to the automotive manufacturing industry through the Passenger Motor Vehicle Manufacturing Plan (hereinafter referred to as "the PMV Plan");
- o there is a prospect that new emission controls will be

considered in the near future.

The scope for achieving these or any target rests on the ability of the industry to deliver technical improvements into new vehicles and the ability of the Government to influence the choices made by manufacturers and the public.

During the Study, it became evident that commercial vehicle derivatives, which are currently a very small component of passenger motor vehicle stocks, may attract a much larger share of passenger car buyers than at present. The Study was unable to deal with this issue in any depth, but where increased penetration of commercial vehicle derivatives may prejudice the information provided, a comment was included as appropriate.

1.4 REPORTING SYSTEM

Many of the detailed results of the investigation are contained in a series of seven Working Papers as follows:

Working Paper No.

| Paper No. | Title |
|-----------|---|
| | |
| 1 | Available Options for Fuel Efficient Technology |
| 2 | Documentation of Technologies Available to Improve |
| | Vehicle Fuel Economy |
| 3 | Production and Marketing Factors Affecting |
| | the Introduction of Fuel Efficient Technology |
| 4 | Population, Passenger Car Stocks and Fuel |
| | Consumption Performance |
| 5 | Report on an International Conference on Tomorrow's |
| | Clean and Fuel-Efficient Automobile, Berlin, |
| | 25-28 March, 1991 |
| 6 | Review of Policy Instruments Available to |
| | Governments |
| 7 | Definitions, Process and Procedures |

While every attempt has been made to incorporate in this Report sufficient information to support the interpretation and conclusions made, the reader is encouraged to examine the various Working Papers (hereinafter referred to as WPs) for more detail.

There is an extensive bibliography included in WP7.

THE AUTOMOTIVE INDUSTRY

2.1 INDUSTRY DESCRIPTION

The Australian firms concerned with the sale of passenger motor vehicles can be regarded as comprising the Ford Motor Company of Australia, General Motors-Holden's Automotive Limited, Mitsubishi Motors Australia Limited, Nissan Australia and Toyota Australia (hereinafter referred to as the "Plan Producers"), who manufacture and import passenger vehicles, and some 35 other importers. In addition, there are a number of smaller firms which make specialist vehicles, convert imports or improve performance of products obtained from other firms, but their sales are not large and they are not considered further.

The Plan Producers are wholly or substantially owned by global manufacturers based in the United States and Japan. There are perhaps 500 firms supplying components to the industry.

The Plan Producers have capacity to manufacture some 400,000 units annually, although this might be increased to 600,000 if two shifts were employed (Industry Commission:1990,p.203). Plants are mostly located in the suburbs of Melbourne and Adelaide, though there is a plant in Sydney and an engine plant at Geelong. They typically invest about \$500m annually (1988 dollars) on these facilities, which built 330,416 passenger motor vehicles (PMVs) in 1988.

The Plan Producers employed 32,421 people at December, 1990, and the 35 large component manufacturers employed another 23,266 persons. There were large falls in employment in the second half of 1990 (AIA:1990,p.61). In 1988, there were about 60,000 persons employed in distribution and another 250,000 engaged in automotive repair and servicing (Industry Commission:1990,p.24).

Thus the total employment in the industry is probably in the range 300,000 to 350,000 persons, allowing for falls in the distribution and repair sectors during 1990.

2.1.1 Trends in Motor Vehicles on Register

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The Study obtained from ABARE the outlook for PMVs on register through to 2005 shown in Figure 2.1.

The number of PMVs on register is expected to grow from 7,243,600 in 1988 to 10,257,000 in 2005. During this time the population is expected to grow to about 20.4 million.

Car ownership is expected to rise from 0.44 to an estimated 0.50 passenger cars per person. At this stage Australian car ownership will be well on the way to an assumed saturation figure of 0.55 cars per person.

In 1988, about 86 percent of cars operated in the capital and major provincial cities. About 10.4 percent were operated by businesses, and Fringe Benefits Tax (FBT) was paid on nearly 0.5 million of them.



Source: Donaldson et al (1990); ABS Cat. No. 9303.0

Apart from company owned cars, which are thought to be replaced every 3 to 4 years, the fleet has aged somewhat during the 1980s, from about 6.4 years in 1980 to about 8.6 years in 1988. This ageing arises because of reducing scrappage rates; only about 3.5 percent in 1988.

The age of the fleet is expected to reduce only very slightly during the period to 2005. Tariff reductions under the PMV Plan is expected to induce a fall in real prices, which will flow through to sales volume and scrappage rates. These are expected to rise to about 3.7 percent, or about 380,000 vehicles in year 2005.

2.1.2 Classification of Passenger Cars

Mostly, the industry classifies cars according to a system published by Paxus, a commercial statistician. Paxus does not publish definitions of vehicle classes, and an inspection of Paxus classifications made from the point of view of the Study objectives revealed some inadequacies and anomalies.

The Study therefore reclassified passenger cars into seven market classes, but retaining the Paxus classification as far as possible. The adopted classes were: mini, small, medium, upper medium, sports, luxury and upper luxury. Car models were aggregated on the basis that vehicles in each class were approximately similar in consumer perceived attributes of size, price and performance.

Within a market class, vehicles can be expected to have similar potential for technological improvement, while competitive pressures would assure similar effects on retail price within a class. A list of models by class is provided in WP1. For ease of reference, the Commodore/Falcon size vehicle falls in upper medium, with other locally manufactured cars such as Magna, Camry and Pintara falling in medium class. Mini cars are characterised by the Holden Barina and small cars by the Ford Laser. WP7 describes the class structure, and the inconsistencies which caused the change from industry practice.

It was considered that if Australia were to enter into a policy of fuel economy, a new classification system would be needed for administrative purposes. The nature of any new classification system will, to a large extent, depend on the objectives of the policy formulated. Some useful variations are discussed in McNutt and Paterson (1986).

2.1.3 Trends in Sales of New Passenger Cars

According to the <u>Australian Fuel</u> <u>Consumption Guide</u> to <u>New</u> <u>Vehicles</u> (DPIE:1988), there were over 300 models on sale in Australia in 1988. Most fall in the small and luxury classes, the fewest in upper medium. Figure 2.2 illustrates the sales volume for new PMVs over the period 1975 to 2005, which covers the period over which fuel consumption statistics have been kept in Australia.

Over the last 25 years, new passenger car registrations have fluctuated from just over 330,000 in 1965 to nearly 510,000 in 1985. However, growth is not steady, with a fall to 364,000 in 1987 and subsequent regrowth to 410,473 in 1988 and nearly 450,000 in 1990.

After discussion with other researchers and manufacturers, and consideration of changes to tariff policy following the Government's March Industry Statement, new car sales were projected to rise to about 498,000 in 2005. This forecast used ABARE vehicle population forecasts as a control total. Intermediate estimates of 464,000 and 496,000 were obtained for years 1995 and 2005 respectively.

Passenger cars represented nearly 79 percent of new registrations in 1988. Of these, 26.7 percent were mini and small class vehicles. The proportion of new vehicles sold into the mini and small classes fluctuated through the 1980s, from about 24 percent in 1980 to 27.8 percent in 1989 and nearly 35 percent in 1990.

Sales mix is an important issue for fuel economy, and the Study constructed an econometric model to predict this on the basis of surveys of consumer choice during the early 1980s. Refer WP7.

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This model was used to estimate the sales mix under various technical and policy scenarios. For a "steady as she goes" projection (but accounting for tariff cuts and dollar devaluation) the proportion of mini/small cars at 2005 was estimated to be about one percent above 1988 levels, at the expense of the luxury and upper luxury classes.



The Study views the very sharp rise in mini/small class sales in 1990 as a short term fluctuation; the rise is seen to be due to the 1989-91 recession plus the effects of the luxury car tax which virtually stopped sales of vehicles priced over \$45,000 during the period. Now that the tax has been removed, the sales mix is expected to settle back to former levels as economy recovers.

It is important to note that about 52 percent of all passenger cars sold, or 213,458 cars in 1988, were registered to companies or Government (referred to as "business cars"). Business and Government tend to purchase the larger class vehicles, perhaps 80 percent of upper medium, luxury and upper luxury cars are sold to them.

2.2 MARKET REQUIREMENTS

When considering consumer preferences and the ability of manufacturers to deliver them while continuously enhancing fuel economy, it is important to consider the history and culture of the automotive industry, so as to gain an understanding of the nature and extent of change implied by the prospect of a policy of fuel economy. Private and business new car buyers commonly have different purchasing criteria for their cars, and all Australians drive under quite different conditions than those of the early years of automobile manufacturing in Australia.

Also, it is important to remember that manufacturers are in competition; if consumer preferences point to vehicle attributes which are not conducive to fuel economy, manufacturers will not deliver this. Rather they will seek to outdo one another by supplying the attributes their customers want. For example if customers want (say) acceleration performance, government intervention may be required to limit acceleration and so preempt

the competition.

2.2.1 Background - the Automotive Tradition

The attitudes which drive the design of cars sold in Australia are essentially based in overseas markets, subject to a tradition of the "Australian Car" which has developed since 1948. The myths and legends which grew up in the formative years of the industry through to the early 1970s are still strong in the minds of Plan Producers.

There is a dichotomy of consumer attitudes which is relevant to the marketing of cars in Australia. The first is the "smarter, larger, faster" tradition for which European cars such as Mercedes and Ferrari provide the icon, and which leads a continuing upward pressure on acceleration performance, luxury including a large range of options such as air conditioning, stereo sound systems, and so on. The "Australian Car" derives from the myth of the bush: cars are built for rough country roads, towing horse floats through "Marlboro country" and country picnics with the family.

Both myths are apparent among TV advertising programmes and the images of sales literature. An image of elegance and power is communicated by Mercedes Benz, BMW and more recently the Honda Legend and the Nissan NSX. The workhorse image is found in advertising for Holden and Ford cars and wagons, and some commercial vehicle derivatives such as the Toyota Tarago.

The product features of "Australian Cars" reflect an holistic approach to perceived consumer needs, and variously include: o large interior and boot space provision, to accommodate

- large interior and boot space provision, to accommodate nuclear families, especially on social visits and holidays;
- torque characteristics which deliver high performance with maximum speeds up to 200kph and relatively high acceleration performance (0-100kph in 10 seconds or less) to facilitate overtaking on narrow two lane roads;
- relatively stiff suspensions and direct steering (by American standards), to accommodate tight curves and deliver good road holding capability on poor quality roads;
- strength characteristics, clearances, tyres, accessories (cooling system) and dust sealing to cope with regular use on rough roads.

In addition, the product delivers a good towing capacity (1200-1500kg) to provide for:

- o recreational demands (weekends, holidays in the country);
- rubbish disposal from backyard gardening;
- a large rural market (horse floats, etc.)

This mix of attributes is unusual in other OECD countries and perhaps reflects the experience of the 1960s when imports did not translate well to Australia. Be it exotica or workhorse, neither the marketing images or the product features of the "Australian Car" pay much concern to fuel economy.

2.2.2 The Reality of the Australian Motoring Environment

Some of the assumptions underpinning the automotive tradition in Australia do not stand scrutiny in the motoring environment of the 1990s, and the outlook departs even further.

Firstly, the market has segmented substantially over the past 20 years, as reflected by the 300 models on offer. This flows inevitably with the growth of car ownership. The rise in car ownership to 0.44 during the last 20 years has been associated with a rise in cars available per household from about 1.10 to nearly 1.5 (in urban areas). Over the last 10 years, average household size fell from 2.98 to 2.71 persons. Females now represent 44 percent of all licensed drivers in Victoria.

This segmentation is expected to continue into commercial vehicle derivatives as our car ownership approaches 0.5 in 2005. In the United States, the rise in car ownership from 0.42 in 1972 to 0.5 in 1990 was associated with a growth in light commercials to about 35 percent. Penetration doubled between 1972 and 1978 (before CAFE legislation was in place).

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It is no longer necessary or desirable for manufacturers to try to produce a vehicle which delivers the full range of services required by all buyers. Rather, niche marketing is a more appropriate outlook for the Australian car industry. Secondly, driving on rough roads is a virtual irrelevancy. Although about two-thirds of Australian roads remain unsealed, only 2 percent of rural car travel occurs on unsealed roads. Urban roads are nearly all sealed.

Thirdly, the condition of the road system does not require high acceleration performance to ensure safe overtaking on two lane roads. WP3 reports a Study investigation which suggests that any vehicle which can accelerate from 70kph to 90kph in three seconds or less can accept the upper two thirds of gaps normally accepted by overtaking drivers. Any car that can meet this performance in top gear is perfectly safe to drive on two lane roads.

In other words, only leadfoots need better acceleration performance, and it was concluded that any car which can accelerate 0-100kph in 10 seconds or less should be regarded as overpowered. There are many exotic cars in this category, and some "Australian Cars" as well. It was concluded that, under any policy of fuel economy, governments may need to cap the continuing upward growth in engine power, and particularly acceleration performance.

WP1 suggests that it may be possible to decrease power-to-weight ratio by 10 percent in all classes except the mini-car class, and an additional 10 percent is possible in the upper-medium and luxury class (for a total of 20 percent). This would place all cars in the acceleration performance range of 10 to 12 seconds for 0-100 km/hr.

A simple calculation shows that this leads to a net 3 percent

reduction in NAFC, possibly at some expense to consumer satisfaction. However, before introducing any such constraint, it would be desirable to consult further with State Road Authorities on the safety implications.

2.2.3 The Consumer's Viewpoint

A little more than half of new passenger cars are bought by companies and Government; the rest by private buyers. The former market can be regarded in terms of fleet vehicles (car pools, taxis, etc.), management vehicles and home occupation.

Although this nominally appears to define four market segments, an examination of the determinants of consumer choice indicate that, from the point of view of this Study, the fuel economy consideration can be validly made in the context of only two markets.

The first is comprised of private, management and home occupation vehicles, which are referred to as the "private market". This group appear to look for the same quality attributes and product features in their cars, and the fact of ownership arrangements can be regarded as incidental.

The second consists of vehicles sold to companies and Government for use in car pools, hire, sales, etc. For this market, price is very significant.

There are many factors which influence a private consumer's decision on which model to buy. Price, size, brand loyalty, appearance, recommendation, engine size and reliability were cited before fuel economy for selecting a particular model.

As is the case in overseas markets, fuel injection and diesel engines represent most of the limited opportunity Australians have to spend more money in search of fuel economy. This reflects the situation that consumers are not particularly interested in fuel economy (fleet managers excepted) and manufacturers promote it in only a limited way.

Price affects both new vehicle purchases and scrappage rates, the elasticities being 0.6 and 0.66 respectively. For fleet vehicles, whole-of-life costs are the most relevant.

However, the attitude to price for top echelon management vehicles is unclear. Research suggests that companies buy these cars on the basis of status and luxury only, with little concern for price. Yet the recent 50 percent luxury car tax had a very significant impact on sales of new luxury cars. However, the tax was not applied long enough to indicate whether executives downgraded or simply held the previous car for a year longer.

Consumers do not view the issue of size in terms of "bigger is better". Rather, consumers tend to consider a range of factors, including fuel economy, household life stage, garaging and parking arrangements, etc., and select a size of vehicle which is appropriate to their particular needs.

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They often make this decision before entering a showroom, and once the size decision is made, fuel economy becomes less relevant.

Australians strongly prefer cars with substantial interior volume. They appear willing to trade-off fuel economy for size and performance. Medium, and larger cars made up nearly three quarters of all sales in 1988.

For consumers, appearance and comfort is manifested by the European look, airconditioning and sound systems. These latter penalise fuel economy.

Power and performance is regarded in terms of acceleration or "zip", high cruising speed and towing capacity.

There are two components to acceleration: "launch feel" which is highly valued but which can be economically delivered by appropriate gearing; and overtaking capability which has safety implications. It is important to remember that several research studies have concluded that consumers do not value "zippy" vehicles as much as conventional wisdom might assume.

High cruising speed has been of concern to road administrators in many countries on both safety and fuel consumption grounds. The 55mph speed limit in the US, 100kph speed limit in Victoria, and recent statements in Europe about speed limits on freeways and speed limiters on cars all attest to this concern.

Although some Australian consumers undoubtedly need towing capability, the fact that a "towing pack" is available as an option rather than standard equipment indicates that it is far from a uniform requirement. In addition, towing requirements can be addressed via appropriate selection of drive train, and the various equalising devices which are recommended, even for front wheel drive vehicles.

2.2.4 Market Intervention

There is a great deal of Government intervention at all levels in the market - manufacture, sale, ownership and use of cars. The instruments include the <u>Guide to Fuel</u> <u>Consumption of</u> <u>Australian</u> <u>Passenger Vehicles</u> (hereinafter referred to as the "<u>Guide</u>"); various forms of tariffs, excise, sales taxes, retail fees, and charges; plus command and control instruments such as the Australian Design Rules (ADRs) over vehicle design and emissions.

Taxes and Charges

Very large amounts of money are raised annually, in the order of \$12 billion in 1988-89, with sales taxes, fuel taxes and State registration charges raising the bulk of the revenue. The amount of sales tax raised from the sale of new passenger cars is unavailable, but is thought to be of the order of \$2 billion annually. Resource Rent Tax and excise on fuel raise about \$1.2 billion and registration charges about the same amount. State franchise fees on fuel raise almost \$700 million, and import duties are in the order of \$400 million annually.

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These taxes and charges impact on and distort the price signals received by consumers, and hence affect their decision making and the feedback received by automanufacturers.

There would seem to be ample opportunity for Government to rearrange these taxes and charges so that consumer behaviour more directly impacts on fuel economy, without changing the total revenues obtained by Government. Thus the important road cost recovery and income redistribution issues involved in the system of taxes and charges need not necessarily be prejudiced by such rearrangements.

Tariff Protection

It is expected that production and import of cars will continue to be subject to the PMV Plan at least up to year 2000. The PMV Plan operates on tariff protection, with rates dropping 2.5 percent per year to 15 percent in 2005. There is a complicated system of tariff credits available, whereby Plan Producers can import vehicles duty free provided they create exports.

The Government's stated objective is the development of an Australian automotive industry that is viable and internationally competitive, providing higher quality vehicles at lower real prices to consumers.

However, the system of export credits will decline in value to producers as the planning period proceeds. Thus this type of influence over the industry will decline.

Most observers accept that as protection declines, there will be a major fall in volume of Australian production, although there is considerable debate about the extent of that fall.

Automotive manufacturing is a capital intensive activity, and break even production volumes are not less than about 125,000 vehicles annually, much higher if some types of mass production techniques are used. No Australian plant operates at this level and the viability of Australian manufacturers is compromised by low volume, suboptimal production and work practices, and external costs including Government charges.

Statements by the Minister for Industry, Technology and Commerce have foreshadowed some rationalisation among Plan Producers during this decade. DITAC have argued that the system of export credits will encourage the industry to look to export markets for increased volumes, and hence economies of scale.

In discussions, some manufacturers suggested that their survival to date is largely due to their being able to find a niche in the global strategy of overseas owners.

The strength of the Australian industry is in manufacturing medium and upper medium class cars, although there is a growing export market in components. Much of this is from Plan Producers, but some Australian components manufacturers have strengths which have been proved in the export trade and which should be considered in any future fuel economy policy.

2.2.5 A Cautionary Note

It was concluded that even if there were no further Government pressure on Plan Producers, Australian production in 2005 could easily fall to the lower end of the range estimated by the Industry Commission (1991), i.e. 250,000 to 300,000 units per year. This would mean that only half the new vehicles sold in Australia would be made locally, compared with 80 percent in 1988.

There was a continuing concern in the Study that any fuel economy policy which pressures Plan Producers to change production to mini or small vehicles (if that is required to enhance Australia's fuel economy) will favour importers. Firstly, there is precedence for this in the US. Secondly, Australian production lines are set up to produce medium and upper medium cars, and policies which force change to this will maximise costs to the industry and possible loss of employment. Thirdly, Japanese manufacturers are world leaders in small cars and command much higher volumes per plant than would be possible in Australia. It is difficult to see that Australian plants could compete with them easily.

In a world where there is a surplus of automotive manufacturing capacity, there seems to be no reason for overseas parents to allow Plan Producers to invest in an Australian production capability which will compete directly with overseas plants. It is possible that some advantage to the parents' global strategies can be found, but the nature of this is not now obvious.

Even if they did agree, substantial investment in new plant and equipment would have to be eventually funded from profits made in Australia. The industry has not had a strong record in profitability.

On balance, it was concluded that any significant pressure flowing from a new fuel economy policy which causes a shift in market share from medium/large cars to small cars carries with it considerable risk of an abandonment of manufacturing of the traditional Australian medium and large car and a fall in the number of Plan Producers and plants. This could exceed falls which have already been foreshadowed by the Minister for Industry, Technology and Commerce.

It was concluded that the ADRs constitute a reasonable control over mechanical, safety and emissions matters, and are not unduly intrusive. However, there is still significant scope for harmonisation with standards overseas, and where possible this should be accelerated so that they do not become a defacto barrier to cars made in Australia being marketable overseas without modification.

The Study assumed that additional safety and emissions controls equivalent to the expected US 1994 standards would be promulgated some time between year 2000 and 2005, and it was considered that this would not constitute an unmanageable barrier for producers. 1.1

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2.3 PRODUCTION CONSTRAINTS

Automobile production is a "long lead" technology, which means that even in the "leanest" production plants, manufacturers' product cycles, and consequently their production programmes, are held for at least 5 years and a period of 20 years can elapse between design conception and full production.

Right up to the 1980s, there was little need for manufacturers to think internationally. Australia was perceived to be a unique, low volume market and, given the wide choice of models demanded, manufacturers had to minimise investment costs and extend model life to 8 years or more, so that economic production volumes could be achieved.

In recent years, Plan Producers have been working hard to introduce flexible manufacturing techniques to allow a greater range of products and shorter model runs. Doubtless this will continue, but it is important that any new fuel economy policy envisages manageable changes to manufacturing process; this means having an eye to vehicle attribute changes which can be implemented at the margin, rather than a complete restructuring of production lines.

Even if technology costs could be recovered from the market, major changes to process might take years to implement and place a manufacturer in a position where the only alternative may be to revert to producing the previous generation of vehicles.

If this were to occur, either fuel economy of new vehicles in the Australian market will not improve, or there will be a rapid rise in imports. The following discussion considers the industry's capability to cope with additional pressures.

2.3.1 Development Potential

With few exceptions, the original design of cars sold in Australia is sourced in Europe, Japan and the U.S.A. Holden and Ford have strong design staffs, but Australia is too small a market for all Plan Producers to do this. Nonetheless, Australian designers have influenced the global strategies of more than one overseas owner.

The main implication of this situation is that Australia is not in a position to introduce technology in local vehicles ahead of its development overseas by parent companies. The overseas parents are, of course, technology leaders and familiar names such as Ford, General Motors, Toyota and Volvo appear in the ranks of makers of prototype and concept cars.

Whether Australia lags behind the rest of the world in fuel economy depends on a number of factors, including:

- the signals given to manufacturers by consumers. If new car buyers place no value on fuel economy and a manufacturer perceives this, then there is little incentive for the manufacturer to build clean and fuel efficient cars;
- the competitive climate; i.e. if a competitor is increasing market share at the expense of one company because the

competitor's cars are more fuel efficient, then it is to be expected that the company will seek assistance from its parent; ÷ -,

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o the global strategies of parents. Typically, manufacturers target the large markets (i.e. Europe, Japan, the US) and would look to a small market such as Australia as an add-on to those large markets. Driving on the left side of the road does not assist Australia in that respect.

There are however, one or two qualifications. In other industries, such as computer manufacture, Australia is used as a test market and hence equipment is brought here almost as soon as it appears in large markets.

This does not usually happen in Australia as far as can be ascertained, because of a lack of test facilities. However, there have been incidences where cars have been brought to Australia for testing in the outback.

Introducing new technology is very expensive in terms of research expenditure and retooling. Australian human resources in research are good but the establishments are still evolving under Government incentives of the last few years. Also, while tax incentives for research are adequate, incentives for development investment and capital equipment are not as advantageous as in some other countries, including the home countries of the global manufacturers.

There is also a problem in that further engineering of overseas manufacturer's products by third parties in Australia have to run the gamut of legal constraints which prevent the Australian third party from holding a patent.

Rather than overseas countries using Australia as a base, the experience has been that Australian inventors and researchers have had to go overseas for development capital (e.g. Sarich). Those inventors' experience is that the Australian Government is singularly unsympathetic to the prospect of incentives to manufacturing development.

It is possible that a change to this climate would encourage the overseas parents to look more sympathetically on technology transfer to Australian staffs, but such a change to this climate was considered unlikely and not developed in the Study context.

2.3.2 Manufacturing capability

As discussed in WP3, all Plan Producers manufacture or assemble engines locally, and between them a full range of sizes (1.6 litre to V8) are produced.

The components sector should not be underestimated. Holden has a multi-million dollar export business with its Family II engine, Mitsubishi and Nissan export aluminium castings, and National Springs exports springs to Mercedes. Total components exports amounted to \$449 million in 1989.

For Australia's export potential to continue, it seems likely

that channels through the Plan Producers' overseas owners may have to be enhanced. Hence the design of vehicles manufactured in Australia should desirably be compatible with the global product of manufacturers offshore, and requirements in the mega-markets.

There is an extensive R&D capability in Australia, but it is suggested that there is a significant gap between the capability here and that available in the larger markets.

Most Australian suppliers have access to R&D facilities overseas via their parent company or by licensing agreements with overseas firms. This is particularly so for critical items including pistons, electricals, bearings and seals.

Local R&D facilities are mostly used for auditing and process improvement, with overseas parents' specifications being used for the products that are purchased locally.

A special case is the research arm of the Orbital Engine Company which is becoming recognised as a technological leader in the area of fuel economy, and has one of the best independent R&D establishments for internal combustion engines in the world.

Uncertainties affect the propensity of manufacturers to invest. In a business environment where there is significant Government intervention, manufacturers are less likely to be willing to invest in plant which cannot be amortised quickly. Rather, they will undertake assembly by manual techniques and import or buy in components.

It appears that rates for direct labour are not a significant penalty on Australian manufacture. However, labour costs per unit of production are of concern due to production inhibiting work practices which have evolved over the years. These, together with a choice of mass production versus lean production techniques, the need for microeconomic reform in other economic sectors and the plethora of Government charges, cause Australian cost structures to be uncompetitive. Refer WP3.

It should be noted that Plan Producers already have extensive employee relations programmes in place, for implementation of cost savings and quality improvement.

The ease of introduction of new technology can only be assessed subjectively, because judgement depends on whether a manufacturer adopts mass production or lean production techniques, the capability of component suppliers, penalties applicable to imported components, and the microeconomic environment imposed by industrial relations matters and systems of Government supervision, taxes and charges.

Introducing new technology will be easier for some Plan Producers than others. For example, the Falcon and Commodore are technologically old vehicles (from a fuel economy point of view, e.g. they both are still rear wheel drive). It may be expensive for them to change.

On the other hand, Plan Producers have already embarked on

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programmes of reducing weight and drag, and improving tyres and lubricants. The penetration of these devices varies with manufacturer.

Also, Plan Producers' ongoing capital investment programme, although confidential to each firm, is likely to include many of the technologies required for fuel economy discussed in Chapter 3.

However, a judgement was made that a new fuel economy policy would require Plan Producers to bring forward investments totalling about \$1700m. in 1988 dollars, which would otherwise be spent between year 2000 and 2010. This is elaborated in Section 5.3. In addition, they would have to import those necessary components which cannot or would not be manufactured in Australia due to capital availability and volume restrictions.

The Orbital Engine Company has no plans to manufacture engines in Australia and it was assumed for the purpose of assessment that 2-stroke engines would be imported.

It was concluded that Plan Producers could respond to a fuel economy policy which requires maximum penetration of applicable and available technology, but that they would have to bring certain investment programmes forward by five years. The estimated net present value of this additional capital expenditure was estimated to be about \$200m. in 1988 dollars.

2.4 A LOOK TO THE FUTURE

Policies which encourage fuel economy in new vehicles sold in Australia will need to encourage manufacturers to design, produce and bring to the domestic and export market a range of clean and fuel efficient passenger cars. In the absence of such encouragement, there are no imperatives which require overseas owners to comply.

Some of the dimensions relevant to policy formation include:

- the Australian domestic new car market is likely to grow only slowly to 498,000 PMVs by 2005. Even if sales tax were abolished, it would grow only to about 558,000 PMVs.
- Within this market, the proportion of commercial vehicle derivatives is likely to grow from about 4 percent in 1988 to about 18 percent, or about 90,000 to 100,000 units in 2005.
- 3. There is likely to be a very large developing market in countries within striking distance of Australia (viz. South East and Central Asia, Africa). However, there are two factors which make it unlikely that Australia will be able to export assembled cars to those countries in any quantity (Britten:1991):
 - those countries are likely to want to assemble cars themselves under protective tariffs;
 - established global manufacturers are facing shrinking home markets and have large surplus capacity. They may

not welcome Australian subsidiaries' pressure to export assembled cars, particularly small cars;

- 4. It is not unlikely that, provided the global strategies of overseas owner manufacturers permit (or can be made to), there could be a large market in Australian made components, and especially if the domestic and export markets are technically compatible. The PMV Plan is of course pursuing this and other export possibilities.
- To maintain a components industry, Australia will have to maintain an assembly function. This appears entirely feasible, especially if Plan Producers can make 125,000 or more cars per plant per year using lean production techniques (Womack et al:1990).
- However, the pressure of the PMV Plan, global rationalisation of manufacturers and lean production techniques among Australia's competitors may lead to a rationalisation among Plan Producers.
- 7. For a range of reasons, it is likely that cars manufactured in the developing countries will not be particularly fuel efficient, despite the economic imperatives that will apply in those countries. They will look for employment opportunity before environmental protection and may receive favoured treatment in the purchase of fuel.
- 8. A lead based on fuel efficiency, if any, is likely to come from those global manufacturers who first get a foothold in those countries. For Australia, it is clear that a reputation for making fine cars and components needs to be maintained. This includes demonstrating that Australian cars are as fuel efficient as others overseas.
- 9. The current pressure for fuel economy in light passenger vehicles is driven by the greenhouse agenda. This may or may not be reinforced by concerns about fuel security. According to ABARE (1991), fuel security seems to be a 50/50 bet; but whatever that outcome it would be sensible for Australia to develop policies which minimise fuel use. A new fuel economy policy might consider this.
- 10. It is not unlikely that pressures for clean and fuel efficient motor vehicles will move higher and higher on the public agenda; it would be sensible for governments to reinforce this.
- Thus the pressure for "smarter, larger, faster" cars is likely to be reversed; indeed there is evidence of this happening already.
- 12. If this scenario is accurate, the competitive position of Japanese based manufacturers in Australia will improve. The parents of US based Plan Producers could introduce cars such as Corsair and Taurus, which consume less fuel than, for example, Commodore and Falcon, but this is not likely to reverse the outcome.

FUEL ECONOMY PERFORMANCE

The Study was required to assess the performance of cars sold and used in Australia, and sought to identify measures of performance at different levels, viz., at the individual vehicle, the National Average Fuel Consumption (NAFC) and the Fleet Average Fuel Consumption (FAFC). The NAFC represents a sales weighted average of the fuel consumption of new vehicles which enter the fleet each year, while FAFC represents the average on road fuel consumption across all passenger cars on register.

As discussed later, international comparison was used as the basis of assessment, so comparable measures were required.

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3.1 EXISTING TEST PROCEDURES

In the main, fuel economy testing of motor vehicles in Australia is undertaken by manufacturers only, the exception being that there are testing facilities in New South Wales and Victoria which test on a sample basis.

There is no mandatory requirement for manufacturers to test new vehicles for fuel consumption, but a voluntary arrangement exists whereby manufacturers report tests undertaken according to AS 2877-1986. This test procedure prescribes strictly controlled rules over standard loading, dynamometer settings, consumer driving cycle, as well as some other significant matters.

Manufacturers submit test results to the FCAI pursuant to the FCAI <u>Uniform Code of Practice on Furnishing Fuel Consumption</u> <u>Data</u>. The FCAI collate these results and they are then published annually by the DPIE in the <u>Australian Fuel Consumption</u> <u>Guide for</u> <u>New Car Buyers</u> (DPIE:1990).

The only testing of on road vehicles is undertaken by the EPAs in NSW and Victoria, whose primary purpose is to test for emissions. Fuel consumption results are reported at the test car level, but there is no attempt to use these results to obtain FAFC.

An alternative method of estimating FAFC is through national statistics on vehicle use and energy consumption. This is done from time to time by purpose driven studies and as the statistics come available (about every three years).

3.1.1 Test Procedures - Are They Good Enough?

Concerns about the prevailing test procedures were a recurring theme throughout the Study. These arose because of a finding that cars sold in Australia appeared to be less fuel efficient than apparently similar cars sold overseas. This issue is addressed in Section 3.4.

Requests made to Plan Producers for information about test results and Corporate Average Fuel Consumption (CAFC) were refused, even after DOTC had interceded on behalf of the Consultant. If manufacturers' achievements in fuel economy measures are to be monitored in future, either under a voluntary code or through regulation, more rigorous procedures need to be instigated to ensure this information is both available and capable of being readily verified.

A second issue arises when attempts are made to use information in the <u>Guide</u> for the purpose of international comparison. Nominally, AS 2877-1986 is identical to the US Federal Test Procedures (1976) and an attempt was made to compare results with information available in the US EPA Test Data Book.

For several reasons, it was necessary to use some caution in the comparison. Note that the FCAI Code provision for rounding of test results can introduce a discrepancy of plus or minus 3 percent in the published figures.

For comparisons made on the basis of FAFC, on road fuel consumption can be up to 25 percent higher than the AS 2877-1986 figure because of:

- the effects of age on engine tuning, friction resistance, transmissions, tyres, etc.;
- aggressive driving including rapid acceleration, and high speed driving;
- on-road congestion, short journeys, cold starts etc, which results in actual drive cycles differing from test drive cycles.

A systematic bias is introduced into this comparison by the use in AS 2877-1986 of a US drive cycle(s) and a 55/45 weighting for city/highway driving. The Australian urban drive cycle is different (Watson:1991) and the city/highway transport task is 73/27 in Australia.

If Australia is to encourage consumers to place more emphasis on fuel consumption in their purchasing and vehicle management decisions, something must be done to provide clearer and more meaningful comparative data. Any factor applied to the AS 2877-1986 test results should result in a fuel consumption figure typical of that which the average driver would achieve under normal driving conditions.

Government should also note that overseas countries which administer a fuel economy policy have robust testing procedures.

3.2 TRENDS IN NATIONAL AVERAGE FUEL CONSUMPTION

Figure 3.1 shows that following a sharp drop between 1978 and 1980 (coinciding with the introduction of voluntary standards), the NAFC has declined more or less linearly, achieving 9.2 1/100km or a 23 percent decrease by 1989.

The increase above the trend during the 1986-87 period appears to coincide both with an increase in sales of upper medium classes (which may reflect the importance of class mix in the trends) and the introduction of ADR 37 (which may reflect the fuel consumption penalty associated with emissions control).

The figure shows the FCAI target of 8.0 litres/100km for 2005, which essentially extrapolates the trends of the period 1981-1986. Wylie (1990) commented that this target could be reduced

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only if there were a downsizing of the mix of vehicles sold. This happened in 1990, and the official NAFC was put at 8.92 litres/100km.

FIGURE 3.1: ACTUAL AND TARGET NAFC, 1978 - 2005



--- Actual NAFC by Year

Source: FCAI September 1998

3.3 TRENDS IN FLEET AVERAGE FUEL CONSUMPTION

FAFC fell steadily from 12.6 1/100km in 1976 to 11.8 1/100 km in 1988. Refer WP4. In that period, total distance travelled by cars and station wagons increased by 49 percent, total fuel use by 41 percent and gasoline use by 34 percent.

This improvement in the fleet average is a result of a number of factors, including the declining NAFC and some substitution for gasoline by LPG. The share of total gasoline consumed by cars and station wagons increased from 76.6 percent in 1976 to 81.2 percent in 1988. Improvements may have been retarded by the ageing of the car fleet.

An important issue is the extent to which FAFC is affected by new vehicles entering the fleet. It is perhaps too easy to think that by introducing policies which operate on new vehicles only, that the NAFC will quickly fall into line.

The low volumes of new vehicles sold, and low scrappage rates, produce lags which restrain the flow through of savings arising from new clean and fuel efficient vehicles into FAFC. For example, FAFC in 1979 was 16.5 percent higher than NAFC, but by 1988 the discrepancy had <u>increased</u> to nearly 30 percent.

Policy instruments which operate on new vehicles but which might impact on FAFC quickly are those which increase the volume of clean and fuel efficient vehicles entering the fleet, which

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operate to downsize the vehicles bought by companies and Government, and which apply pressure to retire the remaining high consumption vehicles of the 1970s.

3.4 FUEL CONSUMPTION COMPARISON OF AUSTRALIAN AND OVERSEAS CARS

A comparison was made of the fuel economy for passenger cars sold in Australia and equivalent vehicles sold overseas (WP4,Section 6.5). In principle, these comparisons provide an assessment of the fuel efficiency of cars sold in Australia. They were made at three levels, so as to obtain different perspectives:

- (a) individual make/models on sale in Australia in 1990 were compared with equivalent make/models sold in the US. The comparison was made in terms of fuel consumption as reported in the <u>Guide</u> and by the US EPA <u>Test Data Book</u>. This was considered relevant to whether new vehicles available for sale in Australia deliver equivalent or similar fuel consumption to mechanically equivalent vehicles sold elsewhere. The results provided a baseline against which one might assess the benefits of transporting technology available overseas into Australian production;
- (b) a comparison on the basis of the NAFC statistic as published by the authorities in various countries provides a perspective of the fuel consumption implications of the sales mix of new vehicles entering the fleet, and how these might be affected by the overall transport task undertaken;
- (c) a comparison on the basis of FAFC statistic assesses the aggregate outcome of fuel use per unit transport task.

In considering the results, it was not the intention to make a value judgement about the relative merits of cars in terms of their suitability for their respective markets. Doubtless they are all fine cars, and suitable to market, otherwise they would not survive.

3.4.1 Comparison of Individual New Vehicles

The evidence documented in WP4 showed that for more than half the cars examined, there was a discrepancy in the order of 10 to 15 percent in fuel consumption with the Australian models having higher fuel consumption in each significant case. Most of the high sales volume cars, with the notable exception of the Mitsubishi Lancer and Hyundai Excel, appear to have fuel consumption ratings ranging from 10 to 24 percent higher in Australia. Among low volume direct imports, fuel consumption differences are essentially zero, except in isolated cases such as the Mazda 929.

These latter results suggest that there is nothing unique about Australian conditions that should cause a large difference in fuel economy, between equivalent vehicles. This element of the analysis may be controversial, but the fuel economy of Australian and U.S. models should be nearly identical if all technological factors are controlled in the comparison.

The discrepancies identified were referred to Plan Producers, and

discussed with the SAE LVCC and the Client. The discussions indicated that the issue is extremely sensitive and in particular, the US based producers strongly resisted the proposition that such comparisons could be validly made.

Because the Study relied on <u>Guide</u> information, test data and CAFC calculations under the FCAI Code were requested from manufacturers in the hope of obtaining information which would explain the discrepancies. These were not made available.

It is surprising that fuel consumption testing and reporting in Australia is done on such a confidential basis and there is no public awareness of the test results as occurs, for example, with electrical appliance labelling.

During extensive discussion and consideration of the comparison, the study considered the following possible reasons for the discrepancy submitted by manufacturers:

- the rounding rules included in the FCAI Uniform Code of Practice for Furnishing Fuel Consumption Data;
- differences between test facilities and test procedures;
- differences in the general rigour of fuel consumption test practices by testing personnel (as compared to practices for emissions);
- differences in preparation of vehicles for testing; e.g. some vehicles tested may not be the base vehicle; or some not fully run in;
- differences in vehicle fitout, e.g. type or size (mean radius) of tyres, oils used, fitout of safety and emissions devices, etc.) or fuel type may differ between countries;
- differences in calibration of engine and transmission management systems.

The consideration of these matters is discussed in WP4, and it must be stated that manufacturers' refusal to provide dynamometer settings for tests inhibited proper investigation. However, within the information provided, it seems apparent that several high volume manufacturers could, if they desired, reduce fuel consumption test results of their models simply by optimising the calibration of the test facilities, by preparation of vehicles appropriately, by reprogramming of engine and/or transmission management systems or some combination of these possibilities.

It was estimated that such action(s) would produce gains of up to 10-15 percent, of which some would be "paper" gains. Without access to test results, there is no way to be confident about the breakup between "real" and "paper" gains, but an estimate was made on the basis of experience of the likely size of each item, and through the discussions.

On balance, it was concluded that real gains could confidently be anticipated and a "reprogramming benefit" of 9 percent was considered to be available. During assessment of technical options, this was applied to all classes except sports and luxury. These are unlikely to be built to achieve fuel economy targets under any fuel economy policy. The benefit was taken at the first target year (1995) and is believed to be conservative (low). The analysis suggests that under the present market culture and government regulation, there is little incentive for producers to tune engines or programme engine management systems to maximise fuel economy - indeed the ADRs make emissions control a greater imperative. By way of comparison, the US CAFE legislation carries severe financial penalties if fuel economy targets are not achieved.

This issue may be potentially damaging to the market image of Australian manufacturers, particularly those which may be attempting to export vehicles. Although they could of course reprogramme management systems for a particular export market, their reputation will be built on performance in Australia.

It was concluded that the technology incorporated into Australian made vehicles is not the most fuel efficient available in international comparison and that a policy intervention may be required if improved fuel economy is required in Australia. This should not be construed to mean that Australia needs to impose mandatory fuel economy standards simply to obtain a test procedure which is accountable to public and professional scrutiny.

3.4.2 Comparison of National Average Fuel Consumption

Although there are problems with the test procedures used for comparing Australian made cars with those made overseas, the trends in Australian NAFC, shown in Table 3.1, appear to reproduce the two relatively distinct phases in the improvement in fuel efficiency of passenger cars shown in other country statistics. These can be related to a period of high fuel prices, the introduction of efficiency standards overseas and pressure by the Fraser Government in 1979.

Although Australia can claim an overall improvement in average fuel efficiency for new passenger cars, Australia's NAFC of 9.16 litres/100km in 1988 compares poorly with Italy (6.80 litres/100km) or the United Kingdom (7.40 litres/100km). Forecasts for other countries are difficult to obtain. However as an example, Australia's expectation of 8.0 litres/100km in 2005 is 13 percent above that for Germany.

In considering these results, it should be remembered that differences in product mix are important. However, the better fuel consumption in the US is disturbing. Much of this difference appears to be accounted for by the fact that the US equivalents of the Commodore and Falcon 6 cylinder cars are V6's with front wheel drive.

However, the presence of imports is also a factor. Typically, imports to Australia and the US have better fuel economy than domestically produced vehicles. As in the US, a fuel economy policy will tend to favour sale of imports rather than locally manufactured cars.

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| | 1973 | 1978 | 1979 | 1980 | 1983 | 1984 | 1985 | 1986 | 1987 | 1989 |
|----------------|----------|---------|---------|---------|---------|----------|--------|------|------|------|
| | | | | | | | | | | |
| Australia | - | 11.80 | 10.90 | 10.20 | 9.20 | 9.45 | 9,50 | 9,30 | 9.40 | 9.10 |
| Canada | 16.50 | 13.10 | 11.40 | 10.30 | 8.48 | 8.51 | 8.49 | 8.38 | 8.28 | 8.10 |
| Denmark | 9.00 | - | ~ | 7.50 | 7.30 | 7.00 | 7.10 | - | 6,80 | |
| West Germany | 10.30 | 9.80 | 9.60 | 9.00 | 8.10 | 7.80 | 7.60 | 7.50 | 7.70 | 7.90 |
| Italy | 8.40 | 8.30 | 8,30 | 7.70 | 7.30 | 7.00 | 7.00 | 6.80 | 6.80 | 6.80 |
| Japan | 10.40 | 8.80 | 8.60 | 8.30 | 7.80 | 7.80 | 8.00 | 8.30 | 8.60 | 8.60 |
| Netherlands | - | - | - | - | 7.54 | - | 7.15 | - | 7.19 | - |
| New Zealand | - | - | 10.50 | - | 9.70 | 9.40 | 9.20 | 9.00 | 9.00 | 9.00 |
| Spain | - | - | | 8.70 | ~ | - | 7.40 | - | - | 7.40 |
| Sweden | - | 9.30 | 9.20 | 9.00 | 8,60 | 8.60 | 8.50 | 8.40 | 8.30 | 8.20 |
| Switzerland | - | - | - | 9.70 | ~ | - | 9.10 | 8.90 | 8.80 | 8.70 |
| United Kingdom | 11.00 | 10.00 | 9.90 | 9.60 | 7.90 | 7.60 | 7.50 | 7.50 | 7.40 | 7.40 |
| United States | 16.50 | 13.10 | 11.59 | 10.00 | 8.91 | 8.74 | 8.52 | 8.37 | 8,28 | 8.20 |
| Note: 1. | The leve | ls of e | efficie | ency (1 | itres ; | per 100 | km) | | | |
| | cannot b | e dire | ctly ca | ompared | due to | o diffe: | ences | | | |
| | in the t | est pro | ocedure | as, pri | marily | betweer | cars | | | |
| | from di | fferent | t regi | ions. | Effic: | iency ch | nanges | over | | |
| | time are | unaff | ected 1 | by such | dispa: | rities. | | | | |

TABLE 3.1: ACTUAL NEW VEHICLE FUEL CONSUMPTION (1/100KM)

3.4.3 Comparison of Fleet Average Fuel Consumption

McInnes (1991); BTCE.

As shown by Table 3.2, Australia's on road fuel consumption trails behind other countries. Australian fuel consumption fell between 1979 and 1988 by about 7 percent, compared with much higher gains elsewhere (up to 30 percent in the US and New Zealand) in the same period.

| TABLE 3.2: | AVERAGE | FLEET | FURL | CONSUMPTION | (Litres/1 | 00km) |
|------------|---------|-------|------|-------------|-----------|-------|

| 1973 | 1979 | 1980 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|-------|---|--|---|---|--|--|--|--|
| | 12.70 | - | 12.40 | - | 12.00 | - | - | 11.80 |
| 9.02 | - | 8.60 | - | - | 8.80 | - | - | 8.50 |
| - | 15.70 | 13.80 | 13.10 | - | 12.43 | 11.84 | - | - |
| - | 10.80 | 10.80 | 10.90 | 10.90 | 10.90 | 10.90 | 10.80 | 10.70 |
| - | - | 8.50 | - | - | 8.00 | - | - | 7.60 |
| - | 11.80 | - | 11.00 | 11.00 | 12.00 | 10.70 | - | - |
| - | 11.70 | 11.50 | - | 8.20 | 7.80 | 7.80 | - | 7.90 |
| - | 9.50 | - | 8.40 | 8.20 | 8.70 | 8.50 | 8.50 | 8.50 |
| - | 10.90 | 10.90 | 10.80 | 10.80 | 10.70 | 10.50 | 10.30 | 10.30 |
| - | - | 10.70 | 10.32 | - | 9.30 | 9.20 | 9.10 | 9.00 |
| 18.10 | 16.30 | 15.50 | 13.70 | 13.20 | 12,90 | 12.90 | 11.76 | 10.80 |
| | 9.02 - - - - - - - - - - - - - - - - - - - | 1973 1979 - 12.70 9.02 - - 15.70 - 10.80 - 11.80 - 11.70 - 9.50 - 10.90 - 10.90 | 1973 1979 1980 - 12.70 - 9.02 - 8.60 - 15.70 13.80 - 10.80 10.80 - 8.50 - 11.80 - - 11.70 11.50 - 9.50 - - 10.90 10.90 10.70 18.10 16.30 15.50 | 1973 1979 1980 1983 - 12.70 - 12.40 9.02 - 8.60 - - 15.70 13.80 13.10 - 10.80 10.80 10.90 8.50 - - 11.80 - 11.00 - 11.70 11.50 - - 9.50 - 8.40 - 10.90 10.90 10.80 10.70 10.32 18.10 16.30 15.50 13.70 | 1973 1979 1980 1983 1984 - 12.70 - 12.40 - 9.02 - 8.60 - 15.70 13.80 13.10 - - 10.80 10.80 10.90 10.90 - 8.50 - 11.80 - 11.00 11.00 - 11.70 11.50 - 8.20 - 9.50 - 8.40 8.20 - 10.90 10.90 10.80 10.80 - 10.70 10.32 - 18.10 16.30 15.50 13.70 13.20 | $\begin{array}{cccccccccccccccccccccccccccccccccccc$ | $\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$ | $\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$ |

Source: McInnes (1991); BTCE.

Source:

There are no forecasts available for overseas countries, but on a "steady as she goes" scenario, the 2005 FAFC was predicted to be just over 10 litres/100km., which is above the 1988 estimate for five of the countries listed in Table 3.2.

3.4.4 Conclusion

Despite the problems inherent in international comparison, It is difficult not to conclude that Australia's record in fuel economy is one of the worst in OECD countries. There is little evidence that this will change significantly in the short term.

These difficulties are especially trying for lay observers who may wish to compare fuel consumption statistics from different countries. Such people can be expected to take an interest in discussions about a fuel economy policy.

In addition to the problems discussed in Section 3.1.1 and WP4, interpretation of comparisons by lay observers is inhibited by:

- the volumetric measures used (imperial, metric, US), and the US practice of measuring fuel economy in terms of a harmonic mean;
- the process of weighting city and highway test results measured according to AS 2877-1986 for the actual city and highway transport task;
- the weighting process used to average fuel consumption across all new cars as compared with what happens in all cars registered.

When considering a possible fuel economy programme it would be desirable to provide for some research into ways to reconcile alternative sources of information and to devise a measure which is understandable and interpretable to the lay public.

3.5 FUEL CONSUMPTION STANDARDS

In order to encourage or coerce manufacturers to build clean and fuel efficient vehicles, many countries have introduced fuel economy standards. All of these except the US have had a voluntary basis.

3.5.1 Voluntary Standards

Table 3.3 summarises the arrangements in seven countries which have introduced voluntary fuel economy standards. Most countries set voluntary targets by agreement between Government and manufacturers, including Australia. The exception is Japan, which passed a Rationalisation of Use of Energy Act in 1979. Most countries established 1985 as the target date for their guidelines; Australia set its target years as 1983 and 1987.

TABLE 3.3: FUEL ECONOMY TARGETS/STANDARDS FOR PARTICIPATING IN INDUSTRIALISED COUNTRIES (1 of 2)

| COUNTRY | BASIS OF SUMMARY TANGET | NARDATORY | TIME | SCOPE | TARGET/ STANDARD | CONNENTS | |
|--------------|--|-----------|--|---|---|---|--|
| Anstralia | Statement on Energy Policy, June 1979, by Prime Minister. | v | 1978 to 1987 | All new passenger care | National average fuel consumption in 1978 set to be 19.5mpg; in 1983 26.1 | Average of 25 mpg reached in 1983, 1.1 mpg below the target. | |
| Canada | Voluntary agreement backed by threat of mandatory standards | v | Model Year (MY) 1945 to 1986 | All domestic and imported caré | Fleet average fuel economy set to be 19.9mpg in 1980; 27.5 mpg in 1986 | Manufacturers allowed 2% credit for producing lead tolerant vehicles. | |
| West Cornary | Agregment between government and manufacturers in 1979. | ۷ | 1978 to 1985 | All domestic and imported cars | Agreement by German domestic producers to reduce consumption by 12-15% between applicable years. | Data for 1982 above 90% of fuel savings projected for 1985 has already been realized. | |
| Italy | Agreement between government and manufacturers. | ¥ | 1974 to 1983 | All care and dissel- powered industrial trucks. | 10% reduction in national average fuel consumption for cars, 5% for dissel trucks between applicable years. | - | |
| Japan | Targets established pursuant to the "Rationalisation of Energy Consumption Act", 1979. | • | Fiscal Tear (FY) 1980 to 1985 for domestic: FY 1980 to 1988 for imported. | All gasolins-powered pasaroger care. | Targets met for specific weight categories ranging from 46.1 mpg for vehicles up to 12701bs. to 19.5 mpg for vehicles over 2764 lbs; all must be reached by end of target period. | Fiscal year onds on March 31st. Overall goal of targets is to achieve a 12.3% average improvement in efficiency from 26.7 mpg in 1970 to 30.1 mpg in test. | |
| Spain | Agreement between government and industry. | v | 1900 to 1906 | All new passenger cars. | Agreement to reduce specific fuel consumption by 10% between applicable years. | - | |

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TABLE 3.3: FUEL ECONOMY TARGETS/STANDARDS FOR PARTICIPATING IN INDUSTRIALISED COUNTRIES - Continued (2 of 2)

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| countra | RASIS OF SUMMARY YANGET | HANDATORY VOLUNTARY | TIME. MERIOD | SCOPE | TABCET/ STANDARD | COMMENTS |
|----------------|---|------------------------|-----------------|--|---|--|
| 3vedet | Agreement between government and namufacturers pursuant to quidelines for fuel use targets set by Parliament. | v | HT 1900 to 1904 | All new passenger cars. | Target vary by individual manufacturer or importer according to vehicle size mix. Range from 27.6mpg to 31.3 mpg for MY 1986 with average of 28.6 mpg intent to reach average of 31.3 mpg by 1990. | Farticipating producers and importers accounted for 93% of car sales in 1982. Negotiations with car producers and importers for 1990 goals have not yet been carried out. |
| United Kingdom | Collective agreements across all particl- pating producers based upon Energy Act of 1976 and Car Fuel Consumption Order 1977. | v | 1978 to 1985 | About 90% of all new pessenger care sold. | Targets set on a national average fuel consumption basis rising from 23.3 mpg in 1976 to 25.8mpg in 1985. | Goals set based upon intent to achieve at least a 10% improvement in national model average mpg by 1985. Benent Government atolies indicate that efficiency improvements of 35.3% have already been achieved between 1976 and 1983. |

Source: Based primarily on information from the International Energy Agency publication, "Fuel Efficiency of Passenger Care", 1964.

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The type of standard also varied between countries, some including Australia focussing on NAFC, while others set targets for FAFC (Canada), corporate average (Sweden) or by weight class (Japan). Japan avoided corporate average standards because of the diversity of production models between manufacturers, which indicates a reluctance to interfere too much with an industry that brings such wealth to the country.

Results have been mixed. Australia slightly missed its 1983 standard, and others such as Sweden may have been adversely affected during the mid-1980s because of a downswing in new car fuel economy.

In Australia, the voluntary agreement may have engendered the sharp fall in NAFC after the 1979 announcement, to 10.1 1/100km in 1981. After a steady decline to 1983, the NAFC tended to level off, whereas some may have expected that the steady fall would continue.

However, the 1980s saw the introduction of unleaded petrol and other technologies which affected fuel consumption, the introduction of ADR37 and a slight upsizing in the mix of vehicles sold. All of these would have adversely affected NAFC and may explain why Australia missed its 1987 target.

As far as is now known, few nations participating in the original target setting elected to set new higher post 1985 fuel economy goals (or in the case of Australia and Sweden, post 1987 and 1990, respectively). France, which was not involved in the original goal setting agreements, has negotiated an informal agreement with its manufacturers to improve average new car fuel economy from a base of 7.0 L/100km in 1983 to 6.0 l/100km in 1990 (Bleviss:1988 p162).

Thus voluntary fuel economy targets have ceased to be the dominant policy tool in today's world that they were for the previous decade.

3.5.2 Mandatory Fuel Consumption Standards

The US is the only country which has promulgated mandatory fuel economy standards, these taking the form of Corporate Average Fuel Economy (CAFE) legislation. Canada had contingency provisions in its legislation that made its voluntary fuel economy targets mandatory in the event of serious noncompliance by the automobile industry. However, this provision was never used, because Canada's 1985 guidelines (which are identical to the US CAFE standards) were met.

In considering the history of CAFE, it is important to remember that the US, before the early 1970s, was a major oil producer which controlled the maximum price of fuel downward. Thus the US has always had the cheapest fuel in the western world, and the largest cars. The oil shocks of the 1970s changed that attitude significantly. The CAFE system was chosen by manufacturers in preference to a taxation programme in 1974. It was established by the Energy Policy and Conservation Act of 1975, which enabled the Secretary for Transportation to set annual fuel consumption standards for cars and light trucks. The legislation does not mandate standards, but they were introduced from 1978.

Objectives of CAFE

It is important to be clear about the objectives of CAFE which are:

"...to increase the technical level of fuel economy in all vehicles while leaving the mix of vehicle sizes largely to be determined by the market."

McNutt and Patterson (1986)

Discussions with officers of the US Government indicates that some interpret or qualify the objectives in slightly different ways, e.g. some are looking to achieve the maximum feasible level of new fuel economy technology in cars sold in the US, subject to economic practicability. This qualification has been extended by others, including certain arms of the Administration and automotive unions, to assure an element of protection of the US domestic automotive manufacturing industry against inroads from the Japanese.

However, it is clear that the intent is to leave the sales mix of vehicles to be determined by the market as far as possible, although it is recognised that consumers are prone to choose a size of vehicle with an eye to fuel economy considerations.

There is a fine distinction between the objectives of CAFE and objectives of mandatory fuel consumption standards which seek to reduce total fuel consumption or greenhouse gas emissions, as might flow from Australia's commitment to the Toronto target. Reducing total fuel consumption admits of downsizing, whereas the US and Japan (which do not appear to recognise the target) appear more inclined toward market rule.

Administrative Arrangements

The main points to note about the system are:

- it is a regulatory requirement for automakers to achieve a prescribed standard of fuel economy averaged across all vehicles sold in a calendar year;
- o it applies to companies producing more than 10,000 cars a year;
- it includes a supplementary vehicle labelling programme;
- the US EPA undertakes the necessary testing;
- two CAFE figures are obtained as sales weighted averages of all domestic and all imported cars sold by a manufacturer;
- similar calculations are done for trucks;
- o if a manufacturer fails to meet the standard, a fine is incurred of US\$50 per vehicle per MPG below standard;
- manufacturers and importers can earn fuel-efficiency credits by exceeding the standards for three years in a row, or may borrow on future performance if they can satisfy the NHTSA

that they will exceed the standards in any of the next three years.

Note that the law does not prohibit the sale of vehicles above standard, and a clear option for a manufacturer is to ignore the standards and pay the fines. Jaguar took this option before being taken over by Ford.

Effectiveness

CAFE was effective in reducing fuel consumption of new cars in early years, but the 1980s saw the standards rolled back to 26MPG for three years from 1986, and there was little overall progress in the decade. Currently, manufacturers are trading on credits obtained during the rollback. The CAFE standard is 27.5 MPG for cars and 20.5 MPG for light trucks. Car fuel economy is currently around the 1985 level, and light truck fuel economy has been constant for 10 years.

Oil imports to the US have risen sharply since 1985, and fleet fuel efficiency has levelled off although the number of vehicles in the US fleet has increased linearly since 1978. CAFE is blamed for a shift to light commercials but this started before 1978. Refer Section 2.2.2.

Several observers have commented that CAFE is not in the public interest, because buyers place a high value on style, performance and size. Some have argued that losses in utility or usefulness of cars has been associated with CAFE, and attempts to measure these losses have resulted in estimates in the order of billions of dollars. The proponents of CAFE are critical of these attempts, arguing that they are flawed by problems of measurement and mis-specification of the models. However, a consensus is emerging that losses in welfare do exist.

There is considerable dissatisfaction with CAFE's performance in fuel conservation, and even its strongest proponents would agree that results would have been better if the regulation was supported by higher fuel taxes. However, these are politically unacceptable.

Unintended Consequences

On the other hand, there is also considerable dissatisfaction from economic rationalists and the US domestic automotive industry because the legislation and the higher fuel economy standards have been associated with smaller vehicles. Not only has this provided an avenue for Japanese manufacturers to enter the market at the expense of US domestic producers, but there are also concerns about occupant safety in smaller cars. Discussions in the US suggest that these were unintended consequences and there has been considerable pressure to have them corrected.

Probably the most bizarre consequences are manifested by the 'games' played by manufacturers in respect to local content rules . and model classifications. The following reports illustrate: o Ford has reduced the domestic content of the Crown Victoria

and Grand Marquis so that they are included along with

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Festiva in their import calculation rather than in the domestic calculation - this has cost jobs in the US;

- Ford ship US made parts to Mexico so as to keep the Tracer in the domestic calculation while still getting the benefits of cheap labour;
- General Motors assemble the Allante in Michigan, but use enough imported parts to ensure it is included in the import calculation;
- the General Motors-Toyota plant in Fremont, Ca., makes identical cars (the GM Geo Prizm and the Toyota Corolla), but the Prizm is classified domestic and the Corolla as an import;
- Jaguar has stopped paying fines because it was taken over by Ford and the cars are now included with the Ford fleet. (Taylor:1991;Brown:1991).

Clearly, an important dysfunction is that CAFE has caused the automotive industry to apply its creative people to devising complicated avoidance schemes rather than creating ways to conserve fuel.

Conclusion

Some Administrators have admitted that, as it stands, CAFE is bad law:

"CAFE is a dumb, ill-conceived law. It forces everyone to play games, and it ought to be killed outright." J.R.Curry US National Highway Traffic Safety Administration.

However, the Administration accepts that fuel economy needs to be improved as a matter of policy, and the problem is to minimise the cost to manufacturers, consumers and political process which is the current price paid for a fairly low level of fuel conservation.

Proponents of new US legislation for the 1990s are considering alternative criteria as well as substantially higher fuel economy targets. These include identifying standards by different types of product offering; by size class; or weighting by interior volume. A preliminary evaluation of these is given in McNutt and Patterson (1986). The last appears to be most favoured at present, but decisions are a long way off.

3.5.3 Conclusion

Voluntary fuel consumption standards appear to have been at least as successful as mandatory ones, the key to success appearing to be in association with high fuel prices.

It is very difficult to design a command-and-control instrument which will operate successfully and without dysfunction. The CAFE regulation appears to be an extreme example of this difficulty, and the unintended consequences have proved costly to the industry, the community and the political process for only medium success in fuel conservation. It is possible that alternative

performance measures being researched may improve effectiveness, however this remains to be seen.

The CAFE experience is transportable to Australia and, given the already high levels of Government intervention here (which includes the PMV Plan), the miniscule size of our industry and the more attractive market based alternatives, one might import CAFE regulation only as a last resort.



4. IMPROVING FUEL CONSUMPTION THROUGH IMPROVED NEW VEHICLE TECHNOLOGY

Subject to Government intervention in the automotive industry, the point of departure for predicting fuel economy in future new motor vehicles is an examination of the technical specifications of new vehicles now sold in Australia, compared with technology already used in other vehicles in other parts of the world, or anticipated by prototype and concept vehicles.

This information was sourced from discussions with Plan Producers, plus the Consultants' knowledge of manufacturers' global strategies and the status of technical development in passenger cars sold overseas.

4.1 TECHNOLOGY CURRENTLY AVAILABLE

Based on discussions with Plan Producers, Table 4.1 summarises the penetration into the existing fleet at 1990, of a number of technologies which are relevant to the developing outlook for fuel economy in passenger cars sold in Australia through to 2005.

The mechanical details of the technologies listed in the Table are discussed in WP2 and the literature.

TABLE 4.1: 1990 TECHNOLOGY PENETRATION BY MARKET CLASS

| Device | Mini | Small | Medium | Upper Medium | Sports | Luxury |
|----------------------------|------|-------|--------|-----------------|--------|--------|
| Front Wheel Drive | 100 | 100 | 100 | 0 | 100 | 13 |
| Drag Reduction (Cp <0.34) | 70 | 35 | 20 | 55 | 77 | 23 |
| M-5 Transmission | 80 | 60 | 30 | 10 | 75 | 10 |
| A-4 Transmission | 5 | 5 | 70 | 90 | 25 | 90 |
| (Total Auto Transmission) | (20) | (40) | (70) | (90) | (25) | (90) |
| Torque Converter Lock-Up | 5 | 20 | 70 | 90 | 20 | 90 |
| Electronic Trans. Control | 0 | 5 | 35 | 0 | 0 | 18 |
| Overhead Cam Engine | 100 | 100 | 100 | 45 | 100 | 85 |
| Roller Cam Followers | 0 | 6 | 2 | 55 | 0 | 4 |
| Low Friction Pistons/Rings | 0 | 5 | 50 | 100 | 10 | 45 |
| 4-valve/cylinder | 22 | 62 | 36 | 0 | 100 | 34 |
| 3-valve/cylinder | 0 | 7 | 19 | 0 | 0 | 0 |
| Central Fuel Injection | 0 | 12 | 0 | 25 | 0 | 0 |
| Multipoint Fuel Injection | 40 | 36 | 80 | 75 | 100 | 100 |
| 10W-30 0il | 0 | 0 | 0 | 0 | 0 | 0 |
| Accessory Improvements | 0 | 0 | c | 0 | D | 0 |

Source: Automobile manufacturer specifications.

4.2 DEFINITION OF TECHNICAL SCENARIOS

In order to address the technological implications of a fuel economy policy, a new technology forecast was prepared for two scenarios, identified as the "Product Plan" and "Maximum Technology" Scenario.



4.2.1 Product Plan

The "Product Plan" provides the baseline against which the Study assessed the costs and benefits of introducing new technology into new cars sold in Australia.

It is analogous to a 'do nothing' case except that it takes into account the fact that competitive pressures and the evolution of technology will continue the historical falls in fuel consumption described in Chapter 2. At the same time, the size and/or performance of some vehicles will increase, according to available data on manufacturer product plans for the next five years.

However, the Product Plan involves no move to recalibrate test facilities, engines or transmission management systems to attain fuel consumption equivalence with similar vehicles sold overseas.

Also, it assumes that there is no regulatory pressure on the manufacturers to improve fuel economy, although it assumes continuation of the PMV Plan.

4.2.2 Maximum Technology Scenario

The "Maximum Technology Scenario" (MTS) represents an available and applicable technical fix for the high fuel consumption levels found in cars sold in Australia. In this context, "available" means that each technology cited is already in production in at least one model somewhere in the world in 1991, or can be expected to be available for incorporation in Australian production cars before 2005.

The only example of this latter group is the modified (Sarich) two-stroke engine, which is not expected to be in production in cars till towards the end of the decade. Although some observers have expressed skepticism that the device is sufficiently developed for mass production, in the Consultant's opinion it has completed sufficient demonstrations of significant fuel economy benefits on cars up to 1361kg test weight to be able to include it with confidence.

The term "applicable" is used to signify that a technology is specific to a vehicle class(es) and cannot be used in all classes; e.g. continuously variable transmission (CVT) is currently torque limited and cannot be used in large cars, but it is an "applicable" technology for mini and small cars.

This sieving of all possible technologies which may be referenced in the literature ensures that it will be possible for Plan Producers to access and deliver each available and applicable technology in vehicles produced before 2005, and hence the fuel consumption forecasts associated with the MTS are feasible.

The Maximum Technology Scenario holds vehicle size, as defined by interior volume, and vehicle performance as defined by the power to weight and torque-to-weight ratios, constant at Product Plan levels. Of course, history shows that car size and performance have not been held constant but are increasing in response to consumer demand and competitive pressure. In later Sections the technically based forecasts are adjusted to capture the effect of size (weight) and performance requirements. This includes adjustments to capture the effects of new safety standards (which increase weight) or emission standards (which decrease engine efficiency).

- It is emphasised that the Maximum Technology Scenario:
- requires all manufacturers to redesign all products to the highest level of fuel efficiency;
- incorporates technologies such as advanced weight reduction and variable valve timing in all cars regardless of cost effectiveness to the consumers;
- does not consider the financial ability of local Australian industry to undertake the extensive product changes required.

However, the MTS retains lead time limitations. Manufacturers' production specifications have been formulated to 1996/1997 and therefore there is no technological difference between the Product Plan and Maximum Technology scenarios for 1995. The two scenarios diverge technologically in 2000 and 2005.

These matters are important and we would caution that the outlook must be understood in the appropriate context. The caveats raised are discussed in other Sections of this report, but it is emphasised nonetheless that the MTS represents, in the Consultants' opinion, a reasonable and achievable target level of technical sophistication through the period to 2005.

At this stage, no consideration is given as to what if any policy action might need to be taken to bring the MTS to fruition. That is left to Chapters 5 and 6. For the moment, the discussion concentrates on what physical outcomes are available and applicable.

4.3 TECHNICAL OPTIONS FOR FUEL ECONOMY IN AUSTRALIA

Forecasts of new car fuel consumption are based on potential technological improvements to cars combined with increased consumer demand for highly efficient and clean automobiles. This is a powerful combination which could lead to important gains in fuel efficiency in Australia.

4.3.1 The Dream: Prototype and Concept Cars

It is clear that the technology exists to produce vehicles with far lower fuel consumption than existing vehicles, and WP1 lists 11 examples which, in the case of the Toyota AXV, claim fuel consumption as low as 2.4 litres/100km. Indeed, marathon cars have been designed which have demonstrated much lower figures than this.

However, an OECD/IEA expert panel in 1990 noted that concept cars and prototypes were yet to give rise to the development and production of highly efficient vehicles based on those

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experiments. This situation has not changed substantively.

Many concept cars are defined so that fuel economy is the only goal. When designing such vehicles, engineers typically do not concentrate on matters such as drivability, ride quality, meeting emission and safety standards, whether advanced materials can be mass produced, relative costs (including energy costs) of advanced materials, recyclability of the machine and so on. Rather, the vehicle represents a design exercise or demonstration project whose aim is simply to evaluate the potential for technological gains in fuel economy (or some other single objective).

In an Australian context, the barriers to introduction of advanced technologies are substantial, not only because the research and development is mostly overseas, but also because it is difficult to recover these costs in such a small market. There are many examples (the modified two-stroke engine being only one) of Australian innovations being taken overseas for development and production.

It was also concluded that while technology can provide benefits, it cannot be used to attain the 100 MPG (2.5 1/100 km) that some prototypes have demonstrated without additional addressing of consumer requirements.

4.3.2 The Reality: Evolutionary Technology

Automotive technology is over 100 years old, the technology improvements likely in gasoline and diesel powered vehicles during the period to 2005 are conceptually well understood. There are global development strategies among manufacturers which are commercialised in major automotive markets elsewhere and are likely to become available in Australia within a year or two of first introduction.

Broadly, design opportunities for improved fuel consumption can be addressed in five areas:

- reduction of weight and aerodynamic resistance in bodywork;
- incremental development of fuel efficiency in engines, especially through increasing use of electronic engine management systems;
- improved efficiency in the drive train through transmission design changes (especially more gear steps), improved lubrication, tyre resistance, and so on;
- reduced energy consumption by essential accessories, such as water pump, generator, etc.;
- reduced weight and energy consumption by optional extras, such as air conditioning, sound systems, luxury appointments, etc.

Each technical option has its own technical, economic or environmental advantages or disadvantages; potential market niches and time horizon.

A summary of the technical options referenced by this Study is provided in Table 4.2. More detail is provided in WPs 1 and 2.

TABLE 4.2: TECHNOLOGY DESCRIPTION - 1 of 2

BODY

Accomplished by restyling and attention to detail; several Drag Reduction I Australian models are CD=0.32/0.33. (CD from 0.37 to 0.32/0.33) Advanced body design. Requires flush fitting glass windows, Drag Reduction II improved assembly techniques to minimise gaps in the body. from 0.32 to 0.29) Extensive use of plastics; Sheet Moulding Compound for hood and Weight Reduction deck lid, Injection moulding for fenders and fascias. Aluminium Material Substitution in some structural parts and wheels (Engine related weight reduction accounted for separately). Conversion of rear-wheel drive cars to front-wheel drive while Front-Wheel Drive maintaining constant passenger and luggage room. Transverse engine allows improved packaging and reduced exterior size; weight reduction also associated with elimination of propeller shaft, differential and rear axle. ENGINES Low Friction Pistons Use of better piston designs, low tension rings and improved quality control. /Rings Roller Cam Followers Use of roller bearing for the cam control surface instead of a sliding contact. Advanced Friction Low mass squeeze cast aluminium pistons, lightweight valves and titanium springs, improved control of bore and piston dimensions. Reduction 4-Valve/cylinder Replaced 2 valve/cylinder OHC engine of equal performance. Improved thermodynamic efficiency due to compact combustion chamber, central spark plug and higher ratio. Reduced pumping loss loss due to reduced displacement and larger valve area. Variable Valve Varies intake valve timing and lift to match engine RPM and load Control requirement. Reduces pumping loss. Two-Stroke Engine Advanced engine as pioneered by Orbital, with direct injection stratified charge combustion system. Central Fuel Replaces carburettor. Improved fuel atomisation and reduced cold Injection start fuel consumption. Eliminates use of air pump to most U.S. 1983 emission standards. Multi Point Fuel Uses one injector per cylinder. Allows more precise fuel metering, use of deceleration fuel shutoff and tuned intake manifold with long Injection runners to maximise torque. TRANSMISSION Torque Converter Eliminates slippage in the hydraulic torque converter used with Lock-up automatic transmissions by means of a rigid mechanical link.

TABLE 4.2: TECHNOLOGY DESCRIPTION - Continued 2 of 2

| Four Speed Automatic | Replaces three speed automatic with an additional overdrive gear. This reduces engine RPM at highway speeds, decreasing both friction and pumping loss. |
|---------------------------------------|---|
| 5-Speed automatic | Adds an extra gear 6-speed manual allows the engine to operate closer to the best fuel economy point at any vehicle speed and load. |
| Continuously Variable Transmission | Logical extension of more gears to an infinite selection. Current designs are torque limited and can be used in small cars only. |
| Electronic Transmission Control | Integrates engine operating information with vehicle speed information to select optimum gear for best fuel economy. Also engages torque converter lockup to minimise slippage. |
| OTHER | |
| 10W-30 Oil | Replaces current 2OW-40, reduced viscosity results in lower friction loss. |
| Improved Tyres I/II | Evolutionary improvements to tyres. Rolling resistance reduced by improved tread/shoulder design and better rubber compounds for lower hysteresis loss. |
| Accessory Improvements | Evolutionary improvements to alternator, oil pump, water pump, fan drive and power steering pump. |
| Electric Power Steering | Replaces hydraulic power steering where considerable energy is wasted in maintaining hydraulic pressure. Large electric power demand may limit technology to small and medium cars. |

All of these technologies are available and applicable to cars sold in Australia, so Plan Producers should have no specific problem in accessing them.

The greatest improvements are delivered by:

- two stroke engines, which can deliver 14 percent benefit over 1990 2-valve OHC engines;
- 4-valve engines with variable valve timing, which produce about 9 percent benefit over 2-valve OHC engines;
- weight reduction, which delivers a 6.6 percent benefit over a base 1990 car.

The fuel economy benefit for diesel over a gasoline engine can vary depending on the type of comparison (equal engine size, equal performance, or model to model). On a 'best-to-best' comparison which approximately equalises performance, the fuel economy improvement over gasoline engines is 20 percent for a naturally aspirated diesel and 30 percent for a turbocharged diesel. They also have a lower fuel economy shortfall between test and 'real world' fuel economy.

The advantages of diesel engines are offset by a 5 percent energy loss in refining. They are also more expensive, and they may have greater difficulty with future NO_x emission standards, particulates, and noise and vibration control.

4.4 DEVELOPMENT OF TECHNICAL SCENARIOS

The methodology used for assessing fuel consumption can be applied to individual vehicle models, i.e. a specific model name/body style/engine/transmission/power output combination. However, there are more than 300 make/model combinations available in Australia and the time and resource constraints did not permit an analysis at this level of detail.

Further, a model based application would need the details of the market penetration of each model/engine/transmission combination. While this is available in manufacturers' annual CAFC calculations, they were not made available by manufacturers.

Hence the analysis proceeded according to the market class structure described in Section 2.1.2, including an estimated penetration of manual vs. automatic transmissions by class, as well as the penetration of "performance engine" options, from limited published data as well as from anecdotal information obtained at meetings with the manufacturers.

Based on the detailed technical specifications of each current model, the current sales mix as available from industry statistics, information gleaned during discussions with Plan Producers and knowledge of their parents' global strategies, the cost effectiveness of technical options to the consumer and the technical outlook to 2005, a technical profile was prepared for each vehicle class.

4.4.1 Technical Definition - Product Plan

The Product Plan shows increased market penetration of those technologies which are partially in the market today. It also envisages partial penetration of a selection of new technologies through to year 2005, as listed in Table 4.3.

For model year 1995, now only about 3 years away, there is no time to incorporate any significant changes in technology beyond what is already planned. The penetration of various technologies at 1995 is listed at Table 4.4, which illustrates the fuel economy calculation for that year.

As shown in Table 4.4, fuel economy attributable to a particular technology is multiplied by the penetration of that technology at the given year, to obtain an estimate of the fleet average benefit. The calculation applies a penalty to account for the average weight and performance increase anticipated as part of the Product Plan.

The details of the calculation are described in WP2 (Chapter 2) and briefly, follows the work of Sovran, who developed a detailed analysis of tractive energy requirements on the US EPA fuel economy test schedule, i.e. the city and highway driving cycle also used by AS 2877-1986. The method used linearises the exact engineering equations, is an approximation which simplifies the calculation effort, yet delivers results that have been accurate to plus/minus 0.2MPG historically.

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TABLE 4.3: PENETRATION OF TECHNICAL OPTIONS INTO PRODUCT PLAN SCENARIO AT 2005

| Technology | Product Plan |
|--|--|
| Weight Reduction | 5 percent for all cars except for Falcon and Commodore |
| Drag Reduction | C _D = 0.30 ~ 0.31 |
| 2-stroke engines | In 20% of mini and small classes |
| 4-valve engines | In all other vehicles except V-8, some mini |
| CVT (replacing automatic transmission) | In 10% of mini, small and 20 percent of medium |
| 5-speed auto transmission | In 50% of upper medium and luxury |
| Variable valve timing | In 50% of 4-valve engine rated over 75 kw |
| Advanced engine friction reduction | In all engines |
| Electric Power Steering | Replaces 50 percent of power steering in mini and small cars |
| Improved Tyres | In all cars |

The Product Plan anticipates a host of new models in mini class, starting with the Daihatsu Mira and Mazda 121 in 1991. It is possible that Honda, Ford and Nissan may introduce their City, Festiva and Micra models if the mini class shows growth over the next few years. Average size and horsepower are not expected to change significantly for this class.

Increases in size and performance of vehicles are expected principally in the small and medium market classes. The new Ford Laser/Mazda 323 models are somewhat larger and offer a higher performance level than the previous models.

New models in the class are expected to continue the trend, with average engine size increasing 5 percent and weight increasing 5 percent over the next five years. Similarly in the mid-size class, Mitsubishi has already introduced a new (for 1991) Magna that is longer and wider and weighs nearly 10 percent (120 kg) more than its predecessor.

This may be an unusually large weight increase, as we expect other models to increase by 60 kg only. For example, Toyota is expected to bring out a bigger Camry in a year or so.

| | INDIVIDUAL VEHICLE | PENETRATION | PENETRATION | FLEET F/E |
|-------------------------------|-----------------------|-------------|-------------|--------------|
| TECHNOLOGY | F/E BENEFIT | 1990 BASE | 1995 | BENEFIT |
| Aero Drag Reduction | 2.3 | 40 | 37.0 | 0.85 |
| 4-Speed Automatic | 4.5 | 54.5 | 4.5 | 0.20 |
| Torque Converter Lockup | 3.0 | 58.5 | 4.0 | 0.12 |
| Electronic Trans. Control | 0.5 | 12 | 34.0 | 0.17 |
| Accessory Improvements | 0.5 | Вазе | 68 | 0.34 |
| Roller Cams | 2.0 | 19 | 27 | 0.54 |
| Low Friction Piston/ Rings | 2.0 | 48.5 | 34.5 | 0.69 |
| 10W-30 Oil | 0.5 | -0 | 66 | 0.33 |
| Tire Improvements | 0.5 | Base | 68 | 0.34 |
| 4-Valve engines | 5.0 | 33.3 | 20.5 | 1.03 |
| Multi Point FI (Over CFI) | 3.0 | 66.3 | 13.5 | 0.41 |
| Central FI | 3.0 | 10.9 | 6.0 | 0.18 |
| Total | | | | 5.2% |
| Size/Wt Increase | -5.0 | Base | 33 | -1.65 |
| Performance Increase | -2.2 | Base | 54 | -1.19 |
| Adjusted Total | | | | 2.35% |

TABLE 4.4: PRODUCT PLAN TECHNOLOGY PENETRATION (PERCENT) AND FUEL CONSUMPTION FORECAST, 1995

Engine output is expected to be in the range 85kw to 94kw by 1995 for this group of cars.

For both small and medium classes, a phase-out of carburettors and 3-speed automatics is anticipated, replaced by fuel injection and 4-speed automatics.

The upper-medium class is not expected to have any new models as both Ford and Holden have an 8-year product cycle and the Falcon and Commodore are relatively new.



No specific scenario was prepared for 2000, but an intermediate forecast point was used, representing the target penetration of technical options. The exact timing of this is not of issue as most of the penetration will take place by 1998 and the last few percent by 2005. Rather, the analysis focused on 2005 using the intermediate forecast point as the starting point for a number of technologies to be utilised in the 1998-2005 time frame.

4.4.2 Technical Definition - Maximum Technology Scenario

The Maximum Technology Scenario envisages deep application of the technical options listed in Table 4.2. It differs from the Product Plan in several important ways:

- it assumes that manufacturers calibrate their cars to be as fuel efficient as their U.S. counterparts at equal weight and performance levels (i.e. no reduction of axle ratios or engine size from expected 1995 levels is assumed);
- o there is an increased level of weight and drag reduction;
- it involves near complete use of either 2-stroke engines in mini and small cars and 4-valve engines with variable valve timing in the other classes;
- similar differences for advanced transmissions.

The penetration of technologies into the MTS at 2005 is summarised in Table 4.5. For interior volume, the MTS assumes that small and medium classes increase interior volume by 5 percent to 1995, and remain constant after that.

4.5 IMPACT OF ANTICIPATED SAFETY AND EMISSIONS CONTROLS

The Product Plan and Maximum Technology Scenarios considered above do not include the effect of new safety or emission regulations that may be imposed in Australia over the next 15 years.

On past experience, such regulations tend to carry penalties for fuel consumption, and it was decided to base a forecast for the purposes of the Study on:

- o recent studies by the FORS into occupant protection;
- the current policy to harmonise Australia's compliance requirements with overseas standards;
- a continuation of past trends whereby Australia adopts overseas (particularly US) standards a number of years after they are promulgated in the host country.

If Australia adopts all of the US 1994 requirements, weight could increase by at least 30 to 40 kg. The estimated fuel consumption penalties on NAFC for safety and emission standards were estimated as follows:

| Air h | bags | 3 | | -0.7% |
|-------|------|-----------|-----------|-------|
| Side | int | rusion/ro | ollover | -1.4% |
| 1983 | US | emission | standards | 0.0% |
| 1994 | US | emission | standards | -0.8% |
| | | | | |
| | | | | -2.9% |

TABLE 4.5: PENETRATION OF TECHNICAL OPTIONS INTO MAXIMUM TECHNOLOGY SCENARIO AT 2005

| Technology | Maximum Technology Scenario |
|--|--|
| Weight Reduction | 10 percent for all cars; 5 percent for Holden Commodore |
| Drag Reduction | C _D = 028 ~ 0.29 |
| 2-stroke engines | In 80% of mini and small and 40% of medium |
| 4-valve engines | In all other vehicles |
| CVT (replacing automatic transmission) | In all mini, small and 30 percent of medium |
| 5-speed auto transmission | In all upper medium, luxury and 40 percent of medium |
| Variable valve timing | In all 4-valve engines rated over 75 kw |
| Advanced engine friction reduction | In all engines |
| Electric Fower Steering | Replaces all power steering in mini and small cars. |
| Improved Tires | In all cars |

The microscopic detail of changes made by the States to local speed limits, delays induced by traffic control devices, random breath testing and so on was not addressed.

4.6 OUTLOOK FOR CLASS SPECIFIC FUEL CONSUMPTION

Forecasts of fuel economy by market class are dependent on the estimates utilised for the fuel economy potential of each technology, the potential for synergy between technologies and constraints on additivity of economy between different technologies in the same vehicle.

4.6.1 Outlook under the Product Plan

The Product Plan envisages fuel consumption by vehicle class and target year as shown in Table 4.6.

Mini class specific fuel consumption was estimated at 5.4 1/100km at 2005, which represents a drop of 15 percent on 1990, and about the same as the existing Suzuki Swift Manual is today. Thus the mini target is quite realistic.



| TABLE | 4.6: | ADOPTE | D FUEL | CONSU | ле | TION | (1/ | /100km | I) BY | TARGET | YEAR |
|-------|------|--------|--------|-------|----|--------|-----|--------|-------|--------|------|
| | | AND VE | RICLE | CLASS | - | PRODUC | СТ | PLAN | 1995- | -2005 | |

| Class | 1990 | 1995 | 2000 | 2005 |
|---------------|-------|-------|------|------|
| Mini | 6.40 | 6.26 | 5.84 | 5.42 |
| Small | 7.70 | 7.41 | 6.89 | 6.39 |
| Medium | 9.00 | 8.88 | 8.30 | 7.72 |
| Upper-medium | 10.60 | 10.45 | 9.70 | 9.14 |
| Sports | 8.20 | 7.96 | 7.54 | 7.11 |
| Luxury | 10.20 | 9.73 | 9.07 | 8.40 |
| Upper Luxury* | 10.90 | 10.50 | 9.78 | 9.06 |

Note: Table does not include effect of new emission/safety standards that may be imposed beyond 1995.

> Not calculated but assumed to follow same trend as for luxury class.

Again, the upper medium target of 9.14 1/100km at 2005 compares with the existing 9.4 1/100km for the existing Nissan Skyline manual, which seems a reasonable expectation of industry trends over the next 15 years. At the level of NAFC, the 1988 sales mix was applied to the 1990 estimates shown in the Table, and an estimated 9.2 1/100km was obtained. This approximates the 1988 FCAI figure of 9.16 1/100km.

It was considered that the correspondence was sufficiently close for the Product Plan Scenario to provide a satisfactory baseline for comparing fuel economy gains against the Maximum Technology Scenario.

4.6.2 Outlook Under the Maximum Technology Scenario

The Maximum Technology Scenario envisages fuel consumption by target year and vehicle class as shown in Table 4.7.

Mini class specific fuel consumption was estimated at 4.47 1/100km at 2005, which represents a drop of about 17 percent on the 1990 fuel consumption of the Suzuki Swift. The anticipated possible drop for the upper medium class was 22 percent by target 2005.

It is to be noted that the MTS includes the 9 percent reprogramming benefit referred to in Section 3.4.1. However, it does not include the effect of new safety and emission standards at about year 2000, which would bring a penalty of about 3 percent.

4.7 PROJECTIONS FOR NAFC TO 2005

Forecasts of NAFC by target year are obtained from a weighted average of the class specific fuel consumption estimates by target year as above, and the estimated product mix in each target year.



| TABLE 4.7: | ADOPTED FUEL CONSUMPTION (1/100km) BY TARGET YEAR |
|------------|---|
| | AND VEHICLE CLASS - MAXIMUM TECHNOLOGY SCENARIO |
| | 1995-2005 |

| Class | 1990 | 1995 | 2000 | 2005 |
|------------------|-------|------|------|------|
| Mini | 6,40 | 5.79 | 5.13 | 4.47 |
| Small | 7.70 | 6.80 | 6.03 | 5.26 |
| Medium | 9.00 | B.07 | 7.21 | 6.35 |
| Upper-Medium | 10.60 | 9.15 | 8.15 | 7.14 |
| Sports | 8.20 | 7.97 | 7.14 | 6.37 |
| Luxury | 10.20 | 9.18 | 8.12 | 7.06 |
| Upper Luxury (1) | 10.90 | 9.91 | 8.77 | 7.63 |

Note:

- Not calculated but assumed to follow the same trend as for luxury class.
- Table does not include the effect of new safety/emission standards that may be imposed beyond 1995.
- Passenger cars only.

4.7.1 Estimates of Product Mix

The forecast of product mix was obtained from the econometric models reported in Section 5.2.2. The determinants of consumer choice assumed in that modelling include price, size, fuel economy, engine power, etc. These factors correlate well with those identified by available market research studies.

WP4 summarises the known product mix by class and year from 1971 to 1990, and reveals substantial fluctuations. Before 1988, the proportion of mini and small vehicles rose from 20.8 percent in 1971 to 26.8 percent in 1988 and 33.4 percent in 1990. Corresponding figures for luxury and upper luxury are 2.7, 6.8 and 7.0 percent. These shifts have been at the expense of medium and upper medium cars which figures are 76.4, 63.3 and 56.2 percent. Note that over time, these differences amount to quite sizable gains and losses in sales (one percent equals about 4500 units), and the losses in the medium/upper medium group tend to contain the products of Plan Producers.

However, they are also associated with sizable savings in energy consumed. As pointed out by Greene and Liu (1988) the downsizing to date has occurred by changing vehicle designs to essentially preserve interior volumes and other desirable dimensions of comfort and styling. Under the Product Plan, it is estimated that the corresponding shares will be as follows:

| Class | 1995 | 2000 | 2005 |
|--------------|-------|-------|-------|
| | | | |
| Mini | 4.95 | 5.04 | 5.10 |
| Small | 21.30 | 21.60 | 21.80 |
| Medium | 30.70 | 30.60 | 31.10 |
| Upper Medium | 33.70 | 33.70 | 33.00 |
| Sports | 2.54 | 2.54 | 2,53 |
| Luxury | 2.84 | 2.74 | 2.66 |
| Upper Luxury | 4.02 | 3.76 | 3.75 |



The medium/upper medium group is estimated to maintain its share at about 64 percent, with the downsizing effectively being from luxury/upper luxury to mini/small cars.

The Maximum Technology Scenario is estimated to produce the following shares:

| Class | 1995 | 2000 | 2005 |
|--------------|-------|-------|-------|
| | | | |
| Mini | 4.65 | 4.83 | 4.84 |
| Small | 20.50 | 21.20 | 21.40 |
| Medium | 30.50 | 31.30 | 31.33 |
| Upper Medium | 35.60 | 34.00 | 34.40 |
| Sports | 2.21 | 2.27 | 2.24 |
| Luxury | 2.70 | 2.63 | 2,37 |
| Upper Luxury | 3.85 | 3.76 | 3.39 |

Under this Scenario, the shares of medium/upper medium classes increase to 67.7 percent by 2005 (or 3.5 percent higher than under the Product Plan) at the expense of both mini/small and luxury/upper luxury classes.

This finding tends to confirm the conclusion reached in Chapter 2 that for Plan Producers, bringing their technology up to international best practice will be good for their domestic business.

4.7.2 Estimates of NAFC

As discussed in Section 2.4.2, the FCAI estimated that year 2005 will be at about 8.0 1/100km, and Study estimates under the Product Plan and the 1988 mix produce a similar result.

The projected changes to mix during the planning period are expected to product the NAFC results in the target year indicated in Table 4.8.

TABLE 4.8: ESTIMATED NAFC (1/100km) BY TARGET YEAR AND SCENARIO

| | Product | Max.Tech. |
|-------------|---------|-----------|
| Target Year | Plan | Scenario |
| | | |
| 1995 | 9.00 | 8.19 |
| 2000 | 8.41 | 7.26 |
| 2005 | 7.83 | 6.35 |

These results take no account of future safety and emissions controls which would raise the fuel consumption estimates by about 3 percent. Thus the Study results are consistent with the FCAI prediction that downsizing of the fleet would allow them to revise their estimate of fuel consumption downwards, and on this basis downsizing will benefit fuel economy by about 2 percent.

However, if a fuel economy policy were implemented to achieve the Maximum Technology Scenario, by 2005 NAFC could be reduced to 6.35 litres/100km, or around 30 percent against the 1988 base. This is about 2.4 times the reduction predicted by the FCAI.

SEL.

In other words, new technology offers considerable scope for fuel economy of cars sold in Australia, provided ways can be found to encourage or coerce manufacturers to introduce this technology.

4.8 EFFECT OF OTHER POSSIBLE TECHNOLOGIES

4.8.1 Class Specific Fuel Consumption -Diesel Engines

The estimate of class specific fuel consumption was prepared assuming an 80 percent penetration of turbocharged prechamber diesel engines into all classes, except sports where this would be inapplicable. The results summarised in Table 4.9 take into account the fuel consumption both before and after the refinery penalty.

A linear interpolation between 0 percent penetration for Table 4.7 and 80 percent penetration in Table 4.9 is valid.

TABLE 4.9: ESTIMATED CLASS SPECIFIC FUEL CONSUMPTION (1/100km) 80 PERCENT DIESEL PENETRATION - MAXIMUM TECHNOLOGY SCENARIO, 2005

| | Refinery | Penalty(1) |
|---------------|----------|------------|
| Vehicle Class | Without | With |
| | | |
| Mini | 4.02 | 4.22 |
| Small | 4.73 | 4.97 |
| Medium | 5.59 | 5.87 |
| Upper medium | 6.15 | 6.46 |
| Luxury | 6.07 | 6.37 |
| Upper luxury | 6.58 | 6.91 |

Note: 1. A factor of 1.05 used to account for refinery penalty.

Comparison between these results (with refinery penalty) and those for 100 percent gasoline engines provided in Table 4.7 under the Maximum Technology Scenario shows that if there were an 80 percent penetration by diesel engines, the fuel economy improvement would be 5.6 percent for mini class vehicles and 9.8 percent for luxury vehicles.

Thus if the penetration of diesel engines were increased from the current 2 percent (approx) to 15 percent, the saving would be of the order of 1.1 to 1.8 percent only, which is considered insignificant.

Accordingly, it was concluded that substitution of diesel engines for gasoline engines at any realistic level was not likely to make any significant difference to fuel economy.

4.8.2 Limits on Acceleration Performance

Section 2.2.2 argued that acceleration performance penalises fuel consumption and that disincentives might be applied to vehicles which can accelerate from 0 to 100kph in 10 seconds or less. Improved engine power could be directed to downsizing the engine

while retaining interior room and volume.

Now the Maximum Technology Scenario holds performance near constant at 1990 levels. It should be noted that several Australian car classes offer very high levels of performance in "family" cars relative to the U.S., and relative even to 1988 Australian levels.

Typically, a 10 percent increase in power-to-weight ratio results in a 2.5 percent increase in fuel consumption. It appears possible to decrease power-to-weight ratio by 10 percent in all classes except the mini-car class, and an additional 10 percent is possible in the upper-medium and luxury class (for a total of 20 percent). This would place all cars in the acceleration performance range of 10 to 12 seconds for 0-100 kph.

If these percentages are weighted by the sales mix at a typical year, it can be shown that reduction in estimated NAFC around 3 percent is obtained. This gain would possibly be at some expense to consumer satisfaction.

4.8.3 Speed Limitation

European luxury, upper luxury and sports cars imported to Australia commonly built to accomodate roads with no no speed limits, or speed limits higher than those in Australia.

Australian manufacturers have little option but to compete with these imports and the competition is seen as one factor which causes engine technology to be consumed in greater power output rather than fuel economy.

It is noted that leading European professionals are starting to advocate introducing speed limits on European roads which are commensurate with those prevailing in Australia, and speed limiters which prevent cars exceeding 160kph (Orfeuil:1991; Al:1991), but this may not occur for some time.

Speed limiters are commercially available which cut fuel supply from the engine at any preset speed. If fitted to higher powered cars, they would detract from their auto racing image and assist in changing the culture which currently promotes continuing increases in engine power. They may have some safety benefits as well. There is however, no data on which the fuel saving can be estimated for Australia, as the incidence of excessive speeding has not been adequately measured across the country.

4.9 ACHIEVING NAFC TARGETS THROUGH TECHNOLOGY

In this Chapter, it has been shown that a serious attempt to achieve maximum fuel economy through technical means can produce a very large reduction in new car fuel consumption.

The 1988 FCAI estimate of NAFC is 9.16 1/100km. and just prior to going to press, it announced a figure of 8.92 litres/100km, which cannot be taken into account by this Study. There is a small (1.4 percent) discrepancy between Study estimates and FCAI results for 1990, which does not make a material difference to the Study

conclusions.

The Brief requires commentary on what actions might be taken by Governments to reduce NAFC to 8.0, 7.0, 6.0 and 5.0 1/100km. by 2005.

4.9.1 Actions to Reach 8.0 1/100km

The analysis of the Product Plan Scenario indicates that if no policy action were taken, manufacturers own plans, plus the introduction of new safety and emission controls in year 2000, would result in a year 2005 outcome of:

Product Plan 7.83 Safety and Emissions penalty (3 percent) .23 8.06

Thus Government need take no action on fuel economy, and could if desired introduce US 1994 safety and emissions controls.

Alternatively, Government could take limited policy action such as reinforcing voluntary standards and tightening audits over testing, to indicate to manufacturers that Government is serious in seeking fuel economy. This would probably be sufficient to encourage manufacturers to reprogramme engine management and transmission systems differently, which makes available a fuel economy benefit of up to 9 percent.

Achieving the full benefit by this means (which might be a little ambitious) would produce a NAFC as low as 7.4 litres/100km. Even if not fully successful, a figure of 8.0 litres/100km could be confidently anticipated.

4.9.2 Actions to Reach 7.0 1/100km

Table 4.8 indicates that an NAFC of 7.0 litres/100km is available by technological fix, although it could equally be achieved by forcing downsizing of the fleet.

Because of the very high welfare losses discussed in later Sections, it was concluded that action to force downsizing simply to reach this small improvement would not be preferred.

Assuming it was desired to introduce US 1994 safety and emissions standards, the following indicates that to achieve 7.0 litres/100km, only a small contribution is required from additional penetration of the devices listed in Table 4.2:

| | 1/100km |
|----------------------------|---------|
| | |
| Product Plan Safety and | 7.83 |
| Emissions penalty | |
| (3 percent) | .23 |
| | |
| | 8.06 |
| Less: | |
| Reprogramming 9% | .73 |
| Technical 4% | .33 |
| | 7 00 |
| | /.00 |

This case envisages taking the full reprogramming benefit but only 4 percent from increased penetration of design modifications to body, engine, transmissions and accessories. Under these circumstances, intervention by way of market based or command-and -control instruments would be envisaged, and the choice of design approach could be left to the manufacturer.

Alternatively, new safety and emissions controls might be avoided and a cap placed on acceleration performance. In combination, these two contributions of 3 percent (each) would cause the target to be reached.

4.9.3 Actions to Reach 6.0 1/100km

Table 4.8 shows that a target of 6.0 litres/100km is beyond the reach of a technical fix, even if Government forgoes the opportunity of introducing safety and emission controls and in addition places a cap on acceleration performance.

This is illustrated by the following:

| | 1/100km |
|------------------------|---------|
| Max Tech Scenario | 6.35 |
| Less: Accel. Cap 3% | .19 |
| • | |
| | 6.16 |

Note however, that the 0.16 margin required to achieve the target could be obtained by encouraging about 20 percent diesel powered cars into the fleet.

Thus 6.0 litres/100km can be regarded as the limit of available and applicable technology for Australia. Strong and possibly draconian policy intervention would be needed to achieve this.

However, if Government policy targets call for fuel consumption targets below 6.0 litres/100km, it may have to consider the magnitude of downsizing required to achieve the target.

This is illustrated by Table 4.10, which identifies a mix of classes chosen arbitrarily to achieve 6.00 1/100km at 2005, both with and without US 1994 safety and emissions controls.

TABLE 4.10: EFFECT OF EMISSION AND ACCELERATION STANDARDS ON NAFC BY VEHICLE CLASS FOR MAXIMUM TECHNOLOGY SCENARIO AT 2005

| | No Safe | sty or l | With US 19 | 94 Safety |
|----------------------------|--------------|-------------|------------|------------|
| | Emissions | Standards | \Emissions | Standards |
| | | | | 1 |
| | Percent | 1 | Percent | 1 |
| | of Vehicle | Litres | of Vehicle | Litres |
| | Class | /100 kms | Class | /100 kms i |
| | | | | |
| mini | 15.1 | 4.47 | 19.3 | 4.47 |
| small | 26.8 | 5.26 | 30.2 | 5.26 |
| medium | 27.3 | 6.35 | 28.0 | 6.35 |
| up medium | 21.4 | 7.14 | 15.6 | 7.14 |
| sports | 3.5 | 6.37 | 2.2 | 6.37 |
| luxury | 3.5 | 7.06 | 2.8 | 7.06 |
| upper luxury | 2.3 | 7.63 | 1.9 | 7.63 |
| | | | | |
| Weighted Average 6.00 5.83 | | | | 5.83 |
| Plus 3 percen | t safety and | d emissions | controls | 0.17 |
| Target NAFC | - | | | 6.00 |

The Table assumes a technological fix has been applied equal to the Maximum Technology Scenario. In choosing the arbitrary mix, it was considered impractical to assume that all luxury vehicles will be eliminated from the fleet, and it was assumed that a reduction of up to 50 percent penetration in upper luxury and luxury classes would be the maximum achievable.

Once that assumption was made, vehicles were simply moved out of the larger size classes in to smaller size classes until a NAFC estimate of 6.0 1/100km was obtained.

In order to appreciate the extent of downsizing required under this outcome, compare the target sales mix for year 2005 shown in Table 4.10 with the predictions given under Section 4.7.1. For Maximum Technology Scenario, the upper medium class share would move from 33.7 percent to 21.4 percent (before safety and emission control penalties are accounted) or 15.6 percent (under the case with penalties).

Mini/small class sales would have to move from 26.9 percent to 41.9 and 49.5 percent respectively. Thus the shifts in sales mix have to be very significant if 6.0 1/100km is to be achieved.

Mini/small class shares in the 40 to 50 percent range are unknown in Australia, and will inevitably bring consumer losses. complaints and probably political action. However, the forced downsizing and technical routes are both options which may have to be considered.
Because the fuel economy penalty for safety and emissions controls exactly cancels out the saving from an acceleration cap, the mix in the second column equates to that required under safety and emissions controls, but with an acceleration cap.

4.9.4 Actions to Reach 5.0 1/100km

The actions needed to achieve a NAFC target of 5.0 litres/100km are draconian but straightforward.

Table 4.6 shows that under the Product Plan, there are no vehicle classes which will deliver this target, not even if all vehicles were mini class.

Table 4.7 predicts that with full penetration of technology, mini classes will deliver 4.471itres/100km. by 2005. Thus a target of 5.01itres/100km is achievable but only by restricting sales of vehicles to mini and small classes. A target mix involving 33 percent mini and 67 percent small cars, with no additional safety and emissions controls, would deliver the necessary target.

This is not considered a likely or feasible outcome, and it was not explored further.