Additional areas where further analysis of welfare gains could be undertaken include re-estimating the parameters of Douglas and Miller's schedule delay formula, deriving a sliding scale for value of schedule delay time for both business and leisure passengers, and interrogating airline timetables to refine our estimates of the impact of changes to direct flight availability. However, while these areas of further analysis would increase the accuracy of our estimates, we believe any resultant changes to the totals would be marginal.

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Energy Market Failure in the Road Transport Sector: Is There Scope for 'No Regrets' Greenhouse Gas Reduction?

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Abstract:

The Australian Government Policy on reduction of greenhouse gas emissions announced in 1990 includes exploring the scope for immediate, low cost reductions. Such measures can be taken as including 'no regrets' policies: those that, in addition to mitigating climate change, confer economic gains (including other environmental benefits) which exceed their costs.

Some possible 'no regrets' opportunities and policies are identified relevant to energy use by the road transport sector over the period to 2020. The MARKAL–MENSA multi-period linear programming model of the Australian energy sector is used to investigate the cost-effectiveness of these policies.

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Introduction

In 1990 the Australian Government adopted an interim planning target which involves, first, stabilising non-CFC greenhouse gas emissions by the year 2000 at the 1988 levels and second, reducing the emissions of these gases by 20 per cent relative to the 1988 levels by the year 2005. An important condition was that any actions taken were not to 'have net adverse economic impacts nationally or on Australia's trade competitiveness in the absence of similar action by major greenhouse gas producing countries' (Kelly and Kerin 1990). This interim planning target currently remains in place, although it does involve larger cuts in emissions than is implied in the recently completed UN Convention on Climate Change.

At the same time, the Government referred to the need to explore the scope for immediate, low cost reductions in emissions by such means as increased energy efficiency and energy conservation and the use of new technology. It has been argued that some of the actions which could be taken in these areas would be 'no regrets' options — that is, they would not only help to mitigate any effects of climate change arising from increased emissions of greenhouse gases, but would at the same time also result in net economic benefits (or at least no economic cost) to the economy. In other words, it would make good economic sense to undertake these actions irrespective of the benefits of lower greenhouse gas emissions.

In a market economy, the presence of unrealised opportunities to make economic gains implies both the existence of some form of 'market failure' (defined below) and the prospect of policy intervention to correct this failure. However, it is not clear that all market failures are amenable to cost-effective intervention. Also, in responding to a given market failure, there is typically a range of policy options, and care is needed in choosing the most cost-effective level and form of intervention.

In this paper, some of the possible market failures that have been identified in the Australian road transport sector are reviewed and possible strategies to overcome these are examined to determine whether they constitute 'no regrets' options for reducing greenhouse gas emissions. To determine whether these strategies would lead to both net economic benefits and a lower level of greenhouse gas emissions, simulations were undertaken using the MARKAL/MENSA model of the Australian energy sector. The conclusion reached from the model results is that care must be taken in identifying 'no regrets' policy options in the road transport sector because there is a danger that some intuitively attractive policies may turn out to be costly.

Before examining some possible areas of market failure which have been identified in the road transport sector, the use of energy in this sector and the level of associated greenhouse gas emissions are outlined.

Road transport energy use and greenhouse gas emissions in Australia

In 1989-90, road transport accounted for around 30 per cent of final energy consumption in Australia, petroleum products being virtually the only energy source in this sector (Jones, Bush, Kanakaratnam, Leonard, and Gillan 1991). Automotive gasoline, which is predominantly used in light vehicles such as cars, is the most important road transport fuel, provided around 73 per cent of the total energy consumed in the sector. Automotive diesel oil (ADO), which is mainly used in heavy vehicles, accounted for 24 per cent, and LPG, which is used in taxis and other light vehicles covering high annual distances, provided 2.5 per cent. Within the road transport sector, cars are the most important mode of transport and account for most of the fuel used.

It is useful to review the characteristics of car usage in Australia, because this vehicle type is the focus of strategies examined below. The rate of ownership of cars (including station wagons) in Australia in 1990 was around 451 per thousand of total population (ABS 1992a). This compares with rates of ownership of 384 and 554 per thousand of total population in the OECD generally and the United States specifically (table 1). Passenger occupancy is estimated at 1.6 persons per trip, but only 1.2 in urban

Table 1: Comparison of car characteristics in Australia and other OECD countries

	Average annual distance travelled (a)	Cars/1000 population		Fuel consumption per car			
				New (b)		Fleet average (c)	
		1970	1987	1980	1988	1980	1988
	km			L/100 km	L/100 km	L/100 km	L/100 km
Australia	15 600	301 (d)	450 (d)	10.2	9.1	12.0	11.8
W. Germany	14 600	na	na	9.0	7.9	10.8	10.7
Italy	11 700	na	na	7.7	6.8	8.5	7.6
Japan	10 100	85	251	8.3	8.6	11.8	10.7
United Kingdom	14 650	na	na	9.6	7.4	na	na
United States	15 900	423 (e)	554 (e)	10.0	8.2	15.5	10.8
OECD Europe	na	171	319	na	na	na	na
OECD	na	242	384	na	na	na	na

Source: OECD/International Energy Agency (1991).
(a) 1988, except Japan (1987). (b) Measures of efficiency available for new vehicles cannot be directly compared because of differences in test procedures between countries. Also, 'it is extremely unlikely that the average driver in normal conditions will match new fuel efficiencies determined in test cycles.' (c) 1988, except for Japan (1986); calculated on the basis of on-road consumption. (d) Includes New Zealand; figure for Australia alone in 1988 was 470. (e) Includes Canada. na: Not available.

commuting (BTCE 1991a). Cars accounted for as much as 88 per cent of energy used in urban passenger transport in 1988 (BTCE 1991a). In Sydney, private cars accounted for 65 per cent and public transport 30 per cent of commuters' travel (Newman and Kenworthy 1989).

As regards emissions of the greenhouse gas carbon dioxide from the energy sector as a whole, coal accounts for as much as 40 per cent of these carbon dioxide emissions while road transport fuels account for 24 per cent. The proportion from coal is high because coal is the most carbon-intensive fuel, and in Australia is the source of 77 per cent of primary energy in electricity generation, compared with the OECD average of 42 per cent.

While carbon dioxide is the principal greenhouse gas associated with transport use, other greenhouse gases are also emitted from cars or in car manufacture. These include carbon monoxide, methane and CFCs (air conditioners and upholstery blowing agents) (Walsh 1990). While nitrogen oxides are major toxic components of vehicle exhausts, the greenhouse gas nitrous oxide (N_2O) is not a significant component of these emissions. Carbon dioxide is the dominant emission from the Australian road transport sector in terms of global warming effect, accounting for 95 per cent of the total greenhouse gas emissions from the sector on that basis (Australian Draft Inventory Preparation Group 1991).

Types of energy-related market failure in road transport

'Market failure' can be defined as any misallocation of resources (which, in a perfect market, would not occur) due to some imperfection in the market mechanism.Three broad types of market failure relevant to the policy options are examined in this paper. The first two, namely *imperfect knowledge* and *externalities*, are types of market failure in the strict sense. The third, *intervention failure* (Barde and Button 1990), is failure not of the market mechanism itself but of some social attempt to improve on its performance. From an economic standpoint, if a policy change can bring about a net economic gain — as is envisaged here — some market failure must previously have occurred.

Energy market failures arising as a result of *imperfect knowledge* are those in which decision makers forgo, because of lack of information, opportunities to improve their economic position by reducing their energy requirements. For example, a consumer may not be fully aware of the extent of future financial benefits from saving energy. In many cases the opportunity for saving energy involves the use of more energy efficient equipment of higher capital cost. Due to uncertainty about, or underestimation of, the gain from energy saving, some energy saving investment that is economically justified may not occur. Relevant evidence from a wide range of studies of energy-using domestic appliances is discussed by Chernoff (1983).

Note that comparison between present investment and future savings, even with perfect information, depends on the discount rate which the user applies to future

benefits. In practice, however, it is difficult to distinguish between the effect of inadequate information and the effect of a high private discount rate.

An *externality*, in relation to any decision, is a cost or benefit which does not affect the prices which the decision maker faces. Energy market failures associated with externalities occur where the benefit of reducing energy consumption (or activities involving energy consumption) cannot be fully appropriated by the decision maker, who therefore has insufficient incentive to undertake a socially beneficial reduction. Typically, unpriced effects of economic activity upon third parties are involved. The possible exacerbation of global warming by greenhouse gas emissions from the energy sector is itself an example. Local examples are urban traffic congestion and urban air pollution from traffic exhaust.

The private discount rate employed in energy-saving investment decisions may exceed the discount rate of society as a whole. This would imply that society's present evaluation of the benefit from future energy saving is greater than that of the private decision makers, even if they will receive that saving in full.

Intervention failure, in the context of energy markets, refers to a policy which reduces economic efficiency of energy use through the distortion of an otherwise effective price mechanism. It includes the case of a policy (perhaps a response to a perceived externality) which is inefficient in the sense of involving higher costs than are necessary to achieve a given benefit. Examples include the underpricing (for whatever reason) of energy from publicly owned power generators, and the tax treatment of corporate cars (BTCE 1991b). In both these cases, a policy whose purpose is unrelated to energy efficiency may encourage excessive energy consumption.

Some of the market failure issues associated with the potential for improvements in fuel efficiency in a number of sectors in the economy, including road transport, have recently been explored by Hinchy, Naughten, Donaldson, Belcher and Ferguson (1991). Hinchy et al. concluded that, in many cases, further empirical study is needed to assess the extent of energy market failures affecting energy efficiency. Sutherland (1991) has also examined the possibilities for achieving increased energy efficiency by correction of market failure, and is critical of the notion that such opportunities are widespread.

Assessment of some possible policy responses

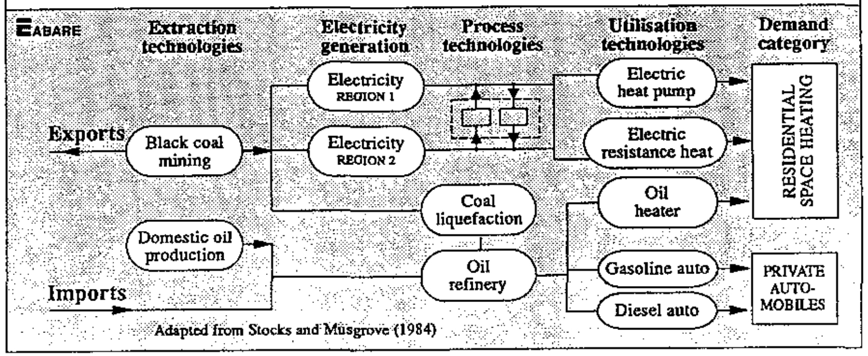
There is a range of policies which could be used to overcome or compensate for perceived market failure in the road transport sector. Four types of action are here assessed to determine whether they can be regarded as 'no regrets' strategies. These are policies which would bring about:

- the use of more efficient motor vehicles;
- a combination of traffic management and behaviour changes;
- the earlier scrapping of older (less fuel efficient) vehicles; and
- the increased use of natural gas as a vehicle fuel.

The MARKAL/MENSA model of the Australian energy sector is used in assessing whether these changes would lead to net economic benefits. MARKAL is a multi-period linear programming model of the energy sector developed for the International Energy Agency during the 1970s and which now exists in versions specific to several countries. MENSA is a regionalised Australian version which was developed in CSIRO (Musgrove, Stocks, Essen, Le and Hoetzl 1982; Stocks and Musgrove 1984) and has since been produced in the PC version (Intelligent Energy Systems 1991) used in ABARE.

It is a data-intensive model in which linear programming techniques are used to determine optimal configurations of the energy sector as a whole over a specified time period. The model enables the user to take account of the complex technical, regional and market interactions within the energy sector. The model framework is illustrated in figure 1. The database and assumptions of the model are documented by Jones, Naughten, Peng and Watts (1991); the specification of the road transport sector employs data obtained from the Bureau of Transport and Communications Economics (BTCE 1991a).

1 Regionalised representation of part of a typical energy system in MENSA



In this paper, the model is used to discover whether the above changes enter into those solutions which minimise the total discounted cost of the energy sector as a whole over the period from 1990 to 2020, while providing the levels of the various energy services (such as travel in passenger-kilometres) that are currently projected for those years. The changes specified will enter into the model solutions if they reduce the total discounted cost of the energy sector compared with the standard (baseline) model solution which does not include these policies. In this way, MENSA is useful in identifying policies which are 'no regrets' options in the sense that, while mitigating climate change by reducing greenhouse gas emissions, they also provide other net economic benefits unrelated to this objective. The results of the model simulations, discussed below, are summarised in table 2. Note that the solutions reported are for a situation in which no constraint is imposed on carbon dioxide emissions.

Table 2: Effects of selected policies on the cost of energy services in Australia and the level of CO_2 emissions (a)

	Change in costs (b)		Change in CO_2 emissions: 2005	
	Including fuel tax	Excluding fuel tax	Road transport	Total energy sector
Policy	\$ billion	\$ billion	%	%
High energy efficiency cars	–3.5	0.3	–13.1	–2.1
Improved traffic management and driver behaviour	–7.7	–5.6	–5.9	–0.8
Early scrapping of cars (c)				
– all cars	79.7	85.2	–18.3	–3.4
– all 'leaded' cars	19.8	24.9	–11.1	–2.0
Use of cleaner fuels (d)	–2.2(e)	0.2 (e)	–5.1	0.6

(a) Comparisons are with the standard model solution which excludes these policies. (b) 1990 real terms. Total real costs over the period 1990–2020 discounted to 1990 at 8 per cent. Some implementation costs not included (see text). (c) High energy efficiency cars, as above, are also assumed available. (d) No tax on natural gas as a vehicle fuel until 2005, then tax at 50 per cent of the rate on conventional fuels. The comparison is with a standard case from which natural gas vehicles have been excluded. (e) Does not include benefits due to lower urban pollution.

The costs represented in the model include all fuel costs, capital costs and operating costs of energy-using equipment (power stations, cars, domestic appliances, for example). Costs over the period are discounted back to 1990 at a real rate of 8 per cent. This was also the rate used in MENSA analyses for the Ecologically Sustainable Development Working Groups (Jones, Naughten, et al. 1991) and is the rate recommended for use by the Commonwealth Department of Finance (1991).

The model results presented in table 2 require some qualifications. These results are based on 'representative' vehicle types specified in the model database. For example, the 'representative' car is assumed to travel 16 000 km annually, which is consistent with the average annual distance travelled by cars in Australia. However, it needs to be recognised that many cars travel less than this distance each year. For example in 1988, 16 per cent of cars travelled less than 5000 km per annum (ABS 1992b). Owners of vehicles which travel less than the average distance could well respond differently to the policies simulated because they face different incentives. For example, the pay-back period for conversion of a petrol car to compressed natural gas would be shorter (the rate of return greater) the longer the distances travelled each year.

Use of more efficient motor vehicles

A study by Difiglio, Duleep and Greene (1990) in the United States suggests that a range of technical approaches are available now, or will be in the near future, which will allow for significant and cost-effective improvements in car fuel efficiencies. Difiglio et al. conclude that, in the period to the year 2000, average fuel efficiencies for new cars could be improved by over 20 per cent (to 6.5 L/100 km), at an additional capital cost of only around 5 per cent per vehicle. Von Hippel and Levi (1983) estimated that improvements in efficiency to 4.6 L/100 km were possible for a maximum additional capital cost of 25 per cent per vehicle. The Difiglio study has been replicated under Australian conditions in a study for the Commonwealth Department of Transport and Communications (Nelson English, Loxton and Andrews 1991), with similar conclusions on the costs.

In the baseline version of the model, the fuel efficiency of the 'normal' new car is set to improve from 10.4 L/100 km at present to 8.8 L/100 km ('on road' basis) over the period to 2005, which accords with what is publicly acknowledged as achievable by the automotive industry (FCAI 1991). For this policy simulation, two categories of high energy efficiency cars were also included in the model. First, 'high' energy efficiency cars, providing improvements in fuel efficiency to 6.5 L/100 km (7.3 L/100 km 'on road'), were allowed to enter the database from the year 2000 at the higher capital cost indicated in the Nelson et al. study. Second, a 'very high' energy efficiency car of 4.6 L/100 km (5.2 L/100 km 'on road'), as in von Hippel and Levi and at their suggested maximum cost, were allowed into the database from the year 2005. The latter was the representative energy efficient car used in one recent study of the costs to the Australian economy of meeting a greenhouse gas target (Marks, Swan, McLennan, Schodde, Dixon and Johnson 1991).

Relative to the standard case, inclusion of high energy efficiency vehicles in the model resulted in a decline in carbon dioxide emissions from cars of 16 per cent (and in the road transport sector 13 per cent) by 2005, and a reduction of $3.5 billion in the total costs associated with providing energy services to Australia over the 1990–2020 period. This is a saving of around 0.1 per cent of discounted GDP over the period to 2020 (on the assumption that GDP grows at 3 per cent per annum to 2000 and 1.5 per cent thereafter).

However, only the 'high' energy efficiency car appeared in the solutions reported in this paper. The 'very high' energy efficiency car was found to be included in the solution only when a sufficiently stringent carbon dioxide target (such as the Government's interim carbon dioxide target) was imposed as a constraint, or (equivalently) when a sufficiently high carbon tax was imposed. Hence the 'very high' energy efficiency car characterised above could not be regarded as a 'no regrets' option.

It is important to note also that the price of transport fuel specified in the model includes fuel taxes, which constitute 35–40 per cent of the pump price of gasoline.

Hence, the measured decline in discounted costs associated with lower fuel consumption includes reduced expenditure on fuel taxes. It could be argued that, from an economy-wide perspective, these fuel taxes are not an economic cost but a transfer from the energy sector (defined here to include motorists) to the government. If the fuel tax is accordingly subtracted from the minimised cost in both this and the standard model solution, the difference in costs between the two solutions is very small.

However, it is reasonable to regard at least some component of the fuel tax as effectively a response to external costs associated with fuel use (traffic congestion, toxic exhaust emissions), and thus as representing a net cost to society. On that view, the net economic benefit of introducing high energy efficiency cars will lie somewhere between the two discounted cost estimates. Subject to any implementation costs of the policies encouraging use of these vehicles, this would appear to be an instance of 'no regrets' reduction in greenhouse gas emissions.

Significant market penetration by more energy efficient cars along such lines may not occur without policy intervention. According to several US studies reviewed by Greene (1983), there is some evidence that in making the trade-off between capital cost and fuel efficiency, motorists implicitly apply high discount rates (in other words, require short pay-back periods) for the energy efficiency benefits. These studies indicated that implicit discount rates of 20-40 per cent are common.

These discount rates are higher than the rates of return found by Difiglio et al. in respect of gains in fuel efficiency, which were in the region of 10 per cent. They are also higher than the 8 per cent discount rate used in the present analysis as being appropriate to society as a whole. Hence, the market penetration of these vehicles may be limited unless policies were introduced which had the effect of reducing the private discount rates used by motorists, or incentives were imposed such as increased fuel taxes. Some such policies might entail costs of their own which could bring into question the 'no regrets' status of this option. However, one probably low cost way to reduce the discount rate effectively used by car purchasers might be to improve public information on high efficiency cars (Hinchy et al. 1991). For example, compulsory energy efficiency labelling of cars could improve market acceptance and knowledge, and reduce any privately perceived risk associated with the higher capital investment involved.

In Australia, the availability and adoption of more fuel efficient cars will also be affected by international developments. The market conditions necessary for the commercial development of high energy efficiency cars both in Australia and overseas are likely to depend on international judgments about the need to reduce greenhouse emissions and any consequent overseas government interventions promoting energy efficient technologies and their use (Ecologically Sustainable Development Working Groups 1991).

Improved traffic management and other non-vehicle measures

The pattern of land use within cities, including population densities, is a major determinant of the level of transport energy use. Because urban forms are a complex result of market and government planning decisions, it is conceivable that instances of 'market failure' arising from externalities, imperfect information and 'intervention failure' could arise.

To date, urban planners and administrators in Australia have not emphasised reducing energy use as an important planning criterion. Typically, Australian cities have a suburbanised structure with low population densities, favouring the use of private cars relative to public transport. By OECD standards, Australians use a relatively high level of energy in urban transport (Newman 1992).

Newman and Kenworthy (1988) also make the point that the common response to the problem of traffic congestion, namely the building of more freeways, may increase the energy intensity of cities by encouraging more road traffic. They argue that congestion has a useful function as a 'proxy price' having the effect of limiting car transport in cities. However, both this and the 'pro-freeway' position may neglect the perspective that peak traffic congestion is an external effect (Neutze 1965), at least in a situation in which efficient road pricing is infeasible. An appropriate system of road pricing, or rate of fuel tax, will tend to correct this traffic congestion externality by having some disincentive effect on the marginal user. Such policies will also tend to improve fuel efficiency, reduce fuel usage and consequently reduce greenhouse gas emissions. To the extent that toxic exhaust emissions are exacerbated by congested traffic conditions, road pricing or fuel taxes may also reduce urban air pollution.

There is a range of policy actions which could reduce the energy required to perform a given total private car transport task in cities without changing the composition of the car fleet. These include regulations and incentives designed to improve vehicle maintenance, vehicle occupancy rates and driving habits, and further improvement of traffic management. There is also a second class of policy responses, the aim of which is to reduce the car road transport task itself while still achieving the purpose of any journey. These include not only modal shifts (including increased use of public transport) but substitutes for travel through changes in urban structures and innovations in telecommunications. This second class of changes was not examined in the present exercise.

The potential benefits from a range of policies designed to reduce the energy required to perform a given transport task, without involving any change to vehicles, were included in a simulation. Improved occupancy rates and improved on-road fuel efficiencies were assumed for all classes of car represented. In this simulation average car occupancy was assumed to improve marginally from 1.60 to 1.66 by the year 2005 and remain at that level to 2020. Improvements in driver habits and urban traffic management were assumed to increase on-road fuel efficiency by a factor of 1.07 to 2005 and by 1.25 from that date to 2020 (see Watson 1992).

Results from this model simulation show a saving of $7.7 billion in total cost associated with providing energy services when the fuel tax component is included, and of $5.6 billion when it is excluded. Compared with the standard case there is a decline of 7 per cent in carbon dioxide emissions from cars by the year 2005. The apparent cost

reduction from this policy option is larger than that in the first simulation. However (as in the first simulation) the costs encountered in implementing the policies were not taken into account. These will therefore be 'no regrets' policies (on the basis of the MENSA model results) if the costs of implementing these policies is less than the estimated savings identified above.

In addition, some associated costs not modelled here may not be readily measurable in financial terms — for example, disutility felt by some motorists as a result of higher car occupancy rates or more conservative driving habits. On the other hand, not all such costs will necessarily be positive — for example, there may be safety benefits, in addition to improved fuel efficiencies, associated with speed limits and 'traffic calming'.

Earlier scrapping of vehicles

Motor vehicle industry representatives have proposed that policies should be introduced to encourage the earlier scrapping of cars as one means of reducing road transport carbon dioxide emissions (FCAI 1991; Industry Commission 1991). All else equal, this approach by lowering the fleet average age would increase the average fuel efficiency of the car fleet and hence reduce greenhouse gas emissions. Though the average design life of new cars internationally has significantly increased over recent decades, the average lifetime of Australian cars is particularly high compared to other industrialised countries. Forty per cent of cars in the Australian fleet are now over 10 years old (EPAC 1991) and the average age of cars on the road exceeds 9.7 years (ABS 1992a). The warm, dry climate (which reduces corrosion problems) and high tariff-inclusive real price of new vehicles could be among the factors accounting for the longer average lifetime of Australian cars.

In this policy simulation, the lifetime of a car (not to be confused with the average age of the fleet) was reduced from 15 years in the baseline model to an internationally more typical value of 10 years. In this simulation it was also assumed that 'high' efficiency cars are available as in the first simulation.

The model results indicate that an 'early scrapping' policy, at least in this simple form, would be a very high cost method of reducing carbon dioxide emissions, both in total cost and per unit reduction in emissions. Carbon dioxide emissions in 2005 from cars is reduced by 27 per cent, from road transport as a whole by 18 per cent, and from the energy sector as whole by 3 per cent. The latter figure is only one percentage point more than is the case with high efficiency vehicles alone, without the scrapping policy, and this relatively minor further reduction is at an additional cost of around $80 billion, over the period 1990–2020, which is 1.5 per cent of discounted GDP over that period. On this basis such a universal earlier scrapping policy could be characterised as a potential 'intervention failure'.

As a further indication of the relatively high cost of this vehicle scrapping policy, it may be compared with the cost estimate, from a previous MENSA model study, for meeting Australia's interim carbon dioxide target: approximately $40 billion (0.7 per cent of discounted GDP) (Jones, Naughten et al. 1991). In that case the reduction in the year

2005's carbon dioxide emission level was 35 per cent, as compared with the 3 per cent reduction here. (The 1991 study indicated that the cost-effective combination of changes that would meet the target would have as its principal element significant fuel switching from coal- to gas-fired electricity generation.)

A variant on this 'early scrapping' simulation involved a somewhat more selective early scrapping. In this case, the reduction in car lifetime to 10 years was confined to those existing vehicles using leaded petrol. In the model database, the fuel efficiency of the older leaded gasoline cars averages 11.9 L/100 km whereas, as mentioned above, that for 'normal' efficiency new cars is assumed to improve from 10.4 L/100 km to 8.8 L/100 km over the period to 2005. In terms of potential 'no regrets' opportunities, this case is of particular interest since this is the category of vehicles which in normal operation is considered most polluting in terms of toxic exhaust emissions. (Exceptional conditions of operation are considered below.) This category of vehicles also has the poorest performance in terms of energy efficiency and hence carbon dioxide emissions. Modelling indicated a reduction in carbon dioxide emissions from the road transport sector by 2005 of 11.1 per cent at a cost of around $20 billion, or 0.4 per cent of GDP. While this additional cost is only about a quarter of that of the scrapping policy involving the whole fleet, it is still clearly a considerable cost with only relatively modest reductions in carbon dioxide emissions resulting. Such a policy could not be regarded as a 'no regrets' approach to reducing greenhouse gases simply on the basis that it also happens to involve, as a secondary benefit, some reduction in toxic exhaust emissions.

It is likely that much more selective approaches to the problem of exhaust emissions will be more cost-effective than such broad-ranging scrapping policies. Evidence from infrared monitoring, involving a sample of 500 000 cars, has shown that as much as 50 per cent of car exhaust emissions are produced by only 10 per cent of vehicles in the fleet (P. Anyon, Federal Office of Road Safety, personal communication, April 1992). Furthermore, it has been estimated that poor emission performance once identified can be rectified for an average cost of less than $200 per vehicle (Anyon, April 1992).

Use of non-conventional fuels

The use of alternative or non-conventional fuels in road transport can have significant implications both for toxic emissions and, with some fuels, for the emission of greenhouse gases. Recent research has focussed on the case of natural gas vehicles. As well as producing less carbon dioxide per unit of effective energy than do conventional fuels, natural gas as an automotive fuel has lower emissions of non-methane hydrocarbons, carbon monoxide and nitrogen oxides. Currently, although there is no excise tax on compressed natural gas used in vehicles, market penetration is low because of the lack of infrastructure and specialised vehicles and the perceived risk of a change in fuel tax policy. On the last point, in recognition of the 'clean fuel' status of natural gas there may be a case for guaranteeing both a further defined tax-free period and a subsequent concessional rate of fuel tax on compressed natural gas for motor vehicles. A credible guarantee along these lines could be regarded as a response to a problem of 'imperfect information'.

In this policy simulation, a tax scenario favourable to natural gas vehicles was represented by setting excise at zero until 2005 and at 50 per cent of the excise rate on conventional fuels thereafter. The result was a decrease in energy sector costs, including fuel tax, of $2.2 billion. This reduction in cost was similar to the reduction in tax revenue due to the concessional treatment of natural gas. Carbon dioxide emissions in the year 2005 from the road transport sector declined by 5 per cent. However, carbon dioxide emissions increased slightly for the energy sector as a whole, because a bidding up of the price of gas occurred which reduced its substitution in electricity generation for the much more carbon-intensive fuel, coal. Thus, care needs to be taken with policies that affect gas use if gas supply at a given cost is limited.

ABARE is currently undertaking further research to identify scope for the adoption of natural gas vehicles in Australia.

Conclusion

The above estimates of additional costs (or economic gains) and changes in carbon dioxide emission from the various policies simulated should not be treated as precise. Nevertheless, the simulations at least give an indication of the magnitudes of likely costs or gains, which is a key issue in identifying 'no regrets' policy options. While there may be instances in which new government policy initiatives could be used to rectify 'market failures' in road transport, leading to net economic benefits as well as a reduction in greenhouse gas emissions, considerable care is required in selecting such policy measures. Poor policy responses to 'no regrets' opportunities may instead lead to excessive costs: a form of 'intervention failure'. For example, policies involving the regulated early scrapping of cars appear to be a costly way to reduce greenhouse gas emissions, notwithstanding associated benefits from reductions in toxic exhaust emissions. On the other hand, compulsory labelling indicating the energy efficiency performance of cars appears more likely to be an example of a 'no regrets' policy approach to the reduction of greenhouse gas emissions.

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