The GST Package and Air Pollution

The impact of proposed indirect taxes changes
on atmospheric emissions

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Abbreviations

ABARE	Australian Bureau of Agriculture and Resource Economics
ABS	Australian Bureau of Statistics
ACAI	Australian Chamber of Automotive Industries
AGA	Australian Gas Association
ARRB	Australian Road Research Board
BAU	business-as-usual
bn	billion
BTCE	Bureau of Transport and Communications Economics
c	cents
CH_4	methane
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
CPI	Consumer Price Index
DPIE	Department of Primary Industries and Energy
g	grams
GST	Goods and Services Tax
IEA	International Energy Agency
J	joules
km	kilometres
kWh	kilowatt hour
l	litres
LCVs	light commercial vehicles
LPG	liquified petroleum gas
N_2O	nitrous oxide
NEPC	National Environment Protection Council
NGGI	National Greenhouse Gas Inventory
NGGIC	National Greenhouse Gas Inventory Committee
NMVOCs	non-methane volatile organic compounds
NO_x	oxides of nitrogen
NRTC	National Road Transport Commission
NSW	New South Wales
OECD	Organisation for Economic Co-operation and Development

SEDA	Sustainable Energy Development Authority
SO$_2$	oxides of sulfur
t	tonnes
VOCs	volatile organic compounds
WST	Wholesale Sales Tax
PM	particulate matter

Standard metric prefixes

kilo (k)	10^3 (thousand)
mega (M)	10^6 (million)
giga (G)	10^9 (billion)
peta (P)	10^{15}

Executive summary

This report evaluates the likely effects on atmospheric emissions of the proposed changes in indirect taxes put forward in the Coalition's GST Tax Package. While there is no mention of the environment in the Tax Package, changes in prices of energy intensive activities induced by the Tax Package may affect energy consumption and thus atmospheric emissions.

This report considers impacts on the two major energy sectors. The first is stationary energy which includes electricity, gas and non-transport use of fossil fuels as well as renewable energy and energy efficiency. The second is transport energy which is divided into freight (road and rail), business transport, private transport and public transport.

The analysis captures only the 'first-round' effects of the tax changes. There will be additional impacts due especially to income changes and changes in the structure of industry over time. Nevertheless, the first round effects will be the major ones. The analytical procedure is straightforward: price changes due to the Tax Package are estimated (notably the replacement of WST by GST and changes in excise arrangements); price elasticities of demand are then used to estimate likely changes in demand for the various forms of energy; these changes in demand are then translated into projections of changes in atmospheric emissions.

Stationary energy

The main aspects of the Tax Package affecting the atmospheric emissions from stationary energy sources are:

- prices of electricity for business are expected to fall by 3.1% and for gas by 5.6% resulting in increased emissions;

- real prices of electricity and gas for final consumers are expected to rise by 4.6% and 2% respectively causing a fall in emissions from electricity consumption but a rise from gas consumption;

- renewable energy will be disadvantaged by the Tax Package with prices rising by 6-8% compared to 4.6% for coal-fired electricity. This may discourage the growth of green power; and

- the price of solar hot water systems is expected to rise by around 4% relative to the prices of similar gas or electricity hot water systems.

The total impact of the Tax Package on stationary energy emissions by the year 2010 will be to increase carbon dioxide emissions by around 1.1% (2.3 Mt) and to increase pollutants responsible for urban air pollution by around 0.5-1.2%.

Transport sector

The environmental effects of the Tax Package will be greater from the transport sector than from stationary energy. Many factors come into play and it has not been possible

to accommodate all of them in the absence of a major modelling exercise. However, the projections made here reflect reasonable order of magnitude estimates.

The principal effects of the Tax Package on the transport sector are:

- the increase in freight transport as a result of the 25c/l reduction in the price of diesel for 'heavy' vehicles, and the shift to road freight away from rail freight;

- the increased amount of business transport as a result of the 9.1% cut in the price of petrol and diesel for business users and the 16.6% cut in the price of cars and light commercial vehicles due the replacement of WST by the GST;

- the effect of a 1.9% fall in the real price of petrol and a 10% fall in the real price of cars for private motorists. Increased travel will be partially offset by the faster turnover of the fleet, bringing forward purchases of more fuel efficient vehicles;

- the disincentives to gas-powered cars as a result of the relative increase in the price of CNG and LPG and the increased costs of gas conversions; and

- the disincentives to public transport in the Tax Package, including the erosion of the trend towards purchase of gas-powered buses.

Overall, the Tax Package is expected to result in a long-run increase in greenhouse gas emissions from the transport sector of around 2.8 Mt CO_2-equivalent (a 4.7% increase on 1995 emissions). Although emissions of some urban air pollutants are expected to decline as a result of the tax changes (for example CO, CH_4), a number of pollutants increase significantly (namely particulates, SO_x and N_2O).

The negative environmental impacts are due principally to the excise changes that result in the cut in the price of diesel for 'heavy' vehicles along with the cheaper prices of petrol and diesel for business users. These negative effects are partly offset by the increased rate of turnover of the fleet in response to the cut in the price of new vehicles. Thus in the transport sector the problem lies not so much with the GST itself but with the proposed changes to excise arrangements.

Assessment

While the Tax Package has mixed effects on particular emissions, the overall impact is unambiguous. The proposed tax changes will increase atmospheric emissions and result in increased health and other costs. Greenhouse gas emissions will increase by around 2% above the levels they would otherwise reach, amounting to an additional 5 million tonnes. While some contributors to urban air pollution are expected to fall slightly, the most damaging ones will increase, notably particulates (up by 2.2 kt from transport alone) and oxides of sulfur (up by 5.1 kt or 0.8%).

How big are these increases? At a time when Australian governments have a suite of policies designed to reduce greenhouse gas emissions and urban air pollution, any measures that work in the opposite direction provide significant barriers. Last November, the Prime Minister announced that an additional 2% of electricity in Australia is to be supplied from renewable sources by the year 2010. This policy is expected to reduce greenhouse gas emissions by at most 5.5 million tonnes by the

second decade of the next century. Thus the Tax Package will almost exactly offset the greenhouse gas benefits of the Government's 2% renewables policy.

The implications of the Tax Package on the future of gas-fuelled transport are of particular concern. When a similar price advantage for diesel to that proposed in the Tax Package was introduced in New Zealand in 1989-91, the growth of gas-fuelled transport collapsed. If the proposed changes go ahead it is unlikely that Australian transit authorities will continue to shift to gas-fuelled buses thus choking off a promising industry with strong environmental advantages. More generally, the Tax Package sends a negative signal to Australian industry involved in low-emissions forms of energy.

This raises a wider policy issue, an issue that may turn out to be the most important effect of the Tax Package for the environment. For the last decade or more the trend in environmental policy making world-wide has been towards the use of 'economic instruments', i.e. taxes and charges imposed on environmentally damaging activities in order to discourage them. This represents a strong trend in OECD countries, and the International Energy Agency has recently urged Australia to increase fuel prices.

The essence of the GST is to apply a uniform rate of taxation on all goods and services with as few exemptions as possible. The Coalition has indicated that it will strongly resist attempts to change the rate of GST or exempt particular goods and services other than those already announced. If adhered to this would rule out many of the most effective potential environmental policy measures. As a result, the introduction of the GST could set back progress in environmental policy making for many years and result in significant losses of economic welfare.

Finally, the cuts in fuel prices proposed by the Tax Package appear to contravene the provisions of Article 2 of the Kyoto Protocol signed this year by the Australian Government. While Article 2 itself is not legally binding, the policies and measures embodied in the Protocol have considerable moral force, and there is an expectation in the international community that Parties to the agreement move in the directions indicated. Aspects of the Tax Package move Australia in the opposite direction and will undoubtedly attract international opprobrium.

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1. Introduction[†]

The Coalition's document *Tax Reform: Not a new tax, a new tax system* − referred to henceforth simply as the Tax Package − proposes some far-reaching changes to the tax system in Australia. While a great deal of attention has been focussed on the social welfare implications, and to a lesser extent the economic efficiency impacts, of the proposed changes, almost nothing has been said about the environmental impacts of these changes. Yet it is well-understood that differences in relative prices brought about by tax changes can be a powerful means of changing market behaviour in ways that may be beneficial or damaging to the environment.

This report evaluates the likely implications for atmospheric emissions of the proposed changes in the system of indirect taxation. In the absence of a full-scale economy-wide modelling exercise, this evaluation can only be partial. For example, the changes in the structure of indirect taxes (in addition to the changes in income and other taxes in the Tax Package) will, over time, change the sectoral structure of the Australian economy which will in turn influence levels of atmospheric emissions. While the approach adopted here will pick up the major impacts of the proposed tax changes, the projected impacts are first approximations.

In addition to air pollution, the Tax Package will have a range of other effects on the environment. Some of the more significant may be the impacts of price changes on the incentives to use material-intensive products. One major, and little commented on, benefit of the existing wholesales sales tax system arises from the fact that it falls only on goods and not services. The proposed goods and services tax (GST) would fall equally on goods and services. The production of goods is more resource intensive than the production of services and thereby gives rise to faster depletion of resources and, perhaps more importantly, greater volumes of wastes to be absorbed by natural systems. Further comments on the benefits of differential taxation are reserved for the final section of this report.

This report is structured around the two major sectors of interest − the impact of the proposed tax changes on stationary energy, and the impact on the transport sector. These are the sectors responsible for most atmospheric pollution in Australia. In the case of greenhouse cases, they account for 60% of total emissions (NGGIC 1997, p. xix) with most of the remainder from agriculture and land use change.

The basic chain of analysis for each good or service has five steps: 1) describe the existing structure of indirect taxes; 2) describe the proposed changes, centering on the replacement of wholesales sales tax (WST) by the GST and associated changes to excises; 3) assess the impact of the proposed tax changes on the prices of relevant goods; 4) use elasticity estimates to assess the likely effect of price changes on levels of demand; and, 5) translate these projections of demand changes into expected changes in atmospheric emissions.

Estimating the effects of the proposed tax changes on the prices of the products in question (electricity, gas, petrol, vehicles, etc) is relatively straightforward, although there are many complexities in the existing system of wholesale sales taxes and the influence of these taxes on final prices. The greatest uncertainty is introduced into the analysis in the fourth step – trying to estimate the effects of tax-induced price changes on demand. Estimates of price elasticities are always attended by doubts arising from model specification and data, but one can only work with the best information available.

There is one area that is especially marked by uncertainty, and that is the implications of the proposed tax changes for technological change. Technology would be affected by the tax changes both through the particular price changes they induce, as well as by way of the broader signals to the market. To some extent, estimates of long-run price elasticities capture technological change, but they do so in a crude and incomplete manner.

There are a number of additional impacts of the Tax Package that are not considered. These include the effects of the tax changes on the consumption patterns through changes in income distribution, and indirect price effects induced by changes in direct prices and incomes. In addition, the structure of the economy may be changed through trade effects. If the Government is right about the benefits to export industries of the proposed changes to the tax system, resources will shift to those activities. Those activities may be more energy-intensive and have greater impact on the environment. Despite these limitations, the partial analysis of this report identifies and evaluates the most important impacts of the tax changes.

The Tax Package document itself contains no reference to the possible environmental implications of the proposed changes. This is in marked contrast to the previous proposal to introduce a GST and associated tax changes in the Coalition's *Fightback!* package of 1991 which included a section that considered the possible environmental impacts of the package. This marginalisation of environmental issues may be due to the way in which the two packages were prepared – *Fightback!* was prepared by consultants working with the Coalition over a long period while the latest Tax Package was prepared in secrecy by Treasury – or to a perception that environmental issues have diminished political significance. Whatever the case in Australia, internationally environmental issues are more important than ever. In the final section of this report, we point to a possible conflict between the Tax Package and Australia's international treaty obligations that appears to have been overlooked in the absence of consultation.

2. Stationary energy

Stationary energy consists of electricity generation, gas supply, other fossil-based energy (petroleum, coal and biomass), renewable energy and energy efficiency. The proposed changes in the Tax Package that will have most impact on atmospheric emissions from the stationary energy sector are:

- the effect of the replacement of WST by the GST on business prices of electricity and natural gas;

- the effect of the GST on the price of electricity and natural gas for final consumers; and

- the impacts of the proposed tax changes on the prices of renewable energy and energy efficiency equipment.

2.1 Current tax situation

Electricity

Currently, no wholesale sales tax (WST) is applied to the wholesale generation or distribution of electricity (CCH 1:176)[1]. Although they will not be affected by the reforms in the Tax Package, some states impose levies and taxes on electricity. For example, in NSW electricity is subject to a levy of 0.52 cents/kWh. In South Australia, a 5% tax is levied on gross sales revenue from electricity production (OECD 1995, p. 82, 85). Most electricity used in Australia is generated by coal combustion. Coal is subject to a resource royalty and freight taxes (IEA 1993, p. 34-35).

Some goods used in the operation of facilities producing or distributing electricity are subject to WST. Examples include vehicles, office equipment and some goods used in maintenance. Government bodies operating electricity generation and distribution facilities are able to claim WST exemptions[2]. Diesel and petrol fuel excise incurred principally in the transport of coal to power stations is embedded in the price of electricity. Electricity infrastructure comprises building materials that are mostly WST exempt. Accordingly, the capital cost of such infrastructure is taxed only to the extent that transport fuels used in construction are higher as a result of the excise.

Gas

Gas receives similar treatment to electricity, being exempt from wholesale sales tax (CCH 1997, 1:176). Gas is subject to a resource royalty, levied at a rate of between 10% and 12.5% of the wellhead value, and a production excise (IEA 1993, p. 29). These will not be affected by the Tax Package. Additionally, Victoria imposes an energy consumption levy on major users, and South Australia collects a 5% levy on the gross sales revenue of gas (OECD 1995, p. 82, 85). Materials used in carrying out mining activities are exempt from WST (CCH 1:1).

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[1] This reference refers to the manual *Australian Sales Tax Legislation* (15th Edition) published by CCH Australia (1997), Sales Tax (Exemptions and Classifications) Act, Schedule 1, Item 176.
[2] Corporatised government utilities are expected to incorporate WST-equivalent amounts in dividend payments so that they effectively do pay WST.

Both metal and plastic piping are subject to WST at a rate of 22% (CCH 2:49). Accordingly, the costs of new gas infrastructure would normally incorporate this tax unless an exemption or subsidy was provided by government. However, the cost of pipelines used for transporting gas between premises operated by the same company is exempt from WST (CCH 1:29).

Goods used for purifying and compressing natural gas are exempt, as are cylinders used in the marketing or delivery of gas (CCH 1:172).

Other fossil-based energy

Excluding the transport sector and conversion industries, 34% of the energy consumed in 1997-98 is expected to be obtained from sources other than grid electricity or gas. This energy is supplied from petroleum (38%), coal (29%) and biomass (33%) combustion (Bush *et al.* 1997, p. 96). It is used primarily for electricity and heat generation and some off-road machinery use. Industry is a major user of all of these products, although significant amounts of biomass are used for domestic purposes in the form of firewood.

Although unaffected by the Tax Package it is worth noting here that states levy resource royalties on coal production and excess coal freight rates. For example, NSW levies a royalty of $1.70/tonne plus an additional $0.50/saleable tonne from certain open cut mines. NSW also levies an excise on coal to fund repair of mine subsidence damage. Queensland levies a royalty of 4% and 5% on the freight value of coal from underground and open-cut mines, respectively. Excess shipping rates for coal vary between $4 and $8/tonne in Queensland. There is an additional 5c/tonne royalty on coal used in Queensland (IEA 1993, p. 34-35).

Petroleum is subject to production excise tax, resource rent tax and royalties in addition to a general excise on consumption. The excise on diesel is rebated for a number of activities, but at different rates. Diesel power generation for domestic purposes receives a rebate of 26 c/l. Diesel used in off-road primary production and some mining activities receive rebates of 43 c/l and 40.5 c/l respectively.

Biomass used in industry comprises mainly bagasse, a waste product from sugar refining. Bagasse is not subject to any tax. Biomass combustion is often considered a renewable form of energy and, where relevant, is discussed below with other renewable energies. Unlike other renewable energy sources, however, biomass combustion is responsible for significant atmospheric emissions.

Renewables

Renewable energy sources include solar, wind, hydro, biomass, geothermal, wave and tidal power. Hydroelectric power requiring the construction of new dams is not considered here, since the adverse environmental impacts of new dams make it unlikely that more will be built.

Solar energy can be converted into both thermal energy (heat) and electricity. Currently, photovoltaic cells (for producing electricity) and goods used for collecting the sun's rays as a source of heat are exempt from WST (CCH 1:171). Goods used in facilitating the operation of these solar systems are also exempt. The single exception

is the water tanks required for solar hot water systems, which are subject to a 12% WST. This equates to a tax of around 5-6% on the retail price of an entire solar hot water system (Nick Florido, Solahart, *pers. comm.*).

Wind power systems are subject to WST at a rate of 22%. However, most purchasers of wind power generation systems are able to claim exemptions from WST. Purchasers include almost all government bodies (Commonwealth, State, Local, including corporatised government enterprises, schools, etc.), primary producers and miners, systems destined for export and systems for residential power generation.[3] Furthermore, generating electricity for sale may be treated as a manufacturing-related activity and any equipment used in this process may be WST exempt (CCH 1:18).[4] Recently privatised electricity generators may receive special tax treatment.

Hydro, geothermal, wave and tidal power stations, comprising mostly building materials, attract little WST although all renewable energy infrastructure contains embedded costs attributable to fuel excise.

Biomass is considered a renewable source of energy. Biomass combustion for heating or electricity is expected to reach 208.1 PJ in 1997-98 (or 6.4% of final energy consumption). Most of this is consumed in the manufacturing sector (bagasse and wood combustion) and the residential sector (wood combustion). Biomass fuels are not subject to WST.

Energy efficiency

Equipment and products used for energy efficiency are treated no differently from their less efficient counterparts. Light globes, computers, facsimiles, photocopiers and other office equipment are taxed at 22%. Refrigerators, washing machines, dishwashers and other household appliances are taxed at 12%. Heating and cooling appliances are also taxed at 12%, whereas ducting and channelling are taxed at 22%. Ventilation systems and glazing are WST exempt. Insulation, unless an integral part of the building, is subject to WST at the 22% rate.

2.2 Proposed tax changes and impact on prices

Electricity

Under the Coalition's tax reform package, WST is to be eliminated and replaced by a 10% GST levied on all transactions. Businesses will be able to claim rebates for any GST paid on inputs. Accordingly, the costs associated with the operation, construction and maintenance of power stations will not be subject to GST. Abolition of WST would reduce the capital cost of new infrastructure, including power stations. Treasury estimates that costs to the construction industry would fall by 4.6% (Commonwealth 1998, p.168).

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[3] These bodies or activities receive exemptions under the Sales Tax (Exemptions and Classifications) Act (Schedule 1, Items 1, 2, 126, 126A, 127 and 140) and the Sales Tax Assessment Act, Section 30 (CCH 1997).
[4] According to the ATO the exempt status depends on various circumstances.

The price of diesel fuel used in heavy transport (including transport of coal for power stations) would fall by 25 c/l as a result of the reduction in excise.[5] Other transport fuel costs (mainly petrol for light vehicles) would decrease by 9.1%. Royalties on coal are expected to be unchanged.

Additionally, removal of WST embedded in other goods can be expected to reduce the costs of supplying electricity. The Tax Package estimates that the costs associated with electricity supply will drop by 3.1% (Commonwealth 1998, p. 168). All final consumption of electricity will be subject to a 10% GST. Business customers will receive rebates for this GST. If all savings are passed on to final consumers, the price of electricity could be expected to fall by a similar amount. In net terms, the final price of electricity to private consumers is expected to rise by 6.6%. Using Treasury's estimate of a 1.9% increase in the CPI as a result of the overall Tax Package, the real price increase for electricity for final consumers will be 4.6%.

Gas

Gas will be treated in a similar way to electricity. Embedded WST costs will be eliminated and the costs of construction and operation of the entire gas supply system will be untaxed. Transport costs will also fall due the tax changes. Gas is expected to benefit less from the reduction in diesel fuel excise because transport is primarily by pipeline. Royalties and production taxes are not expected to change.

The removal of WST and reduction of transport costs embedded in the costs of supplying gas are expected to result in a 5.6% fall in costs (Commonwealth 1998, p. 168) with a similar fall in the price of gas for business users. Private consumers are expected to have to pay an extra 3.9% for gas. This equates to a 2.0% real price increase.

Other fossil-based energy

Taxes and royalties paid in the production of coal and petroleum products are unlikely to change. According to the Tax Package, any off-road use of diesel by business will effectively be free of excise. It is unclear which activities will be included in this exemption and whether or not it includes diesel used for remote power generation.[6] This amounts to an extra $490 million (estimated for 2000-01) being rebated from excise.

The price of automotive petroleum fuels used for purposes other than heavy transport will be maintained. However, business will be able to claim a 10% GST rebate on fuel purchased. Accordingly, business fuels will be around 9.1% cheaper. Because the retail price of fuel for final consumers is maintained, whilst the CPI is estimated to increase by 1.9%, the real price of petrol is expected to fall by 1.9%.

The excise rebate treatment of diesel used for domestic power generation is not expected change from the current rebate of around 26c/l.[7] It is unclear at the moment

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[5] Changes in taxes on diesel and petrol are discussed in detail in Section 3.

[6] 'Depends on the definition of off-road use', Tax Hotline *pers. comm.*

[7] 'Separate rebate arrangements will continue to provide relief from excise for certain private off-road use of diesel, such as remote power generation'. Commonwealth, http://www.taxreform.gov.au//facts/sheets/ 503.htm, 19/8/98.

whether this rebate will be maintained when excise is reduced to offset increases in price due to a GST (Tax Hotline, *pers. comm.*). It is anticipated that the current price of diesel for domestic heat and power generation will be maintained.

Off-road diesel use in the mining industry, including remote power generation, will be excise free (Commonwealth 1998) [8]. Again, it is unclear whether this includes all diesel consumed in power generation and how 'off-road' is defined. It may merely mean that instead of receiving the current rebate of 40.5 c/l for certain activities, the rebate effectively becomes 43 c/l, but the scope of activities eligible for this rebate is not increased. For other business, the Coalition's package is committed to 'major reform for business use of diesel' (Commonwealth, 1998)[9]. Accordingly, it is unclear how diesel used commercially will be treated. At a minimum, however, maintaining the retail price of fuel will reduce the business price by 9.1% after the GST rebate.

The off-road diesel fuel rebate scheme is being expanded from \$2.16 billion to \$2.65 billion for the year 2000-01 (Commonwealth 1998, p. 101). Accordingly, off-road activities previously ineligible for an excise rebate will new be eligible, although, as mentioned previously, the definition of 'off-road' is yet to be determined.

In 1997 approximately 12.5 Gl of diesel were sold throughout Australia (DPIE 1997). Estimates from the NGGI suggest that in 1995 52% of diesel was consumed by the transport sector – road, rail and marine (NGGIC 1997, p. 60). The remainder was presumably consumed 'off-road' in power generation, agriculture, logging, construction, on mine sites and/or in other stationary combustion. The additional \$490 million dollars provided to extend the off-road excise rebate will reduce the average price of diesel used 'off-road' by 23%.

The Tax Package estimates that the costs to the coal, oil and gas industries and the coal and petroleum products industries will fall by 4.3-4.7% (Commonwealth 1998, p. 167,168). Presuming decreased costs translate to the final price of coal, coal will be 4.3% cheaper.

Petroleum, coal and biomass[10] combustion have been grouped together in this analysis to include all energy consumed from sources other than electricity and gas. Taking the share of each fuel into account, the collective price of energy from these sources is expected to fall by 5% for commercial users[11], to fall by 7% for industrial users[12] and

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[8] http://www.taxreform.gov.au//facts/sheets/242.htm

[9] http://www.taxreform.gov.au//facts/sheets/503.htm

[10] Although CO2 emissions from biomass combustion are not included in the National Greenhouse Gas Inventory, other biomass emissions are included and have an environmental impact.

[11] The commercial sector sources approximately 90% of its energy from electricity or gas. Ninety-seven percent of the remainder is generated directly from coal and petroleum (mostly LPG and diesel). The cost of producing coal and petroleum products is expected to decrease by 4.3% (Commonwealth 1998, p. 168). Furthermore, assuming retail automotive petroleum prices are maintained, the cost of petrol and diesel for commercial use will drop by 9.1% (assuming the commercial use of petroleum does not qualify for an additional off-road rebate). Taking the share of each fuel into account, costs are expected decrease by around 5%.

[12] Thirty-nine percent of industry's energy needs are supplied by petroleum, coal and biomass. These provide 41%, 35% and 24%, respectively of non-electricity and gas energy. As discussed, coal and most petroleum products are expected to decrease in price by 4.3%. However, diesel consumption represents around half of the petroleum consumed in this sector. This diesel is consumed 'off-road' and is expected to decrease in price by 23% (9.1% for automotive fuels other than diesel or on-road use). Biomass consumed by industry comprises mostly bagasse from sugar refining. Bagasse is a waste

to rise by 6.5% for domestic users.[13]   The real price increase for domestic users, after allowing for 1.9% CPI increase is expected to be 4.6%.

Expected changes in the prices of stationary energy as a result of the Tax Package are summarised in Table 2.1.

Table 2.1 Real price changes for stationary energy due to the Tax Package (%)

	Final consumers	Businesses
Electricity	+4.6	-3.1
Gas	+2.0	-5.6
Other (including biomass)	+4.6	-5.1–-7.2
Biomass	+5.8	0

Renewables

A 10% GST will be levied on all goods and services unless exempted or input-taxed. Electricity produced by renewable generation will be subject to GST, as will the costs of renewable power generation equipment. Businesses will receive a GST rebate when they purchase either. General operation costs in renewable energy generation will be reduced because of reduced costs of maintenance and equipment but, in contrast to coal-fired power stations, renewable power sources do not have continuous input requirements other than maintenance so their operation costs are expected to fall by less.

Accordingly, the decreased costs associated with lower transport and input prices will provide less benefit to renewable generators. Falls in operation and maintenance costs are unlikely to reduce significantly the cost of supplying renewable electricity. Thus the price of renewable energy for business customers (after GST rebates) can be expected to fall by 0% to 2% compared with 3.1% for coal-fired electricity. Private consumers can expect a real price increase of between 5.9% and 8.1%, compared to 4.6% for fossil fuel-fired power.

In the cases of solar and wind generation, although solar energy generation equipment was previously WST exempt, the capital cost of renewable energy provision can be expected to fall marginally due to reduced transport and construction costs.

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product, the price of which is not expected to change. Overall, energy from these sources are expected to decrease in price by 7%.

[13]   Residential use of petroleum (mainly LPG and heating oil) for power and heat generation accounts for 15.6 PJ of residential energy consumption estimated for 1997-98, or 16% of the total. Biomass consumption comprises 82.1 PJ in the same period (mostly wood for heating). Wood products are expected to increase in price by around 5.8%. The price of diesel for domestic power generation is not expected to change (Tax Hotline, *pers. comm.*), but the prices of LPG and fuel oil will increase by at least 5.2% (3.3% real). Taking consumption shares into account, the real price of other fuels used for domestic purposes is expected to increase by 6.5%.

The 12% WST levied on solar hot water tanks (and similarly on gas and electricity hot water tanks) would be removed under the Tax Package. However, the purchase of solar energy equipment by private consumers, including solar hot water systems, will be subject to the GST. This is likely to increase the real price of a solar hot water system by approximately 2.1% (based on current WST tax amounting to a 5% tax on retail price), compared to 1.7% real price decrease for a gas or electric hot water system (based on the predicted increase in the cost of household appliances, Commonwealth 1998, p. 171). This takes into account the removal of WST on water tanks.

Domestic biomass (firewood) will be subject to a GST, whilst the costs associated with producing firewood are expected to decrease through reduced transport costs and abolition of WST on equipment. A GST on biomass for final consumption will mainly affect domestic firewood use. The model used by Treasury does not overtly incorporate final household consumption of wood or wood products for combustion. The factors involved are perhaps best approximated by 'forestry and logging' which is expected to experience cost decreases of 2% (Commonwealth 1998, p. 167). If this applies to commercial firewood, firewood will become 2% cheaper before a GST and approximately 7.8% dearer for final consumers. The real price will increase by around 5.8%[14].

The price (or value) of biomass used in industry is determined by production costs, costs of disposal, and cost of electricity. It is likely that the price of biomass produced as an industrial by-product and used as a fuel source will not change under the proposed tax changes.

Energy efficiency

At present, there are no exemptions or rebates provided for energy-efficiency measures and so all items will be taxed at 10%. Government and business purchasers (major energy consumers and hence major beneficiaries of increased efficiency) will be able to claim GST rebates on energy efficient products. However, prices of energy efficient goods will change in the same way as more inefficient goods. Table 2.2 summarises the expected price changes.

In summary, the price of many of the goods that consume large amounts of energy, and where energy efficiency is important, are expected to decrease for all consumers. Other goods that reduce energy consumption will fall in price for most consumers, although building materials used for energy-efficient building design will become more expensive for private consumers. Goods taxed at 32% WST − including televisions, radios and projection equipment − are not included because they account for a relatively small proportion of total energy consumption and opportunities for cutting consumption through energy efficiency are minimal.

Table 2.2 Effects of Tax Package on prices of energy efficient goods

Old rate of WST	Items	Price changes

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[14] It must be noted that a significant proportion of firewood is obtained from outside the market economy. An increase in the price of commercial firewood may further encourage people to obtain wood illegally from environmentally sensitive areas.

WST		Govt & primary producers[†]	Business	Private consumers
0% (exempt goods)	Glass	-3.8%	-3.8%	+5.7% (+3.7%)
	Building materials, construction	-4.6%	-4.6%	+2.3% (+0.4%)
12%	Light fittings, household appliances	-3.3%	-9%	+0.1% (-1.8%)
	Heating and cooling appliances	-3.3%	-9%	+0.1% (-1.8%)
22%	Office equipment, computers, light bulbs, telephones, insulation, duct-work/channelling for ventilation or air-conditioning systems	-3.6%	-14.1%[*]	-5.5%[*] (-7.3%)

Items in parentheses indicate real price changes.
*may overestimate decrease
†these groups already receive favourable WST treatment
Source: Commonwealth 1998, p. 167-172.

Finally, information and advice are an important part of the shift to energy efficiency. Energy efficiency consultancy and advisory services, which are often critical to the introduction of efficiency measures, will be subject to the GST, but businesses will be eligible for GST rebates on such services.

Providers of energy consultancy services are expected to receive cost reductions of approximately 3.3% (similar to other business services) through reductions in embedded WST and excise costs (Commonwealth 1998, p. 169). This can be expected to reduce the price of the services associated with initiating energy efficiency measures.

2.3 Impacts on demand

Section 2.2 indicates that the proposed changes to indirect taxation centred on the introduction of a GST will have a range of impacts on prices of stationary energy and products associated with energy production and use. The environmental implications of these price changes depend critically on how these price changes influence the demand for energy of different types.

The responsiveness of the change in demand resulting from a change in price is referred to as the price elasticity of demand, measured by the percentage change in quantity demanded divided by the percentage change in price. Thus an elasticity of -0.5 means that a 10% rise in price will induce a 5% fall in quantity demanded.

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Changes in prices of substitute and complementary goods can also affect demand for an item. Thus a fall in the price of natural gas may cause a fall in demand for electricity as consumers switch from electric heaters to gas central heating. This is referred to as the 'cross-price elasticity', in contrast to the 'own-price elasticity' discussed above.

These price elasticities may vary between the short term and the long term, for in the longer term there are more opportunities for consumers to replace equipment and adapt their usual practices. As a result, long-run elasticities tend to be higher then short-run elasticities. This section uses estimates of elasticities to estimate expected changes in consumer demand for energy. The estimates presented below represent long-term changes in demand unless otherwise indicated.

Electricity, Gas and Other combustion fuels

Generally, an increase in the price of a good such as electricity can be expected to result in reduced demand for that good. However, the change in the price of other goods will also affect demand. As suggested above, a fall in the price of natural gas should also decrease the demand for electricity as consumers substitute gas for electricity. Conversely, a large decrease in the cost of electrical appliances may increase the demand for electricity. A change in consumer incomes will also affect the consumption of electricity. (The latter is referred to as the income elasticity of demand.)

There are a myriad of such secondary affects that will ultimately affect electricity demand. This study does not attempt to take these all into account. However, the most important effect is the substitution between electricity, gas and other sources of power in response to price changes, and this is discussed below using estimated elasticities.

The most recent assessment of the price responsiveness of demand for gas and electricity has been undertaken for the Australian Gas Association by ABARE (AGA 1996). The authors warn that some of the estimates are not statistically robust so that the results should be interpreted with caution. The long-run own-price and cross-price elasticities of demand for the residential, commercial and industrial sectors are reproduced in Table 2.3.

Table 2.3 Long-run price elasticities of demand (percentage change in demand in response to a one percent change in price[*])

	Electricity	Gas	Other fuels
Residential sector			
Electricity	-0.24	0.15	0.06
Gas	0.83	-0.78	-0.08
Other fuels	0.43	-0.10	-0.37
Commercial sector			
Electricity	-0.27	-0.03	-0.01
Gas	-0.37	-0.10	0.16
Other fuels	-0.09	0.14	-0.36
Industrial sector			
Electricity	-0.27	0.00	-0.04
Gas	0.00	-0.30	0.07
Other	-0.03	0.02	-0.22

* Thus, for example, a 1% increase in the price of electricity will induce a 0.83% increase in demand for gas.
Source: AGA 1996, Tables 3,4 and 5.

The real price changes estimated for electricity, gas and other fuels in Section 2.2 have been combined with the own- and cross-price elasticities in Table 2.3 to estimate changes in demand. The results, including CO_2 emission levels, are presented in Table 2.4. The reader is reminded that these represent 'first-round' effects only. There will be other influences on the structure of energy demand, including inter-industry effects, income effects and technological change flowing from the Tax Package. Nevertheless the direct price effects identified here are likely to capture the most significant changes.

The elasticities reported in Table 2.3 appear to suffer from internal inconsistency when viewed in terms of the results in Table 2.4. For the residential sector, where the prices of all forms of energy are increasing, overall demand for energy is also increasing. This appears to be anomalous but there may be a straightforward explanation. The fall in the relative price of gas induces an increase in demand for gas in excess of the fall in demand for both electricity and gas due to the absolute price rises.[15]

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[15] Since both demand for energy and the prices of energy rise in the residential sector, expenditure on energy also increases. This is a product of the fact that energy demand is inelastic.

Table 2.4 Impacts of the Tax Package on energy demand and CO$_2$ emissions

	Real price change (%)	Current demand (PJ)	Change in demand (%)	New demand (PJ)	Current emissions (Mt CO$_2$)	New emissions (Mt CO$_2$)	Increase in emissions (Mt CO$_2$)
Residential							
Electricity	+4.6	163.1	-0.54	162.2	45.18	44.94	-0.24
Gas	+2.0	111.8	+1.93	114.0	6.64	6.77	0.13
Other fuels	+4.6	98.0	+0.10	98.1	8.34	8.35	0.01
Commercial							
Electricity	-3.1	134.8	+1.62	137.0	37.34	37.94	0.60
Gas	-5.6	48.9	+0.90	49.3	2.90	2.93	0.03
Other fuels	-5.1	17.2	+1.32	17.4	1.18	1.19	0.01
Industrial							
Electricity	-3.1	280.6	+0.88	283.1	77.73	78.41	0.68
Gas	-5.6	521.2	+1.18	527.3	30.96	31.32	0.36
Other fuels	-7.2	520.9	+1.57	529.1	42.54	43.21	0.67
Total electricity		**578.5**	**+0.66**	**582.3**	**160.25**	**161.29**	**1.04**
Total gas		**681.9**	**+1.28**	**690.6**	**40.50**	**41.02**	**0.52**
Total other fuels		**636.1**	**+1.34**	**644.6**	**52.06**	**52.75**	**0.69**
TOTAL All		**1896.5**	**+1.11**	**1917.5**	**252.81**	**255.06**	**2.25**

Source: Bush *et al*. (1997, p. 96), NGGIC (1997)

On the other hand, these elasticities may have been misspecified. The own-price elasticities of electricity demand (-0.24 for the residential sector) appear to be at the lower end of the spectrum. Reviewing the Australian evidence in the 1970s and 1980s, Lilio (1991, p. 7) concluded that the price elasticity of demand for electricity by households is in the range –0.14 to –0.77.

Despite these uncertainties, inferences about changes in demand can be drawn. Table 2.4 indicates that as a result of real price rises in electricity (4.6%), natural gas (2.0%) and other fuels (4.6%), demand in the *residential sector* for electricity is expected to fall by 0.9 PJ (0.5%), while demand for natural gas is expected to rise by 2.2 PJ (1.9%). Little change is expected in demand for other fuels (principally biomass) although a small shift away from biomass and LPG towards diesel may occur.

In the case of *commercial energy* users, falls in the price of electricity (3.1%), natural gas (5.6%) and other fuels (5.1%) are expected to increase demand for electricity by 2.2 PJ (1.6%), gas by 0.4 PJ (0.9%) and other fuels by 0.2 PJ (1.3%).

Falls in the prices of electricity (3.1%), gas (5.6%) and other fuels (~7%) in the *industrial sector*[16] are projected to lead to increased demand for energy, particularly for diesel and gas. Demand for electricity is expected to increase by 2.5 PJ (0.9%), for gas by 6.1 PJ (1.2%) and for other fuels by 8.2 PJ (1.6%).

Bearing in mind the uncertainties relating to the elasticity estimates, across all sectors demand for electricity is expected to increase by 3.8 PJ (0.66%), gas will increase by 8.7 PJ (1.3%) and other fuels will rise by 8.5 PJ (1.3%). Increased petroleum (primarily diesel) consumption will produce most of the increase in the latter. Consumption of wood biomass is expected to remain unchanged or decline slightly.

Renewables

In the previous section we concluded that renewable energy will be disadvantaged by the Tax Package because it will not enjoy the price reductions associated with transportation of fuels and of the fuels themselves. It is anticipated that the price of renewables for business customers will fall by 0% to 2% compared to a fall of 3.1% in the price of coal-fired electricity, while the real price of renewables for final consumers will rise by between 5.8 and 7.9% compared to 4.6% for coal-fired power.

The impact of the higher relative price of renewables on demand is difficult to estimate. Renewable-source electricity supplied through the Green Power scheme is currently priced up to 40% higher than standard domestic rate (Energy Australia 1997). However, in eighteen months of operation, the scheme had attracted 18,500 residential customers and 1,500 business customers. Business customers accounted for 61% of consumption (Nicole Ghiotto, SEDA, *pers. comm.*).

Although changes in price of renewable energy relative to gas and electricity are expected to further reduce the price competitiveness of renewable energy, price is not the only the motivation for most consumers. The direct marketing of renewable energy through the electricity grid is a recent innovation. The market is still growing as consumers receive more information about renewable energy. Consequently, the price elasticity of renewable electricity demand cannot be determined quantitatively but the Tax Package may impose a slight constraint on the growth in demand for renewable energy.

The price of solar hot water systems is expected to increase by 4% relative to the price of similar gas or electricity hot water systems. Solar hot water systems are already more expensive than competing systems and an increase in price will further discourage consumers from outlaying the initial capital to convert to solar hot water. An increase of 4.6% in the real price of electricity, however, will make the financial benefits of converting more attractive. It is likely that the capital cost effect will dominate the market although this effect can be overcome with information and appropriate policies. Overall, it is unclear whether the increased price of electricity will offset the increased relative price of solar hot water systems. This is discussed further below.

Energy efficiency

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[16] Including mining and construction, but excluding the conversion sectors.

The demand for energy-efficient goods is influenced strongly by the capital outlays required compared to the savings in fuel costs. The long-term estimates of electricity and gas elasticities of demand (AGA 1996, p. 7) take into account the expected changes by consumers in their capital stocks including new equipment and appliances. Therefore, the effect on energy demand of increased energy-efficiency arising from a change in real energy price have been taken into account. However, the impact on energy demand due to changes in the prices of energy efficiency products in households has only been considered in a crude way in our global estimates of demand elasticities. It is worth discussing further the individual impacts, many of which may have significant policy implications.

In assessing the environmental implications of the Tax Package, it is important to focus on demand for goods that consume the most energy as changes in the stocks of these goods represent the greatest potential for energy savings.

Residential users

For private homes, approximately 30% of all energy is consumed in heating water. Most homes use conventional electric hot water systems, although gas is becoming popular due to its lower operating costs and comparable purchase price. Electric heat pumps are also winning market share because they save on energy. However, they require an initial additional outlay of up to $3000. Solar hot water systems use costless energy but also require an initial additional outlay of up to $3000.

Under the taxation reforms, the real price of electricity is expected to increase by 4.6% whereas the price difference between a solar and conventional hot water system is expected to increase 4%. This suggests that solar hot-water systems will become relatively cheaper in terms of lifetime costs. Unfortunately, the major barrier to uptake of solar hot water is the initial capital outlay, which will increase following a GST (Nick Florido, Solahart, *pers. comm.*). The price of heat pump water systems will fall by the same as gas and electric systems (i.e., a real 1.7%), but will become relatively cheaper in terms of lifetime costs. Again, initial capital costs are the major barrier to greater uptake of this technology. Gas will experience a 2.5% price decrease relative to electricity, increasing the competitiveness of gas systems slightly.

Refrigeration consumes approximately 18% of domestic energy. Energy-efficiency experts suggest that high efficiency refrigerators may cost around $300 more and save 300 kWh pa compared with a conventional refrigerator (Alan Pears, Sustainable Solutions, *pers. comm.*). Restructuring the taxation system will barely change this price difference, although the price of electricity will increase. The effect of this price increase on residential electricity demand has already been considered.

Heating and cooling systems represent the next largest category of domestic energy consumption. Insulation and draught prevention, in addition to actual appliances, are important here. The prices of heating and cooling systems are expected to decrease a couple of percent, whereas the real price of insulation could drop in price by up to 7.3%.

Overall, it is not expected that the Tax Package would have any appreciable effect on residential consumption of energy efficiency equipment.

Business and government users

A major cause of inefficient energy use in government and business is poor building design and equipment specification. A fall in the price of business services, including energy efficiency consultants, coupled with the potential for greater returns arising from cheaper equipment costs, may stimulate demand slightly.

For commercial and government users, the major areas of energy consumption include lighting, heating and cooling and ventilation. The relative price of energy-efficient and inefficient heating, cooling and ventilation systems will not change, although the price difference between such systems will decrease by around 10%[17] (depending on the proportion of cost attributable to ductwork and the appliance itself). The price of electricity is expected to fall by only 3.1% so the attractiveness of energy-efficient appliances should increase. The same is true for lighting, although prices may drop by up to 16.6%.

Another significant consumer of electricity, office equipment, will become somewhat cheaper. However, most items sold in Australia are energy-saving capable (Energy Star compliant), although not necessarily enabled (SEDA 1998). Decreased prices of electricity may remove incentives to energy-save enable these appliances and this will work against energy efficiency.

Overall, the Tax Package is unlikely to have a substantial effect on investment in energy efficiency by business. The changes in relative prices of equipment and electricity are unlikely to be sufficient to outweigh the other factors that influence the uptake of energy-efficiency measures. SEDA reports that the current energy-efficiency projects are generating internal returns of over 40%, whereas companies are often willing to implement efficiency measures if returns are greater than 20% (SEDA 1997, p. 4; Harris *et al.* 1998, p. 50). The magnitude of these returns is unlikely to be significantly affected by changes in the Tax Package, although cheaper electricity may remove incentives to initiate such programs. It appears as though other disincentives, or a lack of information, have so far limited the uptake of energy-efficiency measures (Harris *et al.* 1998, p. 9,10).

2.4 Environmental impacts

The two principal environmental problems associated with atmospheric emissions are the global problem of climate change and the local problem of urban air pollution. Carbon dioxide is the principal greenhouse gas associated with stationary energy production while urban air pollution is caused by a number of pollutants, especially sulfur dioxide, carbon monoxide, lead, particulates, oxides of nitrogen and volatile organic compounds other than methane.[18]

Electricity production is responsible for a number of atmospheric emissions. Around 84% of electricity in Australia is generated from the combustion of brown and black coal, although in recent years natural gas has captured 11% of the market (Bush *et al.* 1997, p.96). The average emission factor for electricity in Australia in 1993/94 was 277 kt CO_2/PJ (GCO 1997, p. 29).

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[17] For governments, the price difference is expected to decrease by only 3.5%.

[18] For a discussion of the health costs associated with these emissions see Hamilton (1997, pp. 29-30).

In the previous section we estimated that electricity consumption in Australia is expected to increase as a result of the Tax Package. Table 2.4 contains estimates of the impact of price changes due to the Tax Package on emissions of carbon dioxide. The increased consumption of 3.8 PJ, or 0.66% equates to an additional 1040 kt of CO_2 using an industry average of emission intensity. Emissions of other greenhouse gases are also expected to increase, as are emissions of NO_x and SO_x. Using emission factors in Appendix 1, increased electricity consumption is expected to increase emissions of NO_x by 2.3 kt and emissions of SO_x by 2.5 kt.

The Tax package is expected to see natural gas consumption rise 8.7 PJ or 1.3% (Table 2.4), resulting in the emission of an additional 520 kt of CO_2, 2.9 kt of NO_x and 20 tonnes of SO_x. The combined consumption of coal, petroleum and biomass is expected to increase by 1.34% or 8.5 PJ. Carbon dioxide emissions are expected to increase by 690 kt. Increased consumption of diesel and coal are expected to increase emissions of SO_x by at least 0.72 kt. Emissions of NO_x are also expected to increase by around 4.3 kt.[19]

Emissions of other gases, including N_2O, CH_4 and VOCs, and particulates will also increase. N_2O and CH_4 emissions account for less than 1% of CO_2-equivalent emissions from stationary energy combustion activities and for this reason have not been discussed in detail. Other atmospheric pollutants, including volatile compounds and particulates have not been discussed because although they have local effects, most emissions from stationary combustion occur in areas where local pollution is not a major concern. Conversely, NO_x and SO_x emissions can cause regional acidification (acid rain) and promote stratospheric ozone depletion (OECD 1993, p. 181-183).

In the cases of renewable energy and energy efficiency we concluded that the effects of the Tax Package are uncertain but that it is unlikely to have any significant effect for either residential or business consumers.

2.5 Summary of stationary energy

Table 2.5 summaries the estimated environmental impacts of the Tax Package on stationary energy. The main factors affecting the results are:

- falling prices of energy for commercial and industrial users; and

- shifts in the relative prices of electricity, gas and other fuels for households.

It is apparent from Table 2.5 that the total impact of the Tax Package on stationary energy emissions will be to increase carbon dioxide emissions by around 1.1% and to increase pollutants responsible for urban air pollution by around 0.5-1.2%.

Table 2.5 Summary of environmental impacts of the Tax Package in stationary energy

	CO_2 (kt)	NO_x (kt)	SO_x (kt)

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[19] Industry accounts for 8.2 PJ of the 8.5 PJ increase in demand for other fuels. Accordingly, the aggregate emission factor for NO_x in industry, 0.50 kt/PJ (NGGIC 1997, p. 48), has been used.

Electricity	1040	2.3	2.5
Gas	520	2.9	0.02
Other fuels	690	4.3	0.72
Total	2250	9.5	3.24
Increase in emissions*	1.1%	1.2%	0.55%

* Totals in 1995: CO2 203 Mt; NOx 812 kt; SOx 594 kt. From fuel combustion sectors including Electricity and heat production (1A1a), Industry (1A2), Small combustion (1A4) and Biomass burned for energy (1A6).[20]
* 1995 emissions (NGGIC 1997, p. 36, 44). SO_x emissions include entire Energy and transformation sector (1A1).

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[20] Brackets indicate NGGIC sector classifications (NGGIC, 1997).

3. Transport

In this section, we reverse the format of the previous section by considering each segment of the transport market in turn − freight, business transport, private vehicles and public transport − since, with the exception of private vehicles and public transport, these forms of transport are not substitutes for each other. This section does not examine the impacts on marine or aviation transport.

The principal tax change proposals relevant to the transport sector are:

- a large reduction in excise on diesel for heavy vehicles;

- a cut in the prices of petrol and diesel for business users;

- reductions in the prices of vehicles; and

- changes in the relative prices of diesel and CNG and LPG.

3.1 Freight

Current tax situation

Fuel excise is levied on every litre of petrol and diesel at a rate of approximately 43 cents[21] (45 cents for leaded petrol). A number of exemptions and rebates apply to the excise on diesel used for certain activities.

Primary producers receive full excise rebates for on-farm operations, gathering of primary produce and movement of stock for agistment. Transport on private roads is also exempt. In the mining industry, a rebate of about 40.5 cents/l (2.388 c/l less than the primary production rebate, BTCE 1997, p. 101) can be claimed for any diesel used to transport minerals and ores to a place for beneficiation. Beneficiation includes upgrading and purifying ores, but not final smelting or processing.

A credit of about 26 cents/l is provided for diesel used for domestic power generation or heating (BTCE 1997, p. 99).

Prices of vehicles as well as fuel will also be affected by the tax changes. Generally, trucks are subject to sales tax at a rate of 22%. Exemptions exist for those used exclusively on the premises of a business or as an input in primary production or a manufacturing process (CCH 1:28). Heavy vehicles used in the transportation of livestock in remote areas are also sales tax exempt.

Trains and other equipment required for the operation of public railways transporting passengers or freight are sales tax exempt. Additionally, rail operators are not liable for the state franchise fee-equivalent component (8.1 c/l) of excise.

Proposed tax changes and price effects

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[21] Actual rate from 1st August 1998 is 43.054 cents/l for unleaded and automotive diesel. Leaded petrol is subject to an excise of 45.242 cents/l.

The GST package includes changes to excises on petroleum and diesel. The Coalition plans to maintain the current retail price of petrol and diesel after the introduction of a GST. To achieve this, the petrol and diesel excises are being reduced so as to offset the GST on fuels. For example, to maintain the price of fuel at 70 c/l, the Government will reduce the excise by 6.36 cents. This results in a pre-GST price of 63.64 cents. Imposing a 10% GST brings the price back to 70 c/l. However, for business users, money paid as GST can be claimed as an input credit and is rebated. Accordingly, the price of fuel for business is reduced to 63.64 c/l (or by 9.1%).

For heavy vehicles − defined in the Tax Package as those over 3.5 tonnes gross weight − the diesel fuel excise would be effectively reduced to 18 c/l. This occurs through a combination of the excise being reduced to maintain the retail price, and an additional reduction specifically for heavy vehicle users. This equates to a reduction of around 25 c/l. The reduction in excise on freight fuel consumption represents an expected loss in revenue of $930 million dollars per year from 2000-01 (Commonwealth 1998, p.101).

It is important to point out that the 25c/l cut in diesel prices for heavy vehicles applies to vehicles with a loaded weight of 3.5 tonnes or more. The BTE defines light commercial vehicles as anything less than 4.5 tonnes gross (BTCE, *pers. comm.*). Anything larger than a standard 'one-tonne' flat top truck may qualify as a 'heavy vehicle'. In other words, 3.5 tonnes gross weight is not very heavy and serious problems may arise from threshold effects whereby businesses increase the size of their vehicles somewhat in order to benefit from large savings in fuel costs.

The Tax package proposes to extend the off-road use exemption from diesel excise provided through the current Diesel Fuel Rebate Scheme. For example, mining activities will be eligible for a full rebate. It is unclear from the Tax Package and from the Tax Hotline which additional off-road activities will be eligible.

Wholesale sales tax on heavy road vehicles will be abolished and replaced with a 10% GST. Since businesses and government can claim a rebate for any GST paid, truck prices are expected to effectively fall by up to 16.6%.

It is estimated in the Tax Package that the cost of road freight will fall by 6.7% and the cost of rail freight by 4% (Commonwealth 1998, p.86). These estimates incorporate changes in input prices, including fuel, maintenance and other operating costs. The decreased costs of new road vehicles contributes to lower operating costs for road freight. Removal of WST will not directly change the price of rail engines and rolling stock because they are already WST exempt.

It might be noted that the proposed reduction in diesel excise for heavy vehicles leaves a remaining excise of 18 cents/l. The National Road Transport Commission (NRTC) considers 18 cents/l (of the current 43 cents/l excise) on diesel imposed on heavy vehicles to be a road user charge which partially meets the costs of road damage (BTCE 1997, pp. 29-30). While the Tax Package does not provide a rationale for the cut in excise from 43 to 18 cents, it is reasonable to assume that the Government has accepted the NRTC view. Perhaps the Government has not articulated its reasons because the 'road user charge' of 18 cents/l will also be levied on rail users.

Impacts on demand

Total demand for freight would be expected to increase by a small amount in response to the lower prices of both road and rail freight, although demand for freight is determined primarily by income growth.[22] The change in the relative prices of road and rail freight is likely to be more important. The Tax Package will induce a shift away from rail to road transport. The Australian Road Research Board estimates that the elasticity of the share of road freight with respect to changes in the ratio of road to rail freight prices is -0.80 (Luk and Hepburn 1993, p. 19). On this basis we would expect the share of road freight to increase by 2.3% at the expense of rail.

The decrease in the price of both rail and road freight are likely to increase total demand for freight. The long-run real freight rate (price) elasticity of demand for freight is -0.9 (BTCE 1995, p. 34). Based on the 2010 shares of road and rail freight (BTCE 1995, p. 215, 225, 226), the weighted mean freight rate is expected to drop by 5.5% and demand for freight is expected to increase by 5%. When combined with the relative increase in the price of rail versus road freight (see previous paragraph), a 2.0% increase in rail demand and a 7.3% increase in road freight demand are expected. It should be remembered that this are approximations only. They do, however, appear to be plausible ones.

In 2010, heavy road and rail freight demand levels are estimated to reach 175 and 137 billion tonne-kilometres, respectively (BTCE 1995, p. 215, 225, 226). The Tax Package is expected to increase demand above these levels. Rail freight demand is expected to increase by 2.7 billion tonne-kilometres and road freight demand 12.8 billion tonne-kilometres. On average, rail freight is estimated to consume 0.007 l of diesel per tonne-kilometre (i.e. the carriage of one tonne a distance of 1 km) in 2010, whereas road freight will consumes 0.034 l per tonne-kilometre[23]. Based on these figures, road freight consumption is expected to increase by around 430 million litres per annum above expected growth, and rail freight will use an additional 20 million litres.

Environmental impacts

The main environmental impacts associated with combustion of diesel fuel are greenhouse gas emissions (mainly CO_2) and a number of emissions that give rise to urban air pollution, especially sulfur dioxide, carbon monoxide, particulates, oxides of nitrogen and VOCs.

It is estimated above that consumption of diesel used in heavy freight (road and rail) would increase by around 450 million litres per year as a result of the Tax Package. Based on an emission factor of 2.69 kilotonnes of CO_2/ML (NGGIC 1996, p.43) this will result in an increase in CO_2 emissions of around 1210 thousand tonnes.

The picture is more complex with respect to other air pollutants. The increased demand for freight is expected to result in the entire freight task increasing by 15.5 billion tonne-kilometres. Based on average vehicle loads (BTCE 1995, p. 215), this

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[22] The BTCE derived a long-run income elasticity of demand for road freight of 1.1. In other words, for every 1% increase in GDP road freight demand is expected to increase by 1.1% (BTCE 1995, p. 34-35).

[23] Based on BTCE 1995, p. 40, 54, 215, 216, 225, 226, 229

equates to 1270 million km of additional road freight travel. The additional emissions resulting from this travel are estimated in Table 3.1. It is worth noting the significant increase in particulate emissions. Approximately 540 million km of the additional travel is expected to occur in urban areas (based on BTCE 1996a, p. 336) resulting in a significant deterioration of urban air quality.

Table 3.1 Emission factors and additional emissions from increased heavy road freight

	CH_4	N_2O	CO	NO_x	VOCs	SO_x	PM[†]
Emission factors (g/km)[*]							
Medium trucks	0.02	0.017	1.82	3.10	0.99	0.633	0.95
Heavy trucks	0.07	0.025	7.86	15.29	2.78	1.412	1.5
Additional emissions (t)	53	26	5600	10600	2240	1230	1500

* BTCE 1995, p. 182. This study has generally assumed that rigid trucks weigh between 3.5 and 12 tonnes, whereas articulated trucks weigh in excess of 12 tonnes. This correlates with average vehicle loads estimated by the BTCE (1995).
† based on Faiz *et al.* 1996, p. 41, 58. These estimates are for European and USA vehicles. These countries have particularly tighter emissions regulations and therefore these emission factors may underestimate those of the Australian fleet.

3.2 Business transport

Current tax situation

Currently, businesses pay WST on vehicles at the rate of 22% (CCH, Section 3(2), Schedule 1, 4)[24] and the full excise on purchases of petrol and diesel fuel. Alternative fuels − including ethanol, liquefied petroleum gas (LPG) and compressed natural gas (CNG) − are exempt from excise. The materials for converting vehicles to run on these fuels are also WST exempt. Equipment for storing, purifying and compressing gas is also WST exempt. Production vehicles that run on CNG or LPG, however, are treated the same as other vehicles.

Proposed tax changes and price effects

The Tax Package proposes to reduce existing fuel excise to offset any price increase caused by introduction of a GST on fuels thus maintaining the pre-GST price for final consumers. Businesses, however, will be able to claim a GST rebate on the fuel they consume, effectively reducing the price they pay by 9.1% or around 7 cents/l.[25] (Businesses operating diesel vehicles over 3.5 tonnes gross weight will receive the excise exemption of 25 cents/l.)

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[24] Schedule 1, Item 1(3b), 2(3b), 18(3b), 23(3b), 28(3b), 29(3b), 30(3b), 33(3b), 34(3b), 35(3b), Schedule 4. With the exceptions listed in Section 3.1 above and 4WDs used in agriculture (CCH 1:3).
[25] Remembering that a 10% increase in a price of 63.63 cents gives 70 cents, and that 63.63 cents is 90.9% of 70 cents.

Alternative fuels would remain excise free but would be subject to a 10% GST which would also be rebated to business users so that their prices would be unchanged. Thus for businesses, petrol and diesel prices will fall by 9.1% while the prices of alternative fuels will be unchanged.

In the case of vehicles, wholesale sales tax on vehicles would be abolished and replaced by the GST, but where vehicles represent a business input the GST would be rebated. The Tax Package estimates the final consumers will pay 8.3% less for motor vehicles after the introduction of a GST (Commonwealth 1998, p.171). Businesses will pay the same price, but be able to claim 10% of the cost as a GST rebate. Accordingly, businesses will effectively pay 16.6% less for motor vehicles compared to current prices.

Finally, prices of production vehicles that run on CNG or LPG would fall by a similar amount to other vehicles. LPG and CNG conversions, which are currently exempt from WST, will be subject to a GST, but the tax will be rebated to business users.

Impacts on demand

It is likely that the 9.1% cut in the prices of petrol and diesel for business users, coupled with the 16.6% fall in vehicle prices, would see an increase in the proportion of vehicles being registered in the names of businesses. It is not possible to make any accurate estimate of the likely extent of this factor, not least because it will depend on how tightly the Government polices the use of business vehicles to prevent loss of tax revenue.

The Tax Package also proposes to introduce a large difference in the price of diesel for vehicles above and below 3.5 tonnes gross weight. Some business users may decide to shift to heavier vehicles (and in the process from petrol to diesel) to take advantage of the ability to buy fuel at around 45 cents/l instead of around 63 cents/l. This threshold effect could have significant implications for traffic flows and urban pollution. Business heavy vehicle use is discussed further in Section 3.1.

Demand for business vehicle travel is determined by a number of factors based largely on demand for that particular business's products or services. The fastest growing sector of the transport industry is the light commercial vehicle (LCV) category. A tendency towards just-in-time delivery combined with cheaper fuel is likely to provide some stimulus to numbers of vehicle trips and fuel consumption.

For the year 1994-95, passenger vehicles travelled 123,700 million km. Approximately 21% of these kilometres were travelled for business purposes (excluding travel to and from work) (ABS 1996, p. 17). In the case of LCVs, approximately 61% of travel was for business. All other types of vehicle (apart from motor cycles) travelled almost entirely for business purposes (ABS 1996, p. 17). For passenger cars and LCVs combined, 29% of the total travel was for business purposes. The BTCE estimates that by the year 2000, these two classes of vehicle will consume a total of 767 PJ of fuel (BTCE 1996a, pp. 358, 364). The business component of this consumption is expected to be 229 PJ, assuming the proportions of vehicle travel for business purposes stays the same. By 2010, business travel by these two classes of vehicle will consume 303 PJ.

Using ARRB estimates for the entire fleet, a 9.1% fall in the price of fuel is estimated to increase demand for fuel by 1.1% in the short term. In the long term, demand is estimated to increase by up to 5.3% (Luk and Hepburn 1993, p. 19). Applied to business passenger and LCV consumption, this results in a short-run increase of 2.5 PJ (year 2000) and a long-run increase of 16 PJ per year (year 2010).

The price difference between petrol and LPG or CNG is expected to drop by 7 cents/l or 17.5%, compared to a 5.7% decrease, at best, in the cost of an LPG or CNG conversion. These changes in price are likely to reduce the cost-effectiveness of gas vehicles resulting in falling gas consumption.

The Australian Gas Association (1997, p. 54) estimates that CNG will account for 30.5 PJ of fuel consumed in the road transport sector by 2010, mostly in the urban bus sector and commercial fleets[26]. Light commercial vehicles running on gas are expected to consume around 23 PJ of CNG and 21 PJ of LPG by 2010, out of a total LCV fuel consumption of 276 PJ. However, the anticipated expansion of the share of gas is unlikely to be achieved after the Tax Package changes the relative prices of petrol, diesel and gas. This is discussed in the next section.

Vehicle purchases

A drop in the price paid by business for vehicles should stimulate demand for new vehicles. Business vehicles include commercial vehicles and passenger vehicles. It is unclear how 'company cars' will be treated, particularly as many are used primarily for private purposes. This will depend heavily on the rules governing company cars for the purposes of GST rebates and the degree of enforcement of those rules. As discussed, many businesses will pay up to 16.6% less for commercial vehicles.[27] Combined with the decreased fuel price for vehicles over 3.5 tonnes, this is expected to further increase demand for heavy vehicles.

The effect of decreased prices on demand for passenger vehicles, both business and private, are discussed further in Section 3.3. It must be stressed that these are two distinct populations and we are not assuming otherwise. ABS estimates suggest there were around 2.2 million passenger vehicles used for business purposes in 1994-95 (ABS 1996, p. 17).

In summary, the 9.1% reduction in the prices of diesel and petrol for business users, the disadvantage to gas-powered vehicles and the reduction in the price of business vehicles by 16.6% are all likely to result in an increase in petrol and diesel consumption, partly at the expense of gas.

We estimate that consumption of petrol and diesel by the business sector will increase by 16 PJ per annum in 2010 as a result of lower fuel prices. This represents approximately 5% of the business-as-usual total fuel consumption for business passenger vehicles and LCVs (BTCE 1996a, p. 358, 364). Consumption of LPG and CNG are expected to grow significantly more slowly than they would otherwise.

Environmental impacts

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[26] These projections are consistent with those in BTCE (1997).
[27] Truck purchases may also be stimulated by the fact that the difference in prices of trucks and LCVs will decrease by 16.6%.

While greenhouse gas emissions are a global problem, levels of urban air pollution depend on where the emissions occur. About 60% of kilometres travelled by LCVs occur in urban areas (BTCE 1996a, p. 336). Increased demand for heavy vehicles (as opposed to LCVs) will result in increased urban truck traffic.

The additional 16 PJ of petrol and diesel consumption resulting due to lower fuel prices is expected to result in an additional 1.8 bn km of passenger car travel and 1.9 bn km of LCV travel. Table 3.2 shows the expected changes in emissions from business. In net terms, CO_2 emissions are expected to increase by 1060 kt of CO_2-equivalents.

Table 3.2 Emission factors and changes in urban emissions from business transport

	CO_2	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x	PM[†]
Emission factors (g/km)								
Passenger cars[*]	260	0.21	0.11	18.4	1.95	1.02	0.024	0.02
LVCs[‡]	314	0.11	0.12	18.6	1.63	1.65	0.13	0.06
Additional emissions (t)	1060 (kt)	590	426	68500	6600	5000	290	150

* based on NGGIC 1996, p. 44; BTCE 1995, p. 182 for the year 2010. These factors are for petrol passenger cars.
‡ based on BTCE 1995, p. 182. Around 20% of LCVs run on diesel and 70% on petrol (BTCE 1996a, p. 364). Emission factors have been weighted accordingly. LPG and CNG prices are not changing and, accordingly, consumption of these fuels is not expected to increase above business-as-usual (BAU) levels. In all likelihood, CNG and LPG consumption will fall below BAU levels.
† weighted estimates based on Faiz *et al.* 1996, p. 57, 49.

More efficient and cleaner diesel technology has the potential to greatly reduce these emissions, particularly SO_x, NVMOCs, NO_x and particulates. Similarly, improved petrol engine and catalyst technology is reducing emissions of CH_4, CO and NMVOCs from petrol vehicles.

3.3 Private vehicles

Current tax situation

Private vehicles with a wholesale value of less than $36,995 attract WST at a rate of 22%. Those vehicles with a wholesale value in excess of $36,995 are subject to WST at a rate of 45% for every dollar over $36,995 (BTCE 1997, p. 108).[28] Private consumers pay excise on motor fuel.

Proposed tax changes and price impacts

Petrol and diesel prices for private motorists are expected to remain unchanged as fuel excises will be reduced to offset the GST. However, alternative fuels that are

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[28] Vehicles for use by certain categories of people with disabilities are exempt from WST.

currently excise exempt will be 10% dearer because excise cannot be reduced to offset the price increase due to the GST.

The Tax Package proposes to abolish WST on vehicles and replaced it with a 10% GST. The Tax Package estimates that motor vehicle prices for final consumers will fall by 8.3%. In the case of LPG and CNG conversions, this work will be subject to a GST, whereas it is currently WST exempt. Assuming the price change is similar to the change expected for other mechanical repairs, conversions are likely to cost an extra 3.8% (Commonwealth 1998, p. 172).

In considering the impact on final consumers it is appropriate to introduce at this point a factor that we have so far ignored. The Commonwealth Treasury estimates that the Tax Package as a whole will result in an increase in general inflation of 1.9%.[29] If the CPI is 1.9% higher than it would otherwise be then the real price of new vehicles for final consumers will fall not by 8.3% but by 10%. In addition, the real price of petrol will not remain unchanged but will fall by 1.86%.

Impacts on demand

According to some reports, in response to the fall in new vehicle prices new vehicle sales are estimated to rise to 900,000 per year, compared with 722,000 in 1997 and an average over recent years 600-700,000 (Jim Wiemels, Chairman Holden Ltd., *Australian Financial Review*, 19 August 1998). This estimate of an additional 180-200,000 new vehicle purchases was described as "bullish, but not out of the question" by the Chief Executive of the ACAI (Peter Sturrock, *Australian Financial Review*, 19 August 1998). In this study we make a more conservative estimate of 100,000 additional new passenger vehicles sales per year.

Passenger cars make up approximately 80% of new vehicle purchases, amounting to more than 500,000 annually (BTCE 1996a, p. 351), although a large proportion of these are for business use. Since increased new car purchases may be associated with increased rates of scrappage of old vehicles, the increase in sales will not necessarily increase the number of cars on the roads or at least not by the same number. Lower car prices may also encourage people to purchase larger cars than they would have otherwise.

It should also be noted that the relative cost of public transport would increase in response to the Tax Package, partly due to the fall in the real price of petrol, and this would increase the attractiveness of private transport. Additionally, the ARRB estimates a long-run price elasticity of petrol demand for the vehicle fleet of -0.58 (Luk and Hepburn 1993, p. 19). A 1.9% drop in petrol price is estimated to increase long-run demand for fuel by 1.1%. In Section 3.2 we estimated that 71% of all passenger vehicle and LCV travel is for private purposes, accounting for 538 PJ of consumption in 2000 and 614 PJ by 2010 (ABS 1996, p. 17; BTCE 1996a, p. 358, 364). Accordingly, consumption is expected to increase by 6.8 PJ by 2010 as a result of the Tax Package.

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[29] The 1.9% figure was arrived at by the Treasury making some adjustments to eliminate the effects of other aspects of the Tax Package. A better estimate may be 2.5%.

A further factor to be considered is the impact of price changes on gas conversions and purchase of new gas vehicles. Due to the imposition of the GST on LPG and CNG, which are currently WST exempt, the price of LPG and CNG will rise from around 35 c/l to 38.5 c/l while the price of petrol is unchanged at around 70 c/l. In addition, the cost of a gas conversion will increase by at least 3.8%. These factors are likely to result in a significant fall in demand for conversions to LPG or CNG.

It is worth noting the New Zealand experience with CNG. The New Zealand government provided incentives through the late 1970s and early eighties to promote CNG use resulting in sales of CNG for motor vehicles growing from 0.1 PJ to 5.4 PJ between 1979 and 1986. Incentives were removed between 1984 and 1986. Consequently, gas sales peaked in 1986 and declined steadily thereafter (GASEX, 1996). These trends are shown graphically in Appendix 1. In Australia, the WST exemption for conversions and equipment for storing gas provide an incentive to use gas. In addition, as part of its November 1997 greenhouse policy package the Howard Government announced that it would spend an additional $3.8 million to assist in the development of Australia's gas distribution infrastructure for vehicles. [30] Introduction of the Tax Package runs counter to these incentives and suggests some policy confusion.

In summary, the Tax Package is likely to lead to a substantial increase in the purchase of new vehicles by private motorists, and the fall in the real price of petrol and diesel may increase distances travelled.

Environmental impacts

In the case of private vehicles, the most important aspects of the Tax Package for the environment are the proposed 8.3% fall in the nominal price, or 10% fall in the real price, of vehicles and the 1.86% fall in the real price of petrol and diesel.

Using the elasticities discussed above, the fall in petrol price is estimated to increase fuel consumption in 2010 by around 6.8 PJ (1.1%). This equates to around an additional 200 ML of petrol and 450 kt-CO_2.[31] Emissions of other pollutants will also increase by around 1.1%.

Although the fall in car prices will undoubtedly lead to an increase in new car sales, it will not necessarily lead to more cars on the road and more kilometres being travelled. Moreover, to the extent that new vehicles are more fuel efficient than the fleet average,[32] the more rapid renewal of the nation's vehicle fleet may result in less fuel being consumed. In 1995 the average new car had a fuel efficiency of 10.4 l/100km, whereas the fleet as a whole averaged 12.1 l/100km (BTCE 1996a, p. 351, 352). Increased sales of new cars and scrapping of older, less efficient, cars increases the average fuel efficiency of the fleet.

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[30] In New Zealand, CNG and LPG received favourably excise treatment up until 1989 but failed to maintain market share. Both are still significantly cheaper than petrol, but not diesel.

[31] This assumes 34.2 MJ/l and 66 gCO_2/MJ based on NGGIC (1996, p. 43).

[32] The improved engine efficiency of new vehicles is offset somewhat by the tendency to bigger cars and more fuel-consuming accessories such as air conditioning.

Modelling these various influences is a difficult exercise. The most sophisticated work has been carried out by the BTCE using its CARMOD model of the passenger car fleet.

Using the BTCE's vehicle survival and scrapping rates (BTCE 1996b, p. 8), we estimate that of the additional 1,000,000 cars purchased between 2000 and 2010 (based on an additional 100,000 cars purchased annually from 2001 onwards), about 980,000 will remain in 2010. Using the BTCE estimates of fuel intensity and average vehicle utilisation, these 980,000 cars consume, on average, 10.1 l/100km in 2010 (BTCE 1996b, p. 25, 29, 103, 104). The remainder of the fleet, approximately 10.5 million cars, exhibits a fuel efficiency of 11.5 l/100km in the same year (BTCE 1996a, p. 352).

Taking into account average vehicle utilisation, the additional 980,000 cars increase fleet average fuel efficiency to around 11.4 l/100km. These calculations assume that additional new car purchases do not result in increased scrapping of older cars and actually increase the total number of vehicles on the road. The BTCE predicts that the total number of cars on the road is closely tied to the size of the population, there being approximately one car for every two people. This relationship is robust and not expected to change significantly (BTCE 1996a, 421-422). Accordingly, the total number of vehicles is not expected to increase as much as estimated earlier, and scrapping rates will increase as both new and second hand cars become cheaper. The increased scrapping rates are likely to result in a larger number of older, less efficient cars being retired. This will further improve the average fuel efficiency of the fleet.

Using the BTCE's modelling results, fuel efficiency for the entire fleet in 2010 is estimated to improve from 11.5 l/100km to 11.4 l/100km. This could be expected to improve further for later years. Assuming the number of cars and total travel is maintained, this difference amounts to an annual saving of around 150 ML of petrol (BTCE 1996b, p. 94). In terms of greenhouse gas emissions this means a saving of 340 kt CO_2 in 2010 (using an emission factor of 2.26 kt CO_2/ML, NGGIC 1996, p. 43). The overall reduction would be attenuated by increased purchases of larger cars.

On the other hand, the fall in the real prices of petrol and diesel and the disincentives to gas vehicles will increase petrol and diesel consumption. Consumption is expected to increase by at least 6.8 PJ (see above), resulting in an additional 1.7 bn km travel (of which 16% is non-business LCV travel). In net terms, then, as an approximation we would expect an increase in greenhouse gases from private vehicles of 110 kilotonnes CO_2 as a result of the Tax Package.

With respect to other pollutants, newer cars emit lower quantities of other pollutants. Applying the emission factors used by the NGGIC[33] (1996, p. 44) and BTCE[34] (1995, p. 182) in combination with the 1997 emission regulations (BTCE 1996, p. 429) and fleet characteristics (BTCE 1996b, p. 8, 103, 104), the additional private vehicle emissions resulting from the Tax Package have been estimated in Table 3.3.

Table 3.3 Changes in emissions arising from increased purchases of new cars and increased fuel consumption

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[33] For CH_4, N_2O, CO, NO_x and NMVOCs.
[34] For SO_x.

	CH$_4$ (kt)	N$_2$O (t)	CO (t)	NO$_x$ (t)	NMVOCs (t)	SO$_x$ (t)	PM (t)
New car effect[*]	-3.3	400	-350000	-27000	-17500	-20	ne
Fuel effect[†]	0.33	190	31000	3200	1900	70	45
Total	-2.97	590	-319000	-23800	-15600	50	45

* This includes the new passenger vehicles used for business purposes. Doesn't include new private-use LCVs. It also assumes that cars purchased after 2000 meet 1997 emissions regulations (BTCE 1996a, p. 429) and three-way catalytic converters are installed in 100% of new cars after 2000. Further, 80% of cars from 1995-1999 have 3-way converters, and 20% two-way converters. Proportions back to 1985 are as in NGGIC (1996, p. 45). Also, it assumes emission control technology and deterioration rates are as in NGGIC (1996, p. 44). Accordingly, since technology is expected to improve over time, the actual emissions of newer cars will decrease further. Also, 1997 regulations on hydrocarbon emissions have been translated into both CH$_4$ and NMVOC emissions.
† Using emission factors in Table 3.2.
ne Not estimated. Particulate emissions are extremely difficult to quantify and depend on such factors as how a vehicle is driven and maintained, the quality of fuel and oil used and the warmth of the engine. Undoubtedly the replacement of old vehicles will reduce particulate emissions, but with insufficent information on emission factors according to vehicle age, it is impossible to estimate.

In summary, the likely impact of the Tax Package on atmospheric emissions from private vehicles is to increase CO$_2$ emissions by around 110 kilotonnes (0.2% of 1995 road transport emissions) and to have a mixed effect on urban air pollutants. Emissions of SOx and N$_2$O are expected to increase while emissions of NO$_x$, CO and NMVOCs are expected to decline. The latter effect is due to the more rapid turnover of the fleet as a result of the fall in the price of new cars.

It should be pointed out that the 'new car effect' is a once-off effect only, and that once the benefits of improved emission equipment have been incorporated into the fleet, the disadvantages of cheaper fuel and cheaper cars will be uncompensated.

3.4 Public transport

Current tax situation

All fuel consumed in public transport operations is subject to excise. The main fuel used is diesel, accounting for 80% of bus and rail fuel consumption. Buses, rail locomotives and goods used in the operation of public transport authorities are currently exempt from WST.

Proposed tax changes and price effects

Public transport is a service and purchase of these services will be subject to the GST. Authorities and businesses operating public transport will be able to claim a rebate for any GST levied on new equipment so that equipment used in public transport will remain free of tax.

Diesel used by heavy vehicles, including buses and trains, will have excise levied at a rate of 18 cents/l (instead of 43 cents/l). Other fuels used by buses and trains will

receive the same treatment as if they were used by business. That is, GST on petrol, electricity and gas will be rebatable.

Thus while consumers will pay 10% GST on bus and rail tickets, the costs of providing the services will be reduced as a result of the Tax Package. The Tax Package estimates that public road transport will increase in price by 2.6%, whereas the price of rail transport will increase by around 5.8% (Commonwealth 1998, p. 172). The model used by Treasury estimates that CPI will increase by 1.9% as a result of the tax changes. Therefore, the real price increases for public bus and rail transport will be 0.7% and 3.8%, respectively. Of urban passenger transport in 1993, 4.72 billion passenger-kilometres[35] were travelled by bus and 7.18 billion passenger-kilometres by train (BTCE 1996a, p. 340). Accordingly, the average real price increase for public transport is 2.75%.

Impacts on demand

Increases in public transport fares arising from the GST may reduce demand for public transport, especially when coupled with the fall in prices of cars and the fall in the real price of petrol. Overall, these changes will increase the price of public transport by 6-10% relative to private transport.

The ARRB estimates that the long-run price elasticity of demand for public bus transport is -0.55 and for public rail transport -1.08 (Luk and Hepburn 1993, p. 6). These elasticities suggest that demand for public bus transport may fall by around 0.4% and demand for rail transport by 4.1% as a result of the Tax Package.

Information on the price responsiveness of public transport as opposed to other modes of transport is inadequate, but some approximations are possible. The ARRB review of transport elasticities estimates that the public transport fare cross-price elasticity of car ownership is at least 0.1 (Luk and Hepburn 1993, p. 6, 19). Applying this elasticity to the estimated 2.75% average real price increase of public transport, the changes to public transport fares resulting from the Tax Package are estimated to increase car ownership in the longer term by 0.3%. A 0.3% increase in car ownership translates into to an additional 32,000 cars on the road by 2010.[36,37]

Another potentially very significant impact of the Tax Package lies in the change in incentives for moving to gas-powered buses. A recent decision by the NSW State Transit Authority to purchase 300 CNG-powered buses was made based mainly on commercial considerations. In this case, fuel costs for gas buses were estimated to be significantly lower than their diesel counterparts.[38] The proposed 25 cents/l cut in diesel excise would make these costs almost identical, eliminating any price advantage of gas. Accordingly, future purchases of gas-powered buses appear less likely.

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[35] A passenger-kilometre is a unit equal to one passenger travelling one kilometre.

[36] The effect of these changes on fuel consumption (and thus emissions) from public transport is quite uncertain. On the one hand, falling demand may result in cuts in services and lower fuel consumption. On the other hand, cuts in services may force more passengers into private cars thus increasing fuel consumption. We have assumed no change in fuel consumption by public transport.

[37] Note that this increase in the car fleet arises from the changes in the prices of public transport and is therefore additional to the expected changes in car purchases discussed in the 'Private Vehicles' section which are due to the falling prices of cars and petrol.

[38] Estimates suggest costs may be lower by up to 11 cents/km (*pers. comm.*).

This is important environmentally because gas-fuelled buses emit much lower levels of urban air pollutants than their diesel counterparts. Nitrogen oxide emissions from natural gas used in city buses are only 33% of those from diesel buses, while CO emissions are 54%, particulates are 24% and SO_2 is only 1% of the diesel equivalent.[39]

In New Zealand between 1989 and 1991, the diesel excise was reduced by a total of 26 cents/l ($NZ). As a consequence, diesel consumption doubled between 1991 and 1998 (Fitzsimons, 1998).[40] There are still CNG buses running in New Zealand, although their numbers have not increased significantly since the diesel excise reduction. At the end of their working life these CNG buses are likely to be replaced by diesel buses (GASEX,1996).

The Australian Gas Association (1997, p. 45) forecasts that CNG will account for 30.5 PJ of fuel consumed in the road transport sector by 2010. These predictions are consistent with those from BTCE (1996a, p. 358, 364, 365). A majority of this growth is expected to occur in the urban bus sector and commercial fleets. In 2010 LCVs are expected to consume around 23 PJ, passenger cars around 4 PJ, rigid trucks around 1 PJ and buses the remaining 2-3 PJ. The urban bus sector is expected to consume around 8-9 PJ of all fuels by 2010. The New Zealand experience strongly suggests that the proposed sharp cut in diesel excise for buses will undermine the shift to gas-powered buses, and instead of consuming 2.5 PJ from CNG by 2010 gas consumption by buses will not grow at all above current levels of around 0.05 PJ (based on BTCE 1996a, p. 360).

Environmental impacts

The major environmental impacts arise from the increase in car patronage and the decreased rate of gasification of the urban bus fleet.[41] In the long-run (by 2010), an additional 32,000 cars are expected to consume 2 PJ and travel an 510 million km. Urban buses will consume approximately 2.5 PJ of additional diesel in place of 2.5 PJ of CNG.

The additional 2 PJ of passenger car fuel consumption by 2010 will increase emissions in that year by a similar amount. Replacing 2.5 PJ of gas consumption with 2.5 PJ of diesel is expected to have a further detrimental effect on urban air sheds. Table 3.4 contains estimates of the quantitative effect on emissions as a result of diesel displacing CNG bus fleet growth and additional passenger vehicle emissions arising from increase in public transport fares.

Table 3.4 Additional emissions due to effect of Tax Package on public transport, 2010

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[39] ANGVC 1998. CO_2 emissions from gas-fuelled buses are 91% of those from diesel buses.
[40] See Appendix 2.
[41] To use the NSW STA bus fleet as an example, in 1998 the STA had around 1700 buses of which 1400 were diesel powered and 104 gas powered. However, the STA is about to take delivery of 150 new gas vehicles and a further 150 before the 2000 Olympics (NSW Minister for Transport, Press Release 1997). This will result in over 20% of Sydney's buses running on gas, whilst reducing diesel's share from 80% to 70% (STA, *pers. comm.*). A similar process is underway in other capital cities.

	CO_2 (kt)	CH_4 (t)	N_2O (t)	CO (t)	NO_x (t)	NMVOC (t)	SO_x (t)	PM[‡] (t)
Additional emissions from diesel	175	6.3	5.2	1020	600	325	210	510
Less foregone emissions from CNG	125	253	2.5	3000	500	25	1.0	9
Net additional bus emissions	+50	-247	+2.7	-1980	+100	+300	+250	+500
Additional car emissions[†]	133	107	56	9400	990	520	12	10
Overall impact on public transport emissions	185	-140	29	7400	1100	820	260	510

* These estimates are based on emission factors taken from BTCE 1995, pp. 181, 182, 189, 199, 214
† based on emission factors in Table 3.2.
‡ emission factors based on Faiz *et al.* 1996, p. 41, 59, 238. Calculation of PM for CNG buses assumes CNG buses travel the same distance as their diesel counterparts.

In summary, the main impacts of the Tax Package on public transport are likely to be a fall in demand due to a 6-10% increase in prices compared to private cars and significant disincentives to the shift to gas-powered buses. The increase in private car travel and the shift from gas to diesel buses are expected to increase greenhouse gas emissions by around 190 kilotonnes of CO_2-equivalent.[42] Urban air pollution is expected to worsen with increases in SO_x of 260 tonnes, NO_x of 1.1 kt and particulates of 500 tonnes. However, it is expected that emissions of CH_4 will fall by 140 tonnes due to the fact that gas powered vehicles emit high levels of CH_4 and fewer will be on the road should gas become less competitive (conversely, emissions of almost all other pollutants will be higher).

3.5 Summary of transport sector

This section has considered the likely effects of the Tax Package on atmospheric emissions from freight vehicles, business vehicles, private vehicles and public transport. Many factors come into play and it has not been possible to accommodate all of them in the absence of a major modelling exercise. In addition, some of the key data relating to the responsiveness of demand for transport services in the face of changes to relative prices are very uncertain, a fact that would equally influence a full-blown modelling exercise. Despite these uncertainties, the estimates made in this section reflect reasonable order of magnitude estimates.

The principal effects of the Tax Package on the transport sector are:

- The increase in freight transport as a result of the 25c/l reduction in diesel price and the shift to road freight away from rail freight;

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[42] Based on global warming potentials for CO_2, CH_4 and N_2O of 1, 21 and 310, respectively. Other gases have variable influences on global warming and have been treated as having potentials of zero.

- The increased amount of business transport as a result of the 9.1% cut in the price of petrol and diesel for business users and the 16.6% cut in the price of cars and light commercial vehicles;

- The effect of a 1.9% fall in the real price of petrol and a the 10% fall in the real price of cars. Increased travel will be partially offset by the faster turnover of the fleet, bringing forward purchases of more fuel efficient vehicles;

- The disincentives to gas-powered cars as a result of the relative increase in the price of CNG and LPG and the increased costs of gas conversions;

- The disincentives to public transport in the Tax Package, including the erosion of the trend towards purchase of gas-powered buses.

The impacts on emissions of these effects are summarised in Table 3.5. The estimates are of long-run changes and can be thought to be those that would prevail around the year 2010.

Table 3.5 Summary of effect of Tax Package on emissions from the transport sector

	CO_2 (kt)	CH_4 (t)	N_2O (t)	CO (t)	NO_x (t)	NMVOC (t)	SO_x (t)	PM (t)
Freight vehicles	1210	53	26	5600	10600	2240	1230	1500
Business vehicles	1060	590	426	68500	6600	5000	290	150
Private vehicles	110	-2970	590	-319000	-23800	-15600	50	45
Public transport	185	-140	29	7400	1100	820	260	500
Total	2565	-2470	1070	-237500	-5500	-7540	1830	2195
% increase in road transport emissions [*]	4.5%	-12%	11%	-7.6%	-1.7%	-1.6%	5.2%	na

* these are changes on business-as-usual emissions in the year 2010 as a percentage of 1995 emissions. Based on NGGIC 1997, p. 52. The 1995 emissions are as follows: 56.9 Mt CO_2; 20.5 kt CH_4; 9.6 kt N_2O; 3.1 Mt CO; 316 kt NO_x; 464 kt NMVOCs and 35 kt SO_2. There are no reliable estimates of particulate emissions.

Overall, the Tax Package is expected to result in a long-run increase in greenhouse gas emissions from the transport sector of around 2.8 Mt CO_2 equivalents (a 4.7% increase in 1995 emissions). Although emissions of some pollutants are expected to decline as a result of the tax changes (for example CO, CH_4), a number of pollutants increase significantly (namely particulates, SO_x and N_2O). Emissions of NO_x and NMVOCs are unlikely to vary significantly. The negative environmental impacts are due principally to the excise changes that result in the cut in the price of diesel for 'heavy' vehicles along with the cheaper prices of petrol and diesel for business users. These negative effects are partly offset by the increased rate of turnover of the fleet in response to the cut in the price of new vehicles. Thus in the transport sector the problem lies not with the GST itself but with the changes to the excise arrangements.

4. Conclusions

The analysis of this report has been confined to assessing the effects of the Tax Package on atmospheric emissions from the stationary energy and transport sectors of the economy. While these are without doubt the largest sectors of concern, there are some other areas that might be included in a full analysis. In addition, there are environmental impacts other than atmospheric emissions that will be affected by the Tax Package including the incentives for the expansion of resource-intensive activities. For example, the promised stimulus to primary production may increase rates of land degradation and affect biodiversity through irrigation water use.

The estimated impacts of the Tax Package on atmospheric emissions in the stationary energy and transport sectors are summarised at the end of Sections 2 and 3. The major environmental costs from the Tax Package occur as a result of changes in the transport sector. The changes in question are not so much those due to the GST but to the associated changes in fuel excises.

The most important impacts of the Tax Package for the atmospheric emissions are the following:

- falling prices of carbon-based energy for business users;

- changes in the relative prices of electricity, gas and other fuels for households;

- the increase in freight transport as a result of the 25c/l reduction in diesel price and the shift to road freight away from rail freight;

- the increased amount of business transport as a result of the 9.1% cut in the price of petrol and diesel for business users and the 16.6% cut in the price of cars and light commercial vehicles;

- the effect of a 1.9% fall in the real price of petrol and a the 10% fall in the real price of cars for private motorists. Increased travel will be partially offset by the faster turnover of the fleet, bringing forward purchases of more fuel efficient vehicles;

- the disincentives to gas-powered cars as a result of the relative increase in the price of CNG and LPG and the increased costs of gas conversions;

- the disincentives to public transport in the Tax Package, including a serious erosion of the trend towards purchase of gas-powered buses.

It is apparent that, while the Tax Package has mixed effects on particular emissions, the overall impact is unambiguous. The proposed tax changes will increase atmospheric emissions and result in increased health and other costs. Greenhouse gas emissions will increase by around 2% above the levels they would otherwise reach. While some contributors to urban air pollution are expected to fall slightly, the most damaging ones will increase, notably particulates (up by 2.2 kt from transport alone) and oxides of sulfur (up by 5.1 kt or 0.8%).

These numbers appear to be relatively small. However, the increased levels of pollution come at a time when there are many measures in place aimed at reducing emissions in Australia. In the case of atmospheric emissions, particulates are estimated to account for around 75% of health costs associated with urban air pollution (NEPC 1997) and there is no doubt that the Tax Package will result in increased health costs. One study, based on NEPC data, estimates that urban air pollution costs Australia around $7 billion each year (Hamilton and Saddler 1997, p.30).

In the case of greenhouse gas emissions, the Prime Minister's Climate Change Statement of November 1997 specified that an additional 2% of electricity is to be supplied from renewable sources by the year 2010 (Howard 1997, p.5). This measure is expected to reduce emissions of CO_2 by at best 5.5 Mt by the second decade of next century (ACIL 1998, p. vii). The measures in the Tax Package are estimated to increase emissions (by around 5 Mt) so as to completely offset the reductions achieved by meeting this 2% renewables target.

Moreover, Australia has agreed under the Kyoto Protocol adopted in December 1997 and signed by the Australian Government this year to limit growth in emissions to a level 8% above 1990 levels by the year 2012.[43] Tax changes that are likely to increase Australia's greenhouse gas emissions by 2% will make the task more difficult. Moreover, the Tax Package sends a negative message to industries involved in low-emissions energy sources. The severe disincentive to the fledgling gas transport industry is of particular concern. The New Zealand experience strongly suggests that the sharp cut in the price of diesel will effectively destroy this potentially very important contribution to lower pollution levels.

In addition, there are grounds for believing that some of the measures proposed in the Tax Package contravene the provisions of the Kyoto Protocol. Article 2 of the Protocol reads as follows:

> Each Party included in Annex 1, … in order to promote sustainable development, shall:
>
> (a) implement and/or further elaborate policies and measures in accordance with its national circumstances, such as: ….
>
> (v) Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objectives of the Convention and the application of market instruments.

The 25c/l cut in the price of diesel for heavy vehicles arising from the proposed diesel fuel credit in the Tax Package would clearly be a new tax exemption under the terms of the Protocol. Unlike the emission targets, the 'policies and measures' provision of the Protocol are not legally binding. The Government has argued that Article 2 is no more than a set of recommendations that Parties may or may not choose to pursue. However, the policies and measures have considerable moral force and there is an

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[43] The Protocol will not come into force until it has been ratified by at least 55% of the Parties and by enough Annex 1 (industrialised) Parties to account for at least 55% of the total carbon dioxide emissions in 1990 of Annex 1 Parties, a process that will take at least two years.

expectation in the international community that Annex 1 Parties will broadly adopt these measures in pursuit of their legally binding targets. Article 2 was the subject of a great deal of debate at the Kyoto Convention and it would be a mistake to believe that the inclusion of this provision was arbitrary. The Coalition's tax proposal actually takes Australia in the opposite direction to that urged by the Protocol and would undoubtedly be viewed negatively by the world community.

It might be noted that the OECD's International Energy Agency, arguing that energy consumption in Australia is high partly because fuel is cheap, has urged the Government to *increase* fuel taxes (IEA 1997).

This raises a more general policy issue, an issue that may turn out to be the most important effect of the Tax Package for the environment. For the last decade or more the trend in environmental policy making world-wide has been towards the use of 'economic instruments', i.e. taxes and charges imposed on environmentally damaging activities in order to discourage them. The rationale of these measures − sometimes known collectively as ecological tax reform − is to use the tax system to tax goods and services at different rates to reflect their differential environmental impacts.[44]

The essence of the GST is to apply a uniform rate of taxation on all goods and services with as few exemptions as possible. The Coalition has indicated that it will strongly resist attempts to change the rate of GST or exempt particular goods and services other than those already announced. If adhered to this would rule out many of the most effective potential environmental policy measures. Locking in a uniform tax rate on goods and services that have widely differing environmental impacts will diminish economic efficiency. As a result, the introduction of the GST could set back progress in environmental policy making for many years and result in significant loss of economic welfare.

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[44] For a comprehensive discussion of ecological tax reform in Australia see Hamilton, Hundloe and Quiggin (1997).

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Appendices

Appendix 1. Emission factors for the stationary energy sector

Fuel	CO_2 (kt/PJ)	NO_x (kt/PJ)	SO_x (kt/PJ)
Electricity[‡‡]	277 (87.2)	0.62 (0.23)	0.67 (0.25)
Natural gas	59.4	0.46[*] 0.04[†‡]	0.0023
Biomass	89.3[‡] 94.2[*]	0.08	NE
Coal	90	0.34[*] 0.23[†] 0.19[‡]	0.15-0.37[1]
Petroleum	67.4[*] 62.3[†] 63.0[‡]	0.71[*] 0.10[†] 0.05[‡]	0.0023-1.39[2] (0.085)

Source: based on GCO 1997, p.29; NGGIC 1997, p. 6, 36, 48, 65, 67, 71, 120

‡‡ figures in parentheses are emission factors prior to conversion losses.
* emission factor associated with industrial use (NGGIC 1997, p. 48).
† emission factor associated with commercial use (NGGIC 1997, p. 65).
‡ emission factor associated with residential use (GGIC 1997, p. 67).
1 depending on variety/quality of coal (NGGIC 1997, p. 120).
2 Ranging from 0.0023 kt/PJ for LPG to 1.39 kt/PJ for fuel oil (NGGIC 1997, p. 120). The number in parentheses is the factor for diesel, the fuel with the largest consumption among all petroleum fuels (Bush *et al.* 1997, p. 110-118, 120).
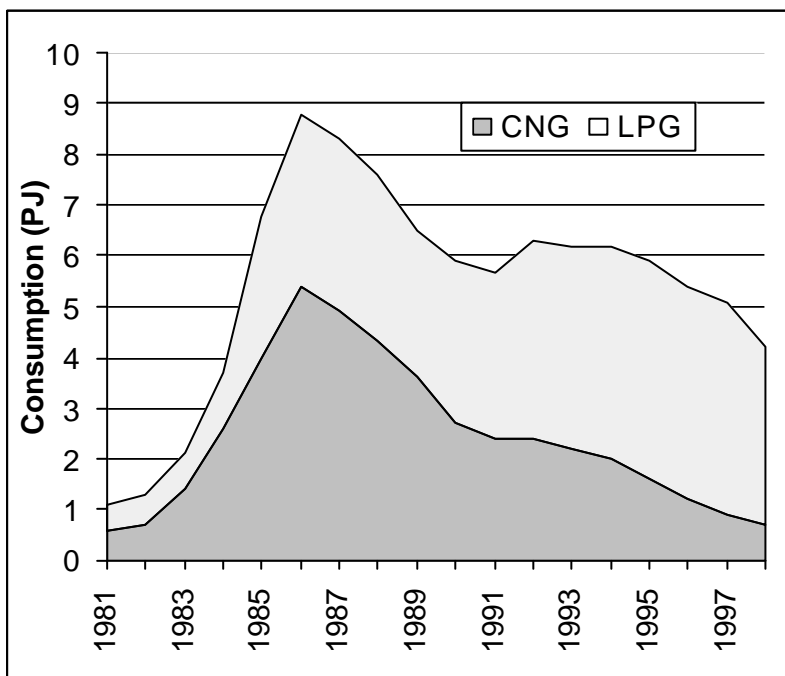
Appendix 2. The New Zealand experience with CNG and diesel

Figure A2.1. Diesel consumption in NZ, 1981-98.
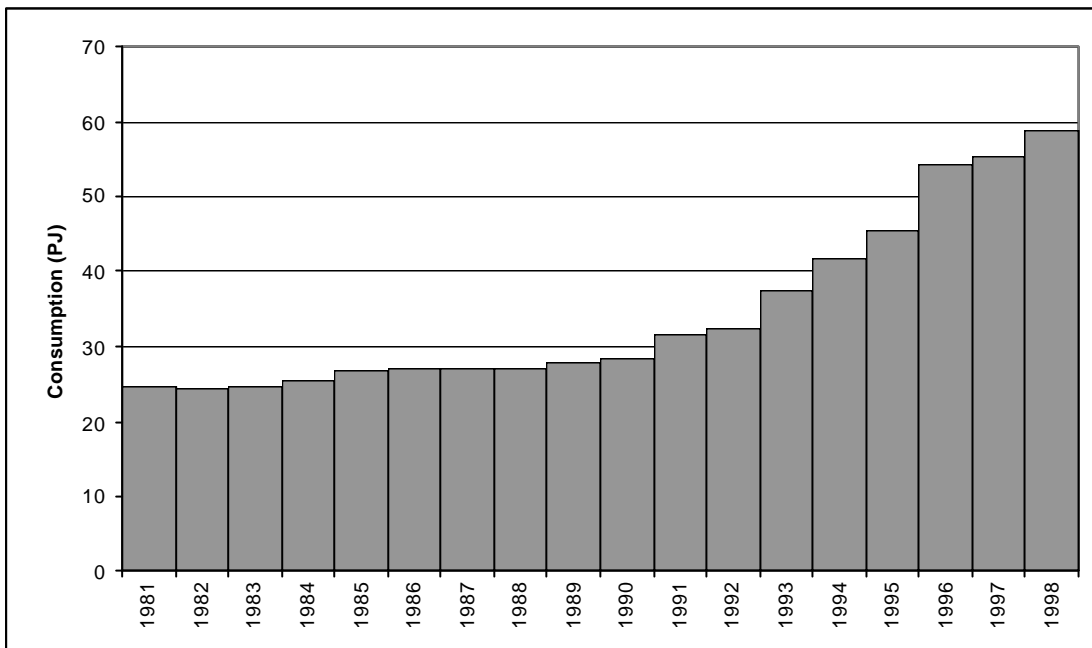
Note: Diesel fuel excise was reduced 26 c/l (NZ$) between 1989 and 1991.

Figure A2.2. CNG and LPG consumption in New Zealand, 1981-1998.

Note: Subsidies for gas were removed in 1986.