Australian Liquefied Petroleum Gas Association Limited (ALPGA)

Submission to:
Australia's Future Tax System Review

17th October 2008

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1 Executive Summary

The Liquefied Petroleum Gas Association strongly supports the need to have a comprehensive review of Australia's tax system and notes that the objective is to examine and make recommendations to create a tax structure that will position Australia to deal with the demographic, social, economic and environmental challenges of the 21st century and enhance Australia's economic and social outcomes.

In response to this review the Liquefied Petroleum Gas Association has endeavoured to address the broader issues surrounding the role of LPG in the liquid fuel transport sector and the impact of the tax system. LPG Australia recommends the continuation of a tax free policy for LPG if we are to maximize the benefits this alternative fuel delivers.

One of the largest demographic, social, economic and environmental challenges facing the world is the dependence on oil as a primary transport fuel source by developed countries, including Australia and the great uncertainty that arises from a "Peak Oil" scenario.

Australia has a unique ability to substantially mitigate the possible effects of "Peak Oil" by continuing to develop the ability of its transport sector, small, medium and large, passenger and freight, to move from oil based fuels to the gaseous based fuels, LPG and natural gas.

Presently a small part of Australia's transport fleet runs on gas. However the conversion rate to gas for both petrol and diesel powered vehicles is increasing and has been significantly stimulated by the current LPG Vehicle Scheme. Clear stable government policy can provide continuing incentives for the gaseous transport fuel industry to expand further and at a faster rate, giving Australia's transport fleet increased independence from a "Peak Oil" scenario and at the same time delivering significant greenhouse and air quality benefits.

Australia's growing dependence on petrol and diesel as a transport fuel has raised concerns over import dependency and security of supply. Seventy per cent of the liquid fuel currently used in Australia's motor vehicles is imported. The future direction and mix for transport fuels in Australia is being discussed in general as policy deals with long term supply security and the task of reducing our greenhouse emissions from our existing and future vehicle fleets.

Australia's indigenous supplies of oil are dwindling but our gaseous reserves, are large and growing.

Current estimates indicate Australia has only 8 years of oil, more than 70 years of gas and 600 years of coal.

The Vehicle Fuel Efficiency Discussion Paper recognises that LPG is the only available viable alternative fuel to petrol and diesel that has the ability to deliver now.

Technically, it is easy to convert vehicles to run on LPG, but from the perspective of the ordinary consumer and businesses involved in conversion, there are large barriers and obstacles, and it is perceived as being very difficult. If it was not perceived as being difficult, many more of Australia's 12 million cars would be converted to LPG than the 650,000 that have been converted today.

Australia's consumers both private and business are very price sensitive to the cost of fuel and government policy that deteriorates confidence in making the decision to convert or move to an LPG dedicated vehicle.

These factors also affect industry investment and ability to deliver the benefits to consumers as seen by the downturns experienced in the past.

In the 1970s and 1980s discussions about, and the brief introduction of excise on LPG caused downturns in the conversion industry. The industry recovered to some extent when excise was repealed.

A very dramatic downturn occurred during the period 1999 to 2003, coincident with discussions about excise and the GST, and the eventual introduction of GST.

Clearly articulated long-term Government policy, consistently applied across all portfolios is the single largest controllable influence on the rate of LPG conversions.

The LPG Vehicle Scheme introduced in 2006 has been a very successful government program which has helped motorists in outer urban and regional areas, with large commuting distances, and poor public transport options, to reduce their fuel costs by facilitating the conversion of their vehicles to LPG.

That the Federal Treasurer has confirmed that the LPG Vehicle Scheme will continue until 2015, is a very encouraging signal from government.

This paper addresses the energy security, carbon pollution, air quality and social benefits of continued policy support for the use of LPG as an automotive fuel.

2 Economic Background

The Australian Liquefied Petroleum Gas Association Limited (ALPGA) makes this submission to Australia's Future Tax System Review 2008. It will focus on the use of LPG as transport fuel – Autogas, and not for its use in the traditional sector as stationery energy for cooking and heating purposes.

ALPGA commissioned a report from Access Economics in May 2003 titled ***The Indirect Taxation of LPG in Australia – Quantifying the Costs and Benefits of the Current Differential Treatment*** ("the Access Economics Report")***.***

That report and its contents are relevant to and included as part of this submission by ALPGA to Australia's Future Tax System Review.
The Access Economics Report is at Appendix A.

3 LPG Industry Structure

3.1 Employment and economic impact

The LPG industry has invested over $3 billion in Australia.

The industry comprises oil and gas producers, refiners, importers, marketers, distributors and retailers. A diagram of the LPG supply chain is included as Appendix B.

A significant number of small to medium sized Australian based firms are involved in the manufacture, importation, warehousing, distribution, and installation and servicing of LPG equipment and related components for motor vehicles.

The total number of people employed in the automotive related LPG industry in Australia is in excess of 10,000, including:

- 2,500 registered installer businesses, employing 7,500 installers
- 15 kit suppliers
- 50 component suppliers and manufacturers
- 50 people engaged in training and certifications
- 3,300 service stations dispensing LPG, 5 bowser dispensing equipment suppliers
- 1,500 in the Autogas marketing and distribution sector.

Appendix C, illustrates the various products either manufactured or imported that combine to form a typical LPG system for motor vehicle application.

3.2 Innovation

Innovation occurs in Australia in the form of locally conducted product development and application engineering for each motor vehicle type and model derivative that is engineered to provide an LPG fuel option, either as a dual fuel or single fuel fitment.

This product development and application engineering is performed either by the Australian vehicle manufacturers, in the case of an original equipment (OE) LPG product, in conjunction with the Australian specialist LPG component manufacturers and/or importers, or, by the Australian specialist LPG component manufacturers and/or importers themselves, in the case of an Aftermarket LPG product.

In both OE and Aftermarket cases, the engineering work associated with the design (where necessary), selection, assembly, calibration and certification testing of the components and the complete vehicle system, must be performed in accordance with the relevant Australian Standards. The various components of an LPG vehicle system upon which this engineering work is performed are described in the following section.

3.3 Automotive LPG System Components

3.3.1.1 LPG Under-bonnet equipment:

Components for the metering and delivery of LPG fuel to the engine of a motor vehicle (LPG under-bonnet equipment) are mostly imported and sourced predominately from Italy, but also from Holland and the USA. They can be categorised into one of two broad technology types:

a) *Vapour Fumigation:*

Vapour Fumigation represents the earliest technology but still accounts for the majority of LPG under-bonnet equipment at present installed in vehicles in Australia manufactured before 2004.

b) *LPG Injection technology:*

LPG Injection technology provides superior motor vehicle performance and significantly reduced Greenhouse Gas Emissions (GGE) compared to Vapour Fumigation. LPG Injection technology in its current iterations complies with Euro 2, Euro 3 and Euro 4 emission standards and was first introduced into the Australian market in 2002.

Following introduction of emission certification in 2004, the fitment of LPG Injection technology under-bonnet equipment increased rapidly. However LPG Injection technology is at present installed in only about 10% of the total Australian light vehicle fleet using LPG.

3.4 Other LPG system components

a) *Electronic Control Units (ECUs)*

Calibration of the imported ECU for each specific vehicle application for fuel-flow control, vaporisation and vehicle performance optimisation is carried out by, or on behalf of, the under-bonnet equipment importers, and/or the Australian vehicle manufacturer in the case of new vehicles offered with OE LPG fuel option.

b) *LPG Tanks*

LPG tanks may require design and testing for pressure integrity and possibly vehicle crash testing for each specific vehicle application, to take into account for example:

- The fuel storage capacity and fuel level measuring requirements for the particular vehicle
- The tank fitment location in the vehicle
- The structural integrity of the tank mounting components.

This application engineering is typically carried out by the LPG tank manufacturers and/or tank suppliers in Australia, in close collaboration with the Australian vehicle manufacturer in relation to locally built vehicles offered with LPG as an OE option.

c) *Various Hoses, Tank Mounting Brackets, Other Hardware*

Similar as for LPG tanks, with application engineering carried out in Australia.

4 Manufacturing / Assembly

Vehicles are currently fitted with LPG equipment on the vehicle production line (Ford), by OEM approved external workshops (Holden and Toyota), or by the broader aftermarket network of mainly small specialist workshops.

This structure has shown an ability to respond quickly to demand as demonstrated by the rapid expansion of capacity following the August 2006 introduction of the LPG Vehicle Scheme.

4.1 Imported LPG Vehicles

Many overseas vehicle manufacturers that trade in Australia offer factory fitted LPG options for new vehicles in other international markets but none import vehicles already fitted with LPG systems to Australia.

Consumer demand for LPG variants needs to be more apparent to manufacturers and importers to help overcome the substantial barriers to entry.

Consumer demand is greatly influenced by government policy.

The Ford Focus is a stark example. Ford in Europe has offered a LPG vehicle for some years, and has recently launched a new LPG version. There is no indication that this vehicle will be available in Australia. http://www.autobloggreen.com/2007/09/11/ford-announces-european-spec-focus-2008/ (also see Appendix D)

There are many more examples.

Source European LPG Association, 2008

The Hyundai Motor Company's LPG hybrid car was reported in *The Age* newspaper on 5th June 2008. http://www.theage.com.au/national/hybrid-lpg-car-in-pipeline-20080605-2m46.html (see also Appendix E).

The owner's manual in the Nissan Tiida sold in Australia has a section on care and maintenance of the LPG system, however the LPG option is not offered in Australia. The owner's manual apparently is prepared for all vehicle options in all international English speaking markets, regardless as to whether an option is offered in a specific market (Appendix F).

5 LPG and the Environment

5.1 Overview

The transport sector is the third biggest emitter of greenhouse gases in Australia. With the recent change in the Federal Government, Australia has moved to ratify the Kyoto Protocol and a mix of new government support opportunities in low emissions research, development and demonstration are in the planning stages.

More recently, Professor Ross Garnaut has released his final report commenting that the “combined effect of rising oil prices and an emissions price will drive greater fuel efficiency, including the take-up of hybrid petrol-electric vehicles, smaller cars and fuel substitution. The latter includes the substitution for petrol by fuels that can be used more efficiently, such as diesel, and by fuels that produce fewer emissions per litre, such as liquefied petroleum gas and ethanol”.[1]

LPG conversions are already available for small vehicles of the makes mentioned in the previous section and the Hyundai LPG-hybrid also mentioned there is a Super Ultra Low Emission Vehicle.

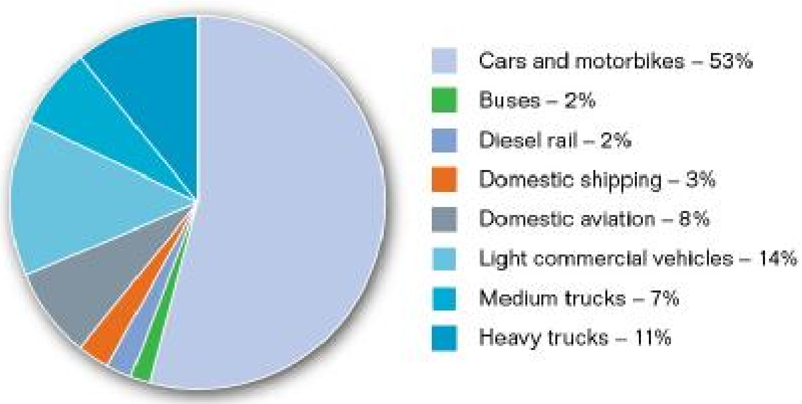
[1] The Garnaut climate change review 2008

5.2 LPG's Carbon Pollution and Air Quality Benefits

Carbon Pollution

Existing LPG vehicle technology can influence 67% of domestic transport emissions (cars and light commercial vehicles, see graph below). [2]

Australian domestic transport emissions, 2006



Note: Excludes electric rail and trams.
Source: DCC (2008a).

LPG use in light motor vehicles is well established. A typical 6-cylinder petrol engine vehicle, travelling 15,000 kms per year and averaging 12 litres / 100 km, generates 4.7 tonnes CO_2-e. If converted to LPG Autogas, it will consume approximately 15.6 litres/100km and generate 4.2 tonnes CO_2-e.[3]

It should be noted that these LPG fuel consumption figures do not fully reflect the beneficial impact of the introduction of LPG Injection technology referred to in section 3.3.1.1.

[2] The Garnaut climate change review 2008
[3] LPG's Role in Australian Energy Policy – April 2008 (ALPGA)

Table 5.1: Full Fuel Cycle CO_2-e Emissions – Transport Fuels [4]

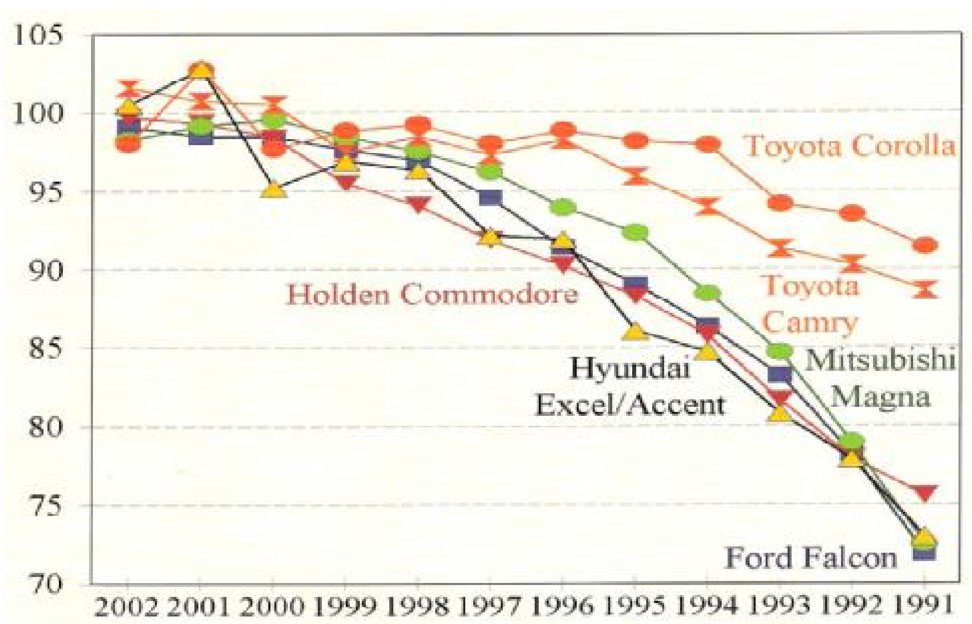
Full Fuel Cycle CO_2-e Emissions – Transport Fuels
(Source: National Greenhouse Accounts [NGA] Factors, January 2008)

Transport Fuel	CO_2-e Emissions Kg/GJ	LPG Benefit %
LPG	65.5	-
Petrol	72.3	9.3

In 2007, more than 100,000 vehicles were converted to LPG. If these vehicles used, on average, the same amount of fuel as the existing LPG fleet, these 100,000 conversions have resulted in 80,000 fewer tonnes of CO_2 being released into the atmosphere in the first year of operation of these vehicles. These savings keep occurring year on year until the end of the vehicle's life. [5]

Possibly due to the fact that salt is not used to de-ice our roads, and thus rusting body work and chassis of cars is not a large problem, Australian motorists keep their vehicles for many years. A car converted to LPG will continue to deliver emissions benefits for the life of the vehicle.

The graph below suggests more than 70% of Ford Falcons were still on Australian roads fifteen years after being manufactured, and this vehicle type had the highest rate of depletion. All of these makes and models have been converted to LPG and CO_2 results for some and for other vehicles appear in Table 5.2.



SURVIVAL RATES OF KEY MODELS
Percent; at 31 March 2006; by year of manufacture; 3 year moving average

[4] Source: National Greenhouse Accounts (NGA) Factors January 2008
[5] LPG's Role in Australian Energy Policy – April 2008 (ALPGA)

Table 5.2: CO_2 Emissions – Same Vehicle on LPG or Petrol - Australia

CO2 Emissions - Same Vehicle on LPG or Petrol - Australia

Sep-07

Dual Fuel CO2 Emissions				RTA Test run using IM240 cycle			Green vehicle guide ADR 81			
Manufacturer	Model	Year	From Standard	Hot LPG g of CO2/km	Hot ULP g of CO2/km	CO2 benefit LPG to ULP	LPG g of CO2/km	L/100 km	ULP g of CO2/km	L/100 km
Ford	BA Falcon	2002	2	232.6	250	7%	246	15.3	272	11.5
Ford	BA Falcon	2003	2	275.7	296.1	7%	246	15.3	272	11.5
Ford	BA Falcon	2002	2	238.1	259.7	8%	248	16.1	277	11.8
Ford	BA Falcon	2003	2	272.6	293.0	7%	246	15.3	272	11.5
Ford	BA Falcon	2003	2	279.9	297.0	7%	240	15.0	272	11.5
Ford	BA Falcon	2004	2	331.0	354.2	7%	246	15.3	272	11.5
Ford	BA Falcon	2005	2	275.1	306.0	10%	240	15.0	272	11.5
Ford	BA Falcon	2005	2	260.9	277.5	6%	246	15.3	272	11.5
Ford	BF Falcon	2006	3	258.4	271.3	5%	255	15.9	250	10.5
Ford	BF Falcon	2005	3	240.6	256.7	6%	255	16.0	250	10.9
Ford	BF Falcon	2006	3	240.8	256.7	6%	255	15.9	250	10.5
Ford	BF Falcon	2007	3	241.9	263.5	8%	244	16.1	255	10.7
Ford	Courier 4.0	2005	2	316.6	343.5	8%	n/a	n/a	300	12.5
Holden	Rodeo 3.6	2003	2	298.7	320.1	7%	n/a	n/a	311	13.1
Holden	VY Commodore 3.8	2004	2	244.7	258.1	5%	255	15.7	255	11.5
Holden	VY Commodore 3.8	2004	2	226.5	242.1	7%	253	15.7	255	11.0
Holden	VY Commodore 5.7	2004	2	360.3	378	5%	n/a	n/a	317	13.4
Holden	VZ Commodore 3.6	2004	2	281.2	291.5	4%	245	15.3	255	11.1
Holden	VZ Commodore 3.6	2005	2	272.4	293	7%	247	15.4	255	11.1
Holden	VZ Commodore 3.6	2005	2	260.6	274.0	5%	245	15.3	255	11.1
Holden	VZ Commodore 3.6	2007	2	270.6	279.5	7%	247	15.3	255	11.1
Mitsubishi	Express Van 2.0	2005	2	224.0	242.3	7%	n/a	n/a	255	11.5
Mitsubishi	Express Van 2.4	2006	3	222.8	242.2	8%	n/a	n/a	284	12.1
Mitsubishi	Express Van 2.4	2006	3	226.7	245.4	8%	n/a	n/a	248	10.4
Mitsubishi	Magna 3.5	2004	2	230.6	262	9%	253	16.0	272	11.5
Mitsubishi	Triton Ute 3.0	2003	2	252.2	277.1	9%	n/a	n/a	285	12.5
Mitsubishi	Triton ute 2.4	2004	2	216.7	229.4	6%	n/a	n/a	250	10.7
Mitsubishi	Triton ute 3.0	2004	2	269.6	286.5	6%	n/a	n/a	285	12.5
Mitsubishi	Triton Ute 3.0	2006	3	240.0	265.1	9%	n/a	n/a	298	12.4
Nissan	Navara ute 4.0	2006	3	297.8	322.2	8%	n/a	n/a	311	12.0
Nissan	Patrol wagon 4.8	2004	2	356.6	392.5	9%	n/a	n/a	405	17.2
Toyota	Camry 2.4	2004	2	205.0	227.3	10%	n/a	n/a	229	9.5
Toyota	Camry 2.4	2004	2	218.2	237.4	8%	n/a	n/a	232	9.8
Toyota	Hilux 2.7	2005	3	219.9	234.0	6%	n/a	n/a	253	11
Toyota	Hilux 4.0	2004	2	293.4	317.5	8%	n/a	n/a	250	11.5
Toyota	Hilux 4.0	2005	2	220.6	239.0	7%	n/a	n/a	250	11.0
Toyota	Hilux 4.0	2005	2	257.5	272.1	5%	n/a	n/a	250	11.5
Toyota	Hilux 4.0	2005	3	243.6	266.7	9%	n/a	n/a	250	11.5
Toyota	Hilux 4.0	2005	3	235.6	251.5	6%	n/a	n/a	250	11.5
Toyota	Hilux 4.0	2005	3	301.0	338.4	11%	n/a	n/a	250	11.5
Toyota	Hilux 4.0	2006	3	268.7	291.5	8%	n/a	n/a	250	11.5
Toyota	Hilux 4.0	2005	3	262.9	276	5%	n/a	n/a	250	11.5
Toyota	LandCruiser 100 ser 4.7	2003	2	400.3	430.5	7%	n/a	n/a	385	16.1
Toyota	LandCruiser 100 ser 4.7	2004	2	376.8	419.0	10%	n/a	n/a	385	16.1
Toyota	Prado 4.0	2005	3	302.4	318.7	5%	n/a	n/a	314	13.2

Notes

Several outlying results both above and below have been ignored.

Where the transmission has been an option it was assumed to be automatic when referring to Green vehicle guide.

It is worth repeating that these CO_2-e figures do not fully reflect the beneficial impact of LPG Injection technology and that further improvement in technology will increase the benefits derived.

LPG is a varying mixture of propane and butane and should produce 13% less CO_2 than petrol, based on energy content, if best technology is utilised.[6]

LPG Autogas-powered vehicles emit significantly fewer greenhouse gases and other pollutants than petrol-powered equivalents. LPG typically has around 20 per cent less ozone forming potential (a measure of the tendency to generate photochemical smog), between 10 and 15 per cent lower greenhouse gas emissions and only one fifth of air toxics emissions.[7]

Air Quality

In urban areas around the world particulate matter (PM) and photochemical smog are significant air pollution problems. Of cities that experience periods of severe air pollution, several restrict or discourage petrol and diesel cars from inner urban areas while permitting or encouraging LPG powered cars. For example, LPG powered vehicles are exempt from London's Congestion Charge and enjoy reduced UK road taxes and license fees.

[6] Dr. Laurie Sparke OAM, Reducing Transport Emissions March 2008 – p14
[7] http://www.lpgautogas.com.au

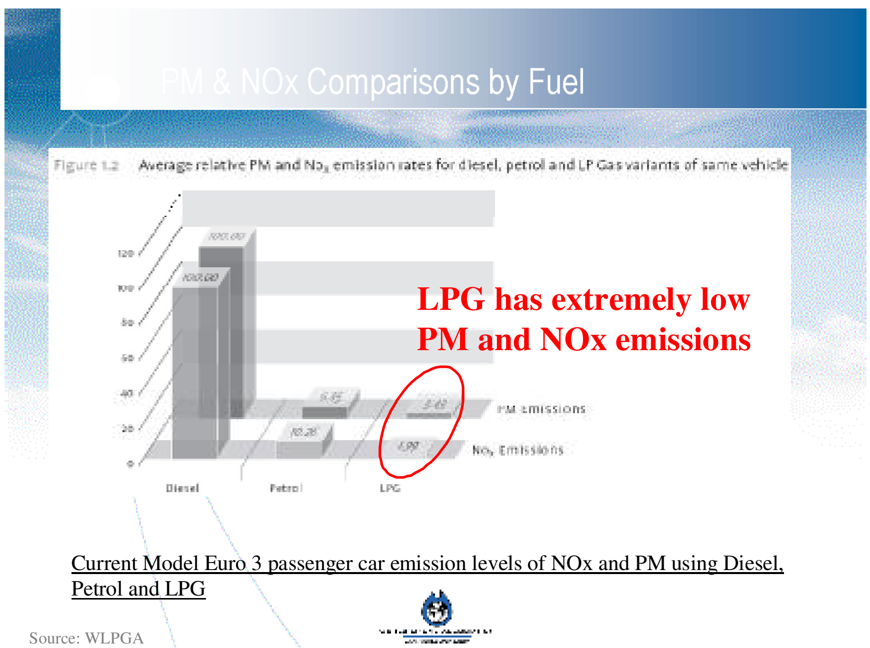
The benefits of LPG were shown recently in an international comparative study of regulated and unregulated air pollutant emissions before and after conversion of cars from petrol to LPG / petrol dual-fuel retrofits. The influences of LPG on air pollutant emission levels and carcinogenic potency were investigated and compared with petrol.

The reduction percentages were 71%, 89%, and 14% for carbon dioxide, total hydrocarbons, and carbon dioxide retrospectively.

The average total polycyclic aromatic hydrocarbons (PAH) emission factor for LPG was 217 µg/km, which is significantly lower than petrol (863 µg/km; $p = 0.05$).[8] PAHs are carcinogenic.

Emissions testing from Australia show similar results on vehicles popularly converted to LPG.

Average relative PM and NOx emission rates [9]



Current Model Euro 3 passenger car emission levels of NOx and PM using Diesel, Petrol and LPG

Source: WLPGA

Many of the LPG Autogas conversions in Australia are done on cars classified for emissions purposes as Euro 3 or less. For many of these vehicles, converting to LPG improves their emissions profiles. Table 5.3 compares average relative particulate matter and NOx emissions for diesel, petrol and LPG variants of the same vehicle.

The next chart summarises the relative levels of some key air toxic pollutants in the exhaust of engines operating on diesel, petrol, CNG and LP Gas.

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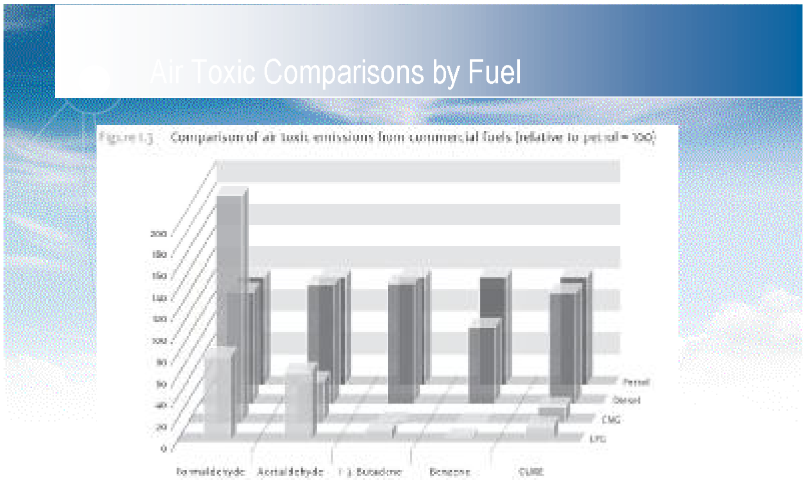
[8] Environ Sci. Technol., 41 (24), 8471-8476 10.1021/es0706495
[9] LPG's Role in Australian Energy Policy – April 2008 (ALPGA)

Comparison of air toxic emissions from commercial fuels (Relative to petrol = 100) [10]



Relative emissions of key air toxics for engines operating on Diesel, Petrol, CNG and LPG

Source: WLPGA

The above charts carry a clear message to policy makers and fleet managers – encouraging the use of LPG will significantly reduce relative emissions of key air toxics.

Both the economy and the community will benefit from governments and industry accelerating the implementation of strategies that encourage the uptake of LPG.

Fuel Attributes
(Relative to Petrol)

	Petrol	LS Diesel	ULS Diesel	CNG	LNG	LPG	Ethanol (corn)	Bio Diesel	Hydrogen
Gaseous Pollutants	O	X	X	√	√	√	√	?	√√
Particulates	O	X	X	√	√	√	O	?	√√
Tailpipe GHG Emissions	O	√	√	√	√	√	√	√	√√
Life-Cycle GHG Emissions	O	√	√	√	√	√	X	?	?
Air Toxics	O	X	X	√	√	√	O	?	√√
Retail Availability	O	O	O	XX	XX	√	X	X	X
On-Vehicle Storage	O	O	O	XX	X	O	O	O	X
Australian Reserves	O	O	O	√	√	√	√√	√√	√√

(Legend: √√=significantly better, √=better, O=neutral, X=worse, XX=significantly worse, ?=Uncertain)

[10] LPG's Role in Australian Energy Policy – April 2008 (ALPGA)

Health Impacts [11]

Motor vehicle air pollution has adverse health impacts on the community, especially for people living in urban areas or in location close to busy roads. These health impacts, which often lead to increased health care outlays and lost productivity, have significant costs to society.

Consider the particulate-matter (PM) related health costs for a diesel-powered light delivery van, operating in a large city. Typically, the van may travel 30,000 km/year and, if reasonably well maintained, will emit roughly 0.2 grams of particles for every kilometre travelled.

Using conservative to moderate estimates of PM health impact, the cost to the community for just this single vehicle will be in the order of **US$600 to US$1,000 per annum.** An LP Gas powered van performing the same task (probably with lower fuel bills) would generate a PM-related health cost of less than **US$30.**

Extrapolating these figures to a city with thousands vehicles provides an indication of the huge economic benefits of migrating to cleaner fuels.

The adoption of complimentary transport fuel and taxation policies, which lead to a strong uptake of cleaner gaseous fuels, can play a very significant role in reducing air pollution and its consequential harm to the community and the national economy.

5.3 Improving Existing Vehicle Emissions

Apart from conversion to LPG, there is no established method to reduce the emissions of existing vehicles.

Recently, ALPGA conducted testing on two comparable high mileage LPG Vehicles for exhaust emissions.

The vehicles were a Ford Falcon AU 2001 Station Sedan bi fuel retrofit venturi gas system, with a odometer reading of 95,000 km, and a Holden VS Acclaim 1996 Sedan bi fuel retrofit venturi gas system with an odometer reading of 215,000 km.

The test cycle Euro 3 in both cases (ADR 79/01 Type 1 test) was used and the fuel was commercially available.

Prior to the test the vehicles received a mechanical tune and a basic check for original specification and fuel functionality. The original exhaust catalyst was retained and the test was performed in June 2008 using a NATA laboratory.

[11] Health effects and costs of vehicle emissions – the invisible challenge. World LP Gas Associatiion 2005

Results

COMPARATIVE IN SERVICE EMISSION TEST USING ADR 79/01 CYCLE ULP vs LPG					
Ford Falcon AU Futura Wagon 4.0L SCT 269 odo 95,154					
FUEL	HC: g/km	CO: g/km	CO2: g/km	NOx: g/km	Combined Cycle L/100 km
ULP	0.479	2.606	270.9	1.509	11.54
LPG	0.173	0.994	240.95	1.29	14.89
Holden VS Acclaim Sedan 3.8L PDT 166 odo 213,942					
ULP	0.525	4.216	278.77	2.365	12.46
LPG	0.479	6.724	247.63	1.658	15.91

Notes

1. All fuels used were from the retail sector (standard pump fuels)
2. Both the 2001 AU Falcon and 1996 VS Commodore were fitted with standard fumigation systems, Parnell/IMPCO
3. To achieve a direct comparison the latest ADR 79/01 test method was used (Euro 3 level)
4. When reviewing the results, both vehicles passed their relevant ADR requirement for their date of manufacture however failed the current 79/01
5. The CO_2 improvements were both over 10%
6. Important to note the kms of both vehicles highlighting the benefits of older installations being installed
7. Both vehicles have their original catalytic converter
8. No optimization was carried on either vehicle prior to the test. Both vehicles had a mechanical inspection ensuring both fuel selection and vehicle/engine performed satisfactorily

The results confirmed significant emissions benefits, including CO_2 can be achieved by converting older vehicles to LPG using existing low cost fumigation systems. The results are reinforced when you consider that the results were achieved with the existing catalytic converter on both vehicles.

6 Energy Security

6.1 Global energy context

Global oil demand is expected to grow by 2% per year for the next two decades. However, current oil availability, expected supply growth, increased cost of accessing new oil sources and the growing threat of global political constraints means that oil supply is unlikely to meet future needs.[12]

"The global supply of oil and natural gas from conventional sources is unlikely to meet growth in demand over the next 25 years" and there are "accumulating risks to replacing current production and increasing supplies."[13]

Although vast amounts of oil and gas remain underground, the International Energy Agency considers that "complex challenges" and "global uncertainties" are likely to put an end to "the sufficient, reliable and economic supplies upon which people depend". The impact will be near-term, with oil production becoming "a significant challenge as early as 2015". The Agency predicts that oil supplies could become "extremely tight" within 5 years.[14]

The consequence is that the effects of "Peak Oil" will hit importing countries disproportionately, and the effects will occur very rapidly, once the exporting trade partner's oil reserves have peaked.

6.2 Australian energy context

Australia increasingly relies on imports for its transport fuels: 70% of crude oil and 15% of refined petrol demand are imported. Crude oil imports are mainly from Asia where local demand is increasing – the prospect is for increasing reliance on the Middle East.

Australia's oil needs will continue to grow into the immediate future, as our oil fields continue to deplete, and we will become increasingly dependant on oil imports. Although we are bringing more capacity online, this has not offset the decline in production of the established fields. Australia imports oil from a number of countries, with the most significant sources being Vietnam, Papua New Guinea, the United Arab Emirates, and Malaysia.

"The demand for refined petroleum products within Australia is increasing at an average of approximately 3.5% per annum since 2001. Rates vary for different fuels, with the petrol demand increasing at 2% and demand for diesel at 5% per annum. Demand for fuel is also increasing internationally. Diesel is the dominant fuel in Asia and in recent years there has been a

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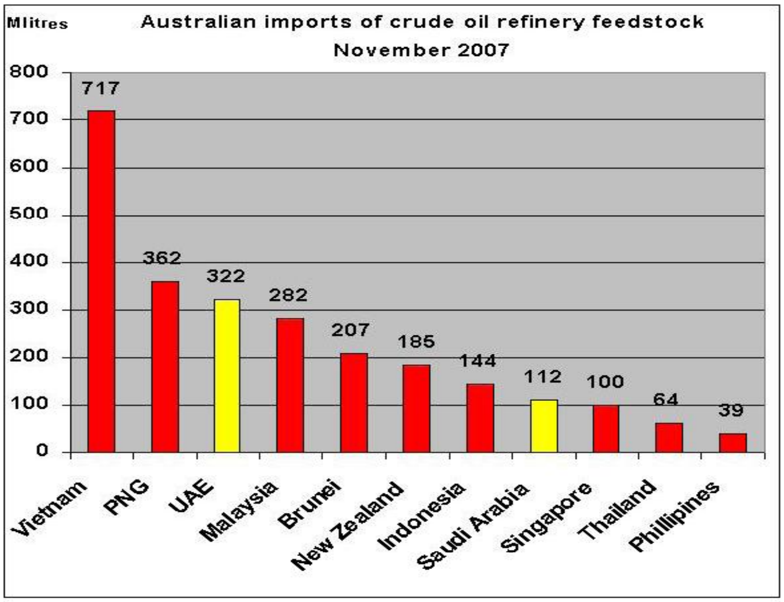
[12] Dr. Laurie Sparke OAM, Reducing Transport Emissions March 2008 – p8
[13] Facing the Hard Truths about Energy, National Petroleum Council USA
[14] International Energy Agency, World Energy Outlook 2007

significant increase in demand. This has resulted in higher international and wholesale diesel prices". [15]

Countries Exporting Oil to Australia *[16]*



Oil producing countries service internal markets first, and then export their surplus. Most oil exporting countries are developing rapidly, and most of our suppliers are experiencing declining production and increasing domestic consumption. As a result, their export capacity is dropping with unexpected rapidity.[17]

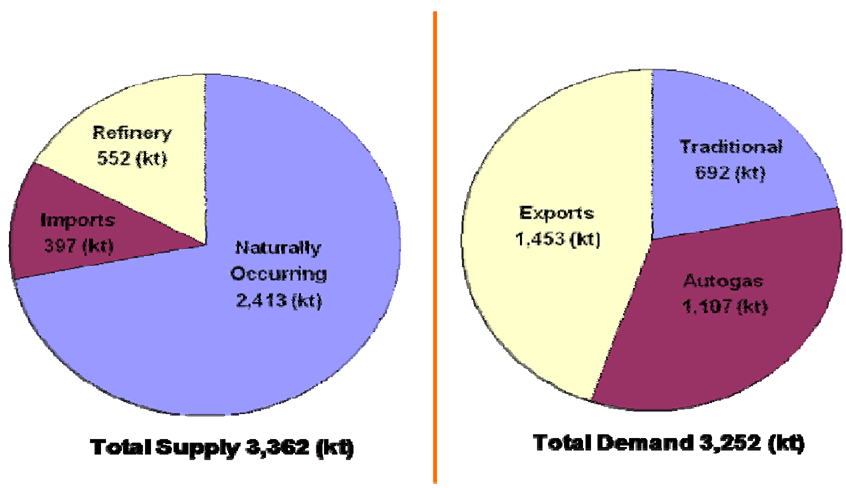
[15] The Vehicle Fuel Efficiency public discussion paper of September 2008 (http://www.environment.gov.au/settlements/transport/publications/pubs/vfe-paper.pdf)
[16] Matt Mushalik, based on data from http://tonto.eia.doe.gov/country/index.cfm
[17] Dr. Laurie Sparke OAM, Reducing Transport Emissions March 2008 – p11

7 LPG Supply and Demand

7.1 LPG in Australia

About 80% of Australia's LPG is derived from oil and gas fields, both offshore and onshore in WA, Victoria, SA and Queensland, and about 20% from refining crude oil at Australia's 7 refineries. Although Australia is a significant net exporter of LPG, for logistical reasons related to the economics of shipping movements, some LPG is imported. The supply and demand situation in 2007 for LPG is summarised in the charts below.

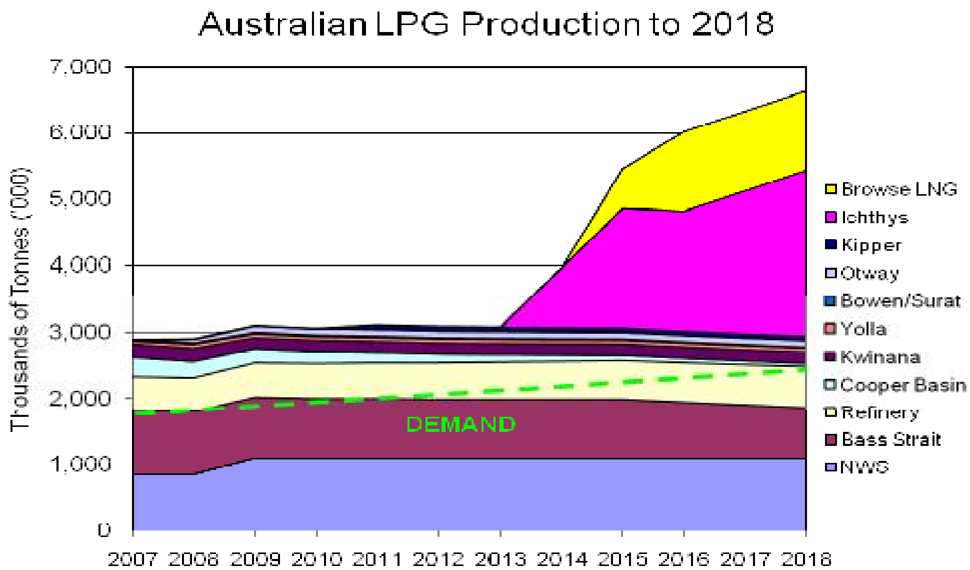
LPG SUPPLY AND DEMAND 2007



7.2 Australia's abundant supply of LPG

Australia has abundant reserves of LPG and with new gas fields being developed, its reserves are expected to increase substantially. The chart below provides an indication of the expected excess production over demand from various gas fields for the foreseeable future.

The Australian consumer pays international prices for LPG so producers of Australian LPG are not disadvantaged if they sell into the domestic market instead of exporting.



Source: LPG Australia, 2008

Australian Bureau of Agricultural and Resource Economics (ABARE) has forecast production of naturally occurring LPG to double by 2030. The continued development of large-scale natural gas projects will increase production of LPG above the ABARE forecasts. A demand growth of over 6% a year to 2030 would not result in demand exceeding supply.[18]

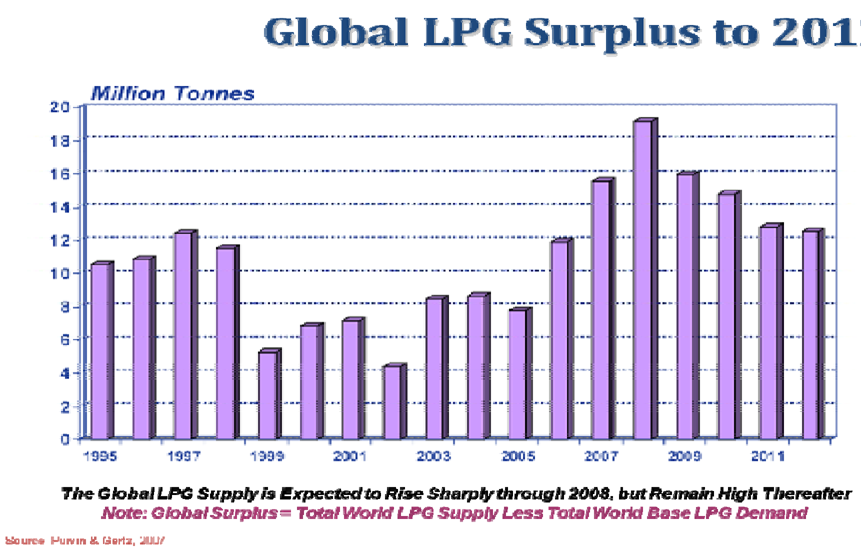
Australia also has abundant supplies of natural gas. In an Australian gas field, about 5% of the gas is LPG and the remainder is predominantly methane, which can be liquefied to LNG, or piped in gas mains to consumers. LNG is also expected to be produced from Queensland's coal seam deposits. These deposits will not yield any LPG.

Australia has a unique opportunity to exploit its abundant supplies of LPG by continuing to encourage increased use of LPG as a fuel for motor vehicles, thereby reducing its growing dependence on imported petrol and diesel oil, increasing fuel security and simultaneously reducing greenhouse and other toxic gas emissions.

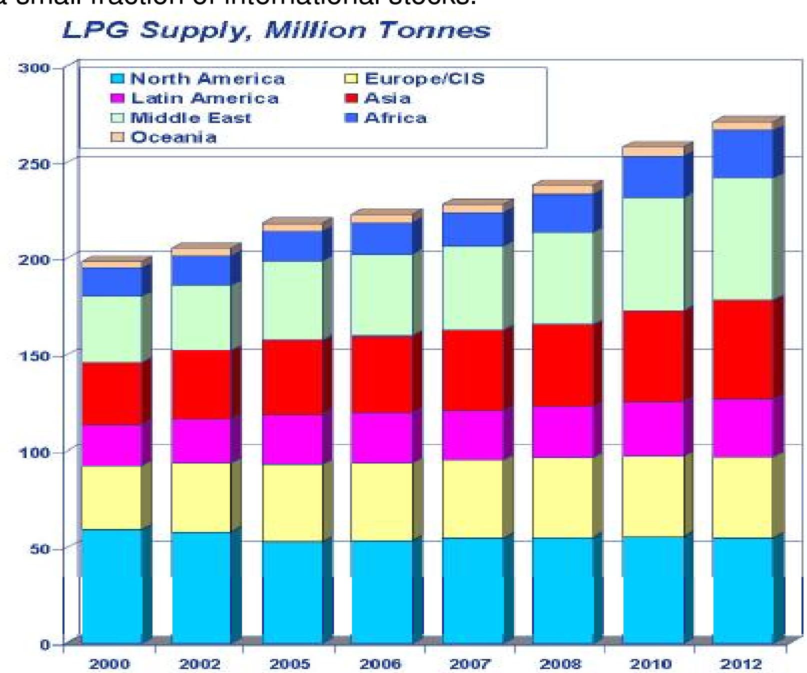
[18] LPG's Role in Australian Energy Policy – April 2008 (ALPGA)

7.3 International supply of LPG

International LPG consultants Purvin and Gertz predict a surplus supply of LPG into the future.



Australian LPG reserves, indicated in the graph below as part of Oceania, are a small fraction of international stocks.

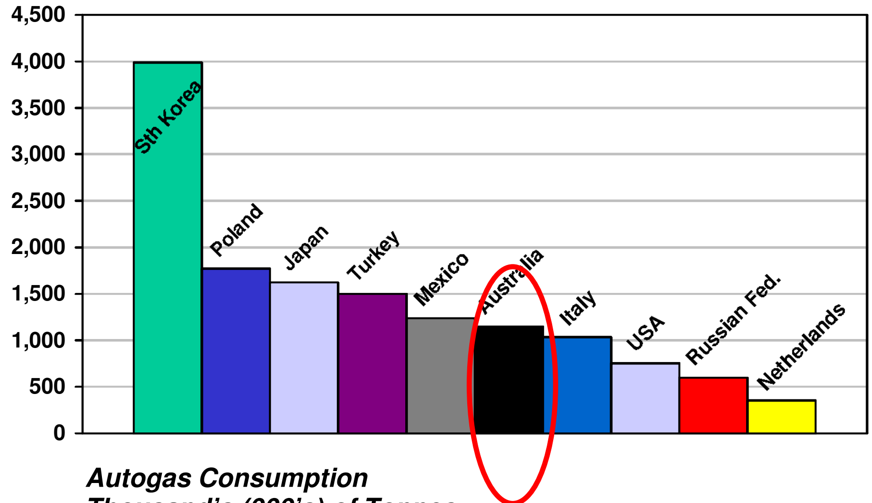


Source: World Energy Review, Purvin and Gertz, 2007

7.4 International Use of LPG as Autogas

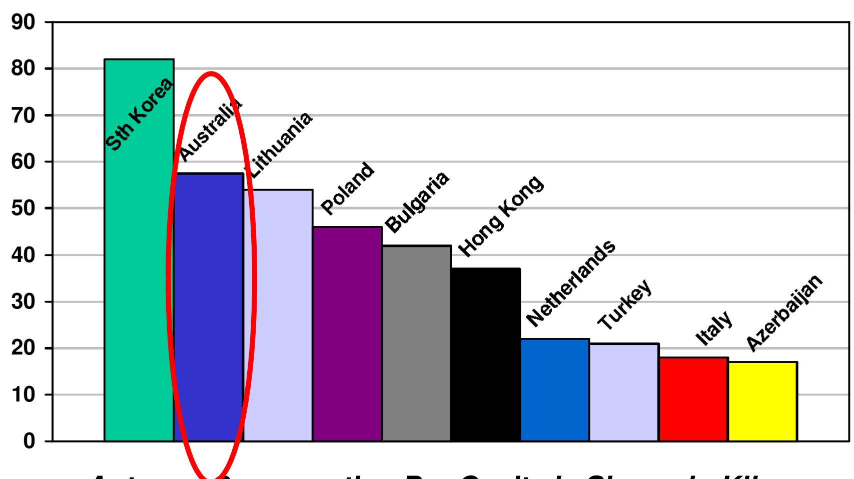
Australia ranks in the top 10 Autogas consuming nations in the world and ranks second to South Korea on a per capita basis – refer to the following charts.

Top 10 Autogas Nations[19]



Autogas Consumption Thousand's (000's) of Tonnes

Top 10 Autogas Nations - per Capita[20]



Autogas Consumption Per Capita is Shown in Kilograms

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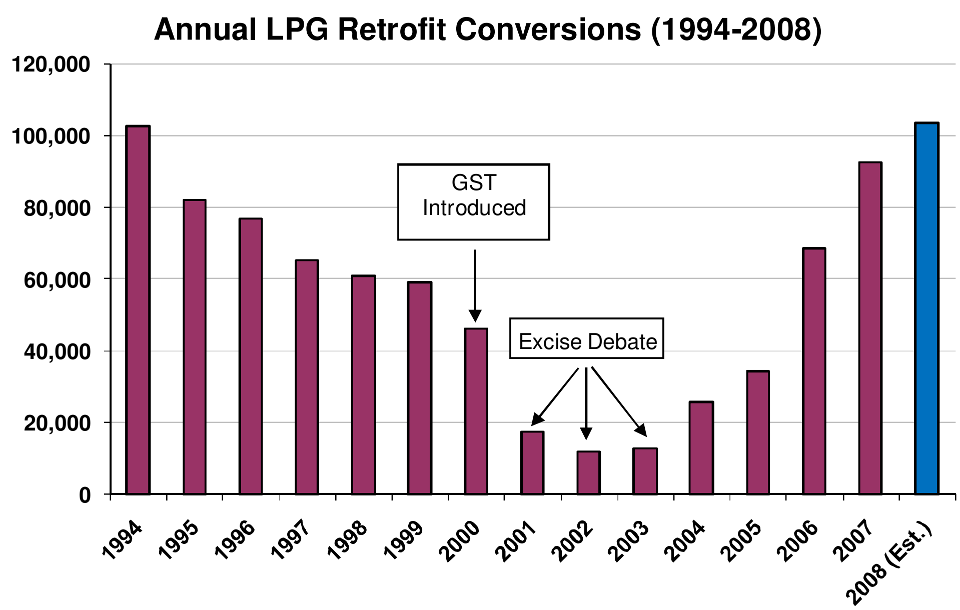
[19] Source: ALPGA – October 2007
[20] Source: ALPGA – October 2007

8 Government Policy Impacts

For environmental (both air quality and greenhouse) reasons and for energy security, the use of LPG as an automotive fuel (LPG Autogas) has received bi-partisan political support in Australia since the early 1970s. The principal policy tool has been LPG's excise-free status, which is still in place today.

For business and the community at large, uncertainty and ambiguity about government policy causes important investment decisions to be postponed.

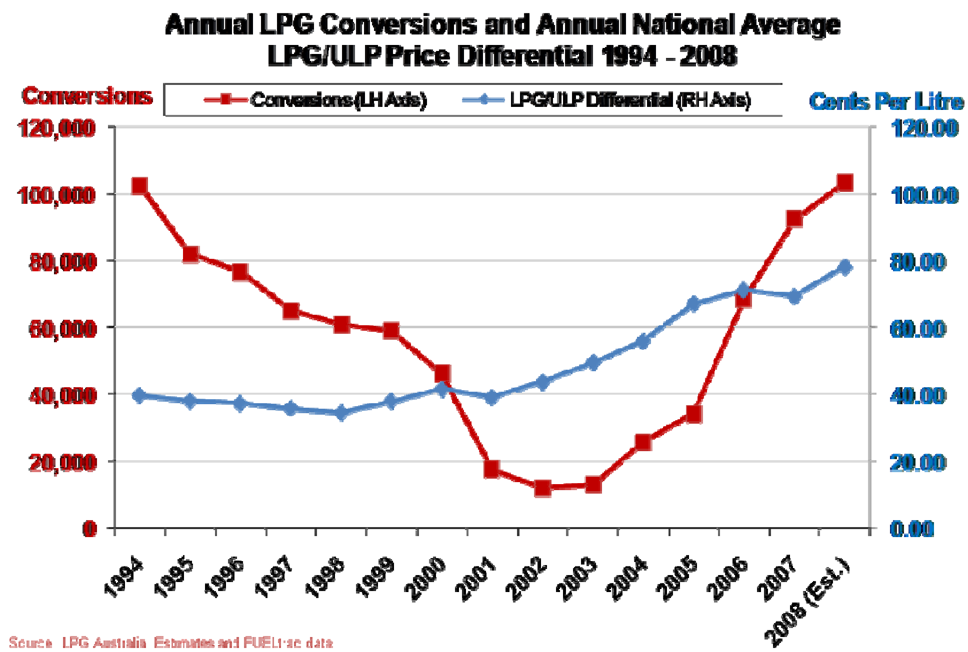
This is clearly evident from the LPG vehicle conversion data.



For motorists, conversion to LPG Autogas is an investment. Ongoing growth in LPG Autogas requires certainty of policy. It is thus essential that Government policy that impacts LPG Autogas is clear and long-term in nature.

The effects of the uncertainty surrounding the introduction of GST and the issue of excise on LPG, is clearly evident in the table above during the period 2001-2003. The then existing uncertainty caused Vehicle Manufacturers to cancel plans to introduce models offering LPG as an OE fitment and adversely affected the perception of general members of the public of LPG as an economic fuel option.

This downturn was not related to the differential in the LPG/petrol price, as demonstrated in the next chart.



The downturn in the LPG conversion industry in the late 1990s and early 2000s had flow on effects to TAFE Colleges and other institutions that trained LPG gas fitters and installers. The advent of the LPG Vehicle Scheme required TAFE Colleges to rapidly reintroduce training courses.

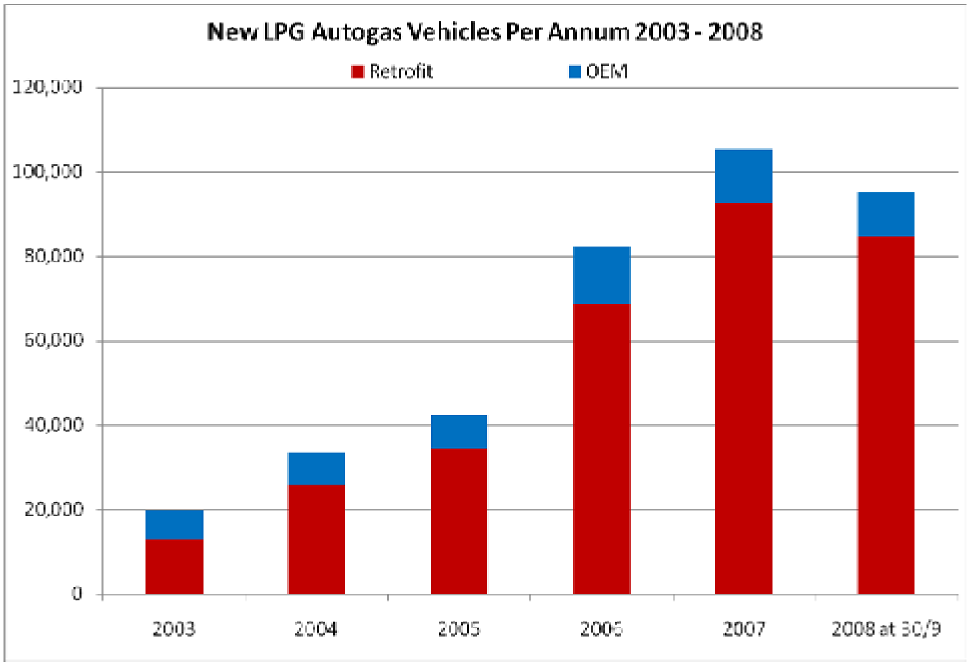
Government policy decisions giving greater certainty further allows training opportunities to be planned and for prospective apprentices to know there is a long term career for them.

The announcement in August 2006, by the then Federal Government to introduce the LPG Vehicle Scheme that provided grants for private motorists of $2000 per vehicle for new and used vehicles converted to LPG and $1000 for vehicles fitted with LPG at the point of manufacture, has been accompanied by a restoration of industry volumes to pre-GST levels. The Scheme was said to last until 2015.

In early 2008, speculation that the LPG Vehicle Scheme was to be cut from the Budget caused considerable chaos in the industry. Small business installers who had made decisions to invest in their workshops, using their home as mortgage collateral, faced losing their businesses and homes if the change in government policy caused the industry to go into decline again.

Confirmation of the Scheme in the Budget and that it would continue until 2015 by the Treasurer has given business operators and consumers confidence.[21]

[21] The Hon Treasurer, Wayne Swan MP, Letter to LPG Australia, 30 May 2008



Retrofitted and OEM LPG Vehicles, Australia 2003-2008 [22]

In discussing the ability of the Australian vehicle manufacturing industry and associated component suppliers to meet the range of challenges and opportunities in its sector, the Vehicle Fuel Efficiency Discussion Paper [23] notes at page 33 some principles that may be observed that will assist in achieving optimum outcomes:

i. Performance-based approach – measures should be designed to achieve the goal;
ii. Certainty – government should aim to provide industry with a certain operating environment as far as possible into the future in support of long-term business planning – this should help minimize the costs of compliance, and promote innovation through better coordination of investments;
iii. Balance – both supply and demand-side measures should be selected and designed in a coordinated way; and
iv. Harmonisation – to minimize the costs of compliance and promote innovation, measures should be harmonized as much as possible with international standards and across Australian jurisdictions.

[22] Source: ALPGA – May 2008
[23] http://www.environment.gov.au/settlements/transport/publications/pubs/vfe-paper.pdf

8.1 LPG Autogas – Social Benefits

The objective of the LPG Vehicle Scheme is to assist private motorists most impacted by high petrol prices. It has been equitable and successful. Based on aggregated data, the regions with the highest number of conversions are located on the periphery of major population centres, from which long commutes are required. Demographically, these areas are often less affluent than inner metropolitan areas.

The majority of LPG Vehicle Scheme grant recipients may be described thus:

- They are families with children;
- They have lower than average disposable income;
- They reside in outer metropolitan areas; and
- They have mortgages

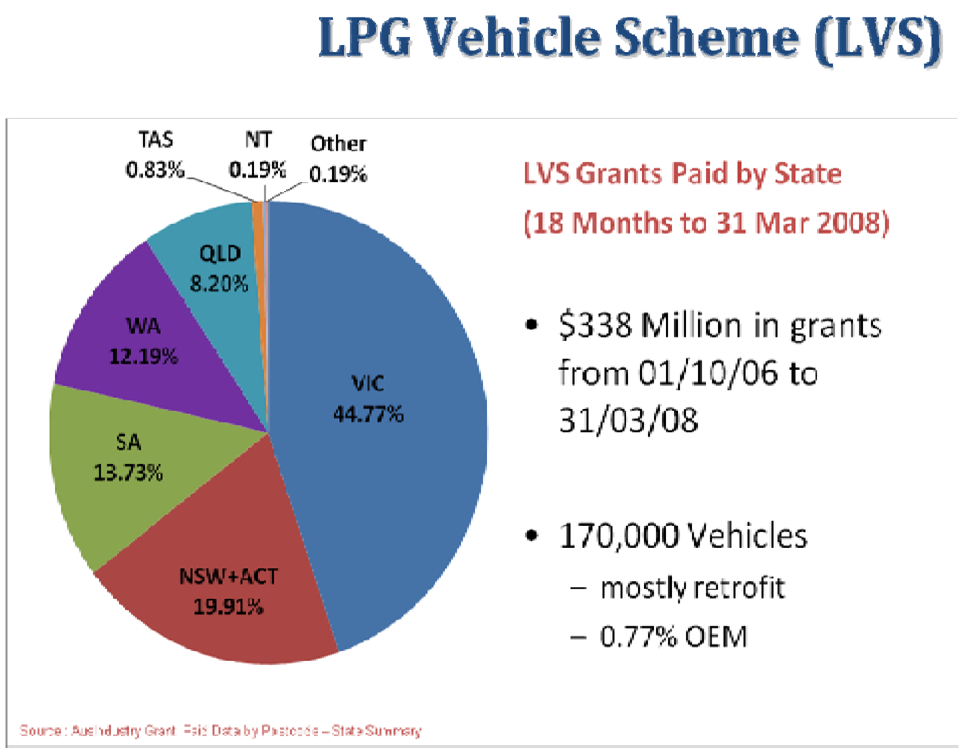
Because LPG conversions are disproportionately sought by people on lower incomes, introducing excise onto LPG will disproportionately affect people on lower incomes.

The take-up of LPG conversions is not even across the Australian community. Significant differences occur between and within states and territories.

The highest rates of uptake as demonstrated by the LPG Vehicle Scheme occur in Victoria (4.8 per 1,000 persons), South Australia (4.3 per 1,000 persons) and Western Australia (2.4 per 1,000 persons). Rates in New South Wales (2.3) and Queensland (1.4) are significantly lower.

Parliamentary Question No 412 answered in the Senate on 14 May 2008[24], confirms the variable conversion rate across Australian states and territories.

[24] Hansard, Senate, 14 May 2008, page 181



Possible reasons for differences in take-up rates maybe that in the higher performing states gas may have a higher community profile due to gas reserves in those states.

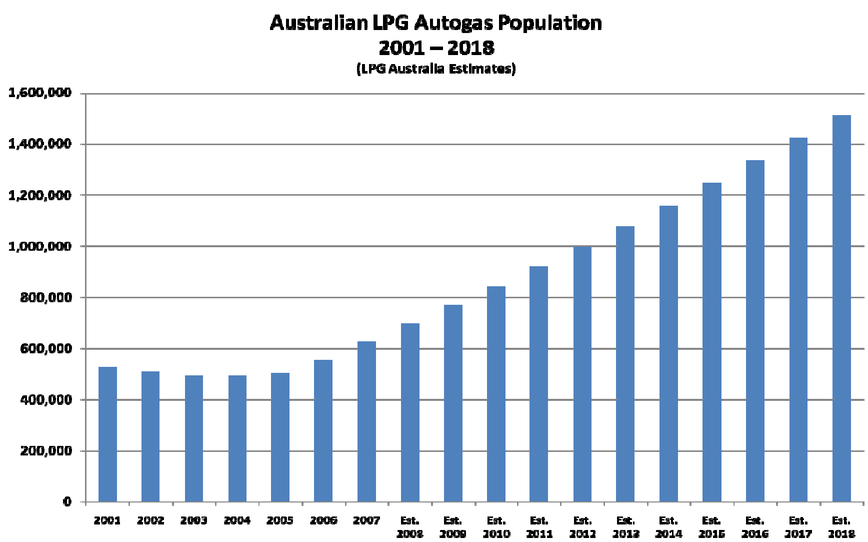
Within states, the highest take-up is in outer urban and regional areas, among families with mortgages, who have the poorest access to reliable and frequent public transport, and have the longest distances to commute. These consumers are most exposed to rising transport fuel costs, far more so than their inner city cousins.

The Vehicle Fuel Efficiency Discussion Paper states "Sustained high prices for transport fuels have the capacity to impact negatively on many sectors of the Australian community. Research suggests that the groups affected quickly and most severely by increases in fuel prices tend to be those who have limited or no alternative to the use of passenger cars (i.e. lack of public transport services). These will often include people living in socially disadvantaged outer suburban areas, the fringes of urban areas or in rural and remote areas".[25]

The table below provides a closer look at the areas in which the uptake of the LPG Vehicle Schedule has been highest.

[25] Dodson J and Sipe N 2005 Oil Vulnerability in the Australian City

Table: Top 5 Postcodes for LPG Vehicle Conversions[26]						
NSW / ACT	**Victoria**	**QLD**	**SA**	**WA**	**Tasmania**	**NT**
Nowra	Narre Warren	Toowoomba	Salisbury	Mandurah	Launceston	Casuarina
Liverpool	Cranbourne	Nerang	Morphett Vale	Safety Bay	Devonport	Alice Springs
Wyong	St Albans	Gympie	Smithfield	Midland	Mowbray	Palmerston
Wagga	Werribee	Bundaberg	Aberfoyle Park	Hamilton Hill	Ulverstone	Bagot
Gosford	Hoppers Crossing	Caloundra	Salisbury East	Wanneroo	Bellerive	Buffalo Creek



Autogas-powered vehicles represent about 5% of the Australian light vehicle market as at end of 2007 (approximately 650,000 vehicles). Given long-term continuity of Government policy in relation to LPG Autogas, it is conceivable that LPG Autogas-powered vehicles could represent at least 10% of Australia's passenger car fleet in 10 years or less time.

A three to four fold increase in the number of LPG vehicles will not result in a proportionate increase the amount of LPG consumed. This is principally because of a high degree of market penetration in the high volume LPG users, such as taxis and commercial fleet operators. Nearly all the 18,000 Australian taxis run on LPG and consume 20% of the total consumption.

[26] LPG Australia 2008

The major growth in LPG conversions will be among existing cars owned by private motorists, mostly doing 20,000 kms a year or more. It is for these motorists that the business case to convert is compelling.

An estimate of the extent of reduced vehicle running costs resulting from this LPG growth scenario can be derived from the relative fuel consumption of petrol versus LPG mentioned in section 4.2, which was expressed as an average 12 litres/100km for petrol and a conservative average of 15.6 litres/100km for LPG.

Based upon current fuel prices of (say) $1.40 per litre for petrol and $0.60 cents per litre for LPG and assuming average annual distance travelled of 15,000km, the above mentioned LPG vehicle growth would deliver total fuel costs savings after 10 years in the order of $725 million dollars per annum to Australian motorists.

Relative fuel consumption of petrol versus LPG - Calculation

LPG running costs calculation

15,000 km ÷ 100 km 150 km
150 km x15.6 litres 2,340
2340 litres x $0.60 cents = $1,404
$1,404 x 10 (years) – $14,040

Petrol running costs calculation

15,000 km ÷ 100 km 150 km
150 km x 12 litres 1,800
1800 litres x $1.40 cents = $2,520
$2,520 x 10 (years) – $25,200

Cost savings

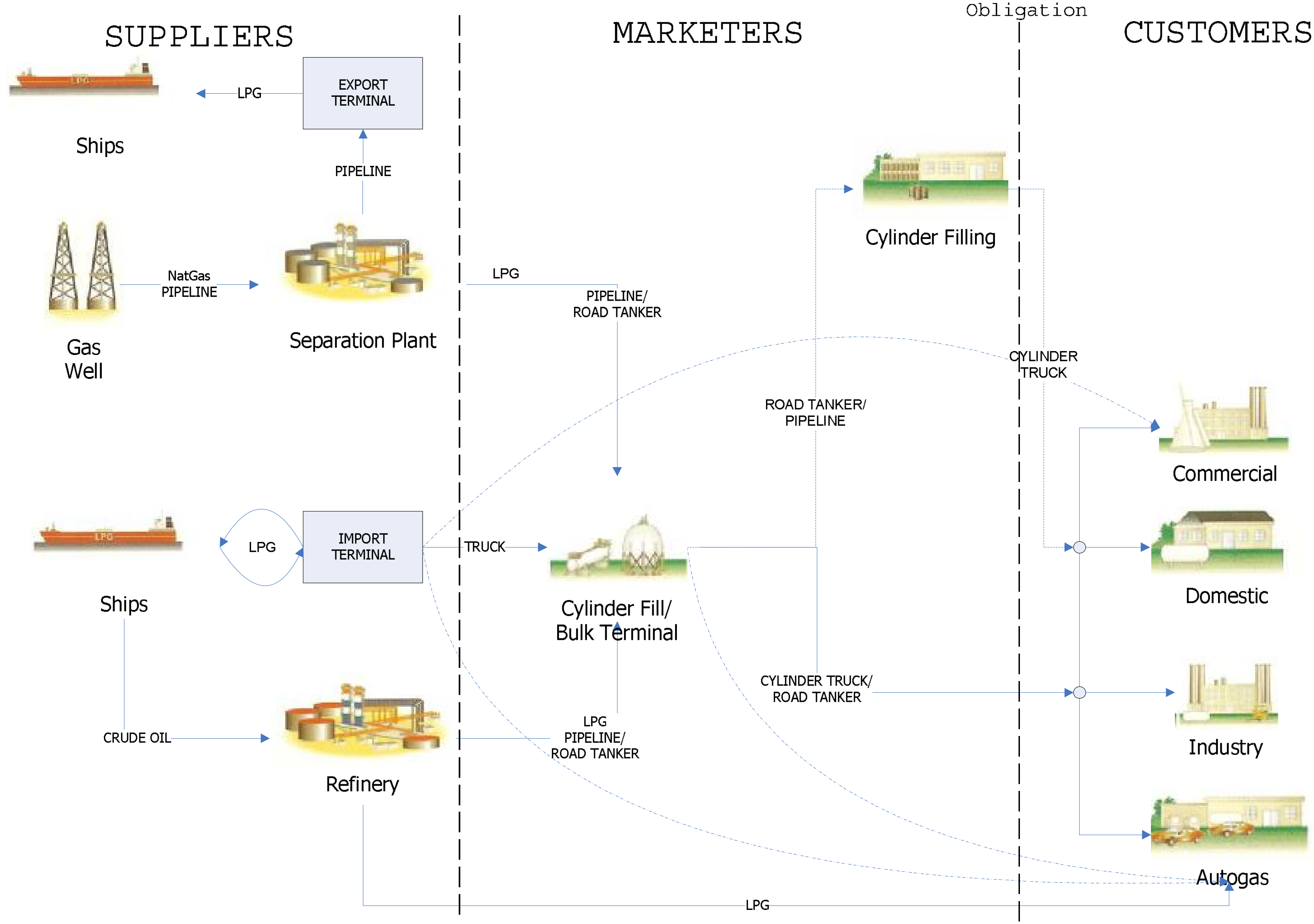
$25,200 (petrol costs over 10 years) - $14,040 (LPG costs of 10 years) – $11,160 savings
$11,160 (savings over 10 years) x 650,000 (vehicles using LPG) – $725, 400,000 savings

LPG fuel savings after 10 years = $725, 400,000

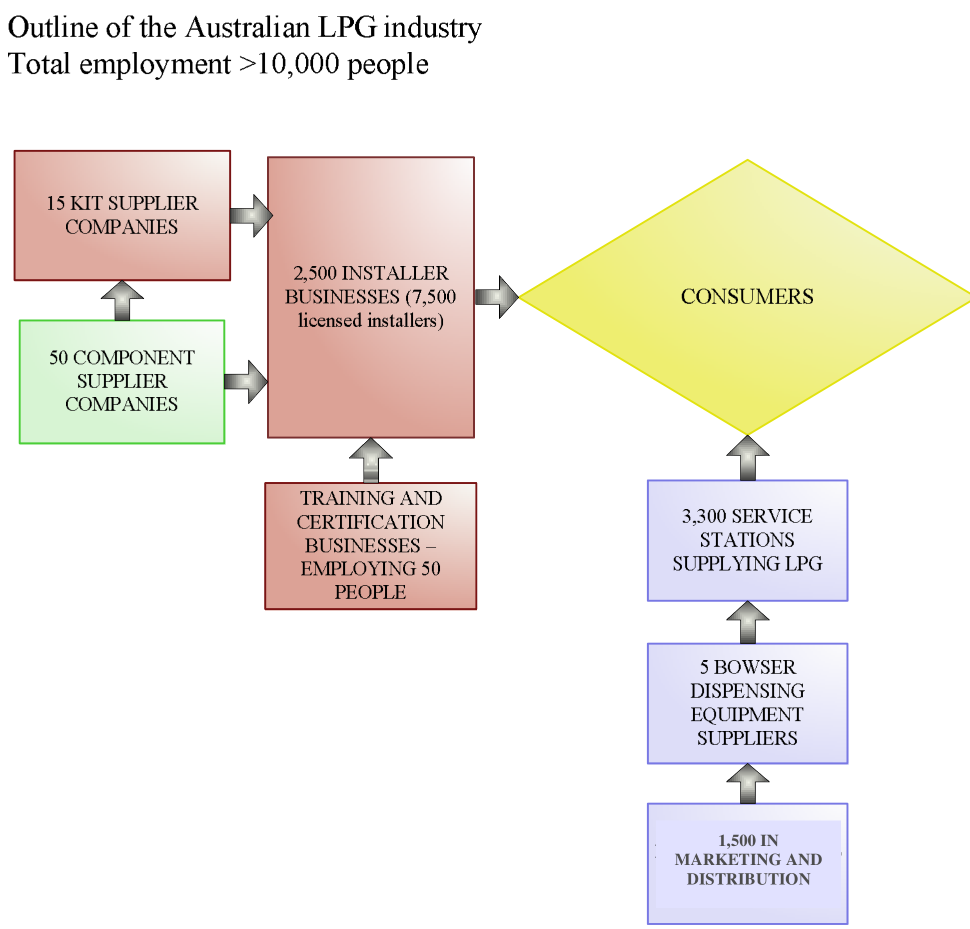
Appendix A – Access Economics Report May 2003

Appendix B – LPG Supply Chain

LPG SUPPLY CHAIN



Appendix C –
Outline of the Australian Autogas LPG Industry



Appendix D –
LPG Powered Ford Focus

Ford announces European-spec Focus 2008

Posted Sep 11th 2007 11:49AM by Xavier Navarro

Filed under: Diesel, Flex-Fuel, MPG, Ford, Natural Gas

Ford Focus ECOnetic 2008

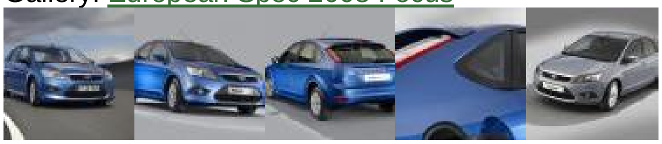
Moving it closer to the new Mondeo and adopting the ECOnetic label for the cleanest model available, Ford has announced a restyled version of the Focus (which is very different from the one in the US, unfortunately).

The changes are mostly aesthetic, giving the model what Ford calls "kinetic design" cues, which, according to the press release are: "Working from the front towards the rear, trapezoidal grilles, swept back headlamps, bold wheel arches, newly shaped rear glass, a contoured tailgate and new tail lamps are the key changes. Higher trim grades benefit from chrome detailing and a stylish, body-coloured upper rear spoiler."

As announced here before, the 2008 Focus can be fitted with a dual-clutch 6-speed gearbox developed by Getrag, mated to the 136 HP and 110 HP versions of the 2.0-litre Duratorq TDCi engine which is claimed to improved fuel consumption by 10 percent.

The 2008 Focus will have engine chioces galore: a Flexifuel engine, an ECOnetic version, as well as CNG and LPG versions based on the 2.0 liter gasoline engine.

Full press release after the jump.
Gallery: European Spec 2008 Focus



* New Kinetic Design exterior
* Enhanced interior quality
* New Ford PowerShift six-speed double-clutch transmission
* **New Focus ECOnetic with average CO2 of only 115g/km**
* New features including Easy Fuel capless refuelling, Ford Power button, tyre pressure warning system, 230 volt socket and LED rear lights
* On sale February 2008

BRENTWOOD, Essex,11 September, 2007 - Winner of more than 80 awards and the only vehicle in the world to be named Car of the Year both in Europe and North America, Ford's Focus has been something of a phenomenon since the launch of the original back in 1998.

Now in its second generation, with more than 1.1 million examples sold in the UK and a range which includes hatchback, saloon, estate and Coupé-Cabriolet derivatives, the Focus success story enters another chapter.

Following its unveiling at the Frankfurt Motor Show, Ford has announced that a new version of its family favourite will begin rolling off production lines from the end of 2007. Three-door, four-door, five-door and estate body styles will be first in UK showrooms, Coupé-Cabriolet and ST sporting flagship variants arriving in spring 2008.

The average fuel consumption improves by around 10 per cent, and CO2 emissions will be lower, compared to a conventional six-speed torque converter automatic transmission. Final homologated fuel economy and CO2 emissions data, as well as performance data for the Ford Focus with this new transmission technology, will be published closer to the car's market launch.

As a direct result of the Ford ECOnetic initiative, all Focus 1.6-litre TDCi variants will achieve 119g/km CO2 and this is regardless of power rating, body style or wheel dimensions. Flexifuel version of the 1.8-litre Duratec petrol four-cylinder engine can be fuelled with bio-ethanol E85-fuel as an alternative to conventional unleaded petrol – or in any mix of both. The Ford Focus range also includes CNG (compressed natural gas) and **LPG (liquefied petroleum gas)** derivatives both based on the 2.0-litre Duratec petrol engine.

Focus on Fuels

One car... 3 fuels

Spoiled for choice

With all the recent advances in alternative fuels a lot of media attention has been focused around fuels such as hydrogen, CNG, LNG, Bio fuel & ethanol and whilst some of these fuels sure do have a place in our future the reality is that main stream vehicles of today are predominately either petrol, Diesel or LPG with LPG being the only viable alternative fuel in wide stream use today

So has recent technology made a difference? Direct injection petrol engines are cleaner and more efficient than ever and modern day Common rail turbo diesel engines have come a long way since their smokey noisy ancestors, they are quiet and produce much less smoke but are still one of the heaviest polluters amongst all transport fuels, particularly in regard to particulate matter or 'black soot' as it is most commonly referred.

LPG has also come ahead in leaps and bounds with the latest electronically controlled sequential vapour injection systems, (SGI) offering the same attributes as their petrol powered counterparts as far as drivability and performance goes but with a substantially reduced operating cost. Ford Holden and Mitsubishi now offer factory fitted or approved LPG systems and there are a wide range of aftermarket SGI kits available to suit almost any passenger vehicle. Recently the Federal Government announced a rebate of $2000 to convert their existing or new vehicle to run on the environmentally friendly alternative fuel LPG and thousands have taken up the offer with record numbers of vehicles being converted.

At the Dealer

Focus LX petrol $23990+orc

Focus Turbo Diesel $27990+orc
Payback in 238,094km or 11.9 years

Focus SGI LPG^ $25990*+orc
Payback in 37,650km or 1.8 years

At the Bowser

Petrol
$10.57 per 100km

Diesel
$8.90 per 100km

LPG
$5.31 per 100km

Diesel

158.9

Unleaded

148.9

LPG

64.0

The battle of the bowser

So which fuel is the best choice for you when considering your new or next car? Fleet buyers and large corporations are all too well aware of the benefits and running costs of LPG vehicles but what about the private motorist. In order to find out we wanted to compare a commonly found car that you can see parked in driveways across the country that matched the demographic of the small 4 cylinder family car market who generally travel about 20,000 km a year. The Ford focus is the perfect candidate and is available in both petrol and turbo Diesel variants, aftermarket LPG system can be fitted to this vehicle using the latest LPG injection systems known as SGI

Out on the road the Petrol Focus uses 7.1L/100km which brings the yearly fuel bill (based on 20,000 km) to $2144. The Diesel Focus has a consumption rate of 5.6L/100km bringing the fuel bill to $1778, a saving to the family of $336 per year. However this saving would only come into affect once the additional price of the diesel option paid for itself through fuel savings, this would take a whopping 238,094km which is the equivalent of nearly 12 years of driving to recoup the additional $4000 cost of the vehicle. The LPG focus uses 8.3L/100km which is more than petrol and Diesel however the substantially lower price means that the yearly fuel bill comes in at a light $1062 saving the family $1052 compared to a petrol vehicle. The payback period of the LPG* is also much more attractive than the Diesel requiring only 37,650km of travel or the equivalent of less than two years to recoup the additional vehicle costs. Quite clearly the reduced payback period and substantially reduced running costs of LPG are the only realistic way for families to beat the price rise

*Price is inclusive of Federal Government rebate of $2000 for private motorists ^SGI Focus is based on LX petrol with and aftermarket SGI system installed. Fuel pricing based on Sydney pump prices as @ 06/01/08. Vehicle prices and diesel / petrol consumption figures are as indicated on www.ford.com.au. SGI price and LPG consumption provided by APA.

Appendix E – Hyundai LPG Hybrid

Hyundai hybrid bid

Elantra LPI HEV

HMCA puts business case to Korean HQ for Elantra LPG hybrid

By PHILIP LORD

HYUNDAI Motor Co Australia (HCMA) has revealed that it has put a business case forward to its South Korean parent for the LPG hybrid Elantra sedan to be sold here.

While the plentiful and cheap supply of LPG and its well-established Autogas infrastructure would make the Elantra LPI Hybrid Electric Vehicle (HEV) a natural for the Australian market, the vehicle is still to be confirmed for right-hand drive.

"What we've said to our parent company is that this is of great interest to this market, and obviously at this point we have put a proposal forward to them, and we're waiting for their feedback on that," said HMCA spokesman Ben Hershman.

However, Mr Hershman added that importing the eco Elantra would depend on whether it was produced in right-hand drive, having been primarily developed for the LHD South Korean and Chinese markets. It will make its market introduction in Korea in July 2009.


i20

The Elantra LPI hybrid will have the latest-generation LPG system – high-pressure liquid injection powering a conventional Gamma 1.6-litre engine. The hybrid will use a lithium polymer battery pack to power its 15W electric motor.

Mr Hershman would not be drawn on pricing, but did indicate how the Elantra would be positioned in the market.

"I would just point you to what Honda and Toyota do – the Honda's (Civic hybrid) premium over the non-hybrid vehicles, for example. We would look very closely at that."

Given the Civic Hybrid starts from the same price point as the Civic Sport ($32,990), that would put the Elantra LPI Hybrid at around $30,000. The range-topping Elantra Elite S starts from $28,990.

Meanwhile, HMCA has revealed that it plans to introduce the forthcoming i20 light car alongside – rather than instead of – the current Getz.

"We don't have confirmation at this stage, but we're very close to bringing the product here. That main point is i20 will replace Getz in Europe, whereas our intention is to retain Getz at this stage, and to have the Getz as the price of entry vehicle in the Hyundai range," Mr Hershman said. "We see the i20 as a larger, more sophisticated motor car compared to the Getz, and we see i20 competing with the Japanese products (such as) Honda Jazz, Mazda2, Toyota Yaris."

Read more: Hyundai shines i20 light

Hyundai adds its first LPG–electric hybrid vehicle in July 2009.

To be sold initially in the Korean domestic market under the Avante badge, the Elantra LPI Hybrid Electric Vehicle (HEV) is the world´s first hybrid vehicle to be powered by liquid petroleum gas (LPG) and the first to adopt advanced Lithium Polymer (Li–Poly) batteries.

Powered by a Liquefied Petroleum Injected (LPI) Gamma engine displacing 1.6 litres, a 15kW electric motor and a continuously variable transmission, the Elantra LPI HEV is a mild–type hybrid capable of delivering a competitive fuel economy rating.

"The Elantra LPI HEV demonstrates Hyundai´s innovative approach: We have leveraged Hyundai´s world leadership in LPG–fueled vehicles to develop a hybrid that will be very economical to operate," said Dr. Hyun–Soon Lee, president of the Research and Development Division.

Comparing operating costs among different types of hybrid vehicles currently available in the marketplace, the Elantra LPI HEV promises to be the cheapest of all to run. The Elantra LPI HEV promises to be as much as 40 percent cheaper to operate than other competitor models in the marketplace and 50 percent less than a conventional Elantra model powered by a gasoline–only engine. (Calculations are based on Korean domestic retail price of 1,907.08 KRW per liter of gasoline and LPG price of 1,828.65 KRW per kilogram as of the first week of June).

The Elantra LPI HEV will have a premium cost compared to a conventional Elantra due to the extra hardware (Li–Poly battery, DC motor and electrical control system). However, with the resulting fuel savings, Elantra LPI HEV buyers can expect to recover the extra cost of the vehicle in about two years.

In addition, the Elantra LPI HEV emits just 103g/km of CO_2 and 90 percent fewer emissions than an equivalent standard gasoline–powered Elantra to qualify as a Super Ultra Low Emission Vehicle (SULEV).

The Elantra LPI HEV will be the first car in the world to use lithium polymer rechargeable batteries, which will be supplied solely by LG Chem*, one of the leading producers of the batteries. Li–poly batteries have significant advantages over lithium–ion batteries including higher energy density, lower manufacturing costs, being more robust to physical damage and they can also take more charge–discharge cycles before storage capacity begins to degrade.

Hyundai developed its very first hybrid electric vehicle in 1995 when it unveiled the Future Green Vehicle at the Seoul Motor Show. In 1999, it showed an Elantra HEV and in 2000, an Accent HEV, both of which featured hard–type parallel electric drive systems and integrated Starter Generator technology. However, these research development vehicles did not go into mass production.

In 2004, the company delivered 50 Getz gas–electric hybrid vehicles (B–segment vehicles badged as Hyundai Click in the Korean domestic market) to Korean government agencies as part of a fleet

demonstration project. These were mild–type hybrid systems using 12kW motors and nickel metal hydride batteries. The hybrid technology development program continued to expand and in 2005, Hyundai and its affiliate Kia Motors Corp. delivered 350 more units to the demonstration fleet, 730 more units in 2006 and 1,682 more units in 2007, including Accent HEVs.

Current plants call for expanding the hybrid vehicle line–up to include mid–sized sedans in 2010.

Initial sales of the Elantra LPI HEV are to be restricted to the Korean domestic market. However, the LPI Hybrid could be exported to markets which are served by an excellent LPG distribution infrastructure.

As the Elantra LPI HEV remains under development, more detailed technical specifications will be released closer to the July 2009 launch date.

Hyundai Motor India launches Santro Eco LPG

September 30th, 2008 — Hyundai

Hyundai Motor India Ltd has launched the LPG version of the Santro and has called it the Santro Eco. The LPG variant will be priced Rs 21500 higher than the existing petrol model.

The new LPG version of Santro, christened Santro eco, comes with a factory-fitted LPG kit and boasts of features that meet global standards of performance and safety, informed a company press release here.
The ex-showroom Delhi price for Santro eco (GL) is Rs 354,294 and Santro eco (GLS) is Rs 373,357.

Powered by the 1.1 litre, eRLX engine, Santro eco offers its customers a unique combination of reliable performance and unmatched fuel economy. With separate petrol (35 litre) and LPG (27.2 litre) tanks, the customers have an option to choose from both LPG and petrol mode.

The LPG tank in the Santro eco has a special ‘Toroidal’ design that allows intelligent use of space and makes larger luggage room available to the customer, the release said.

Appendix F – Nissan Tiida Owner's Manual

Dear NISSAN owners,

We sincerely thank you for choosing a NISSAN vehicle.
We believe that your new NISSAN will bring you complete driving enjoyment and total satisfaction.

Our goal here at NISSAN is to provide you with the maximum satisfaction through a total car experience.
To achieve this goal, we promise to provide you with sincere and thorough support,
as well as continue to make an effort to provide more attractive services to satisfy your needs.

This booklet explains the warranty and maintenance information for your vehicle.
We are sure that this vehicle will meet all of your expectations,
and we hope that you will make the best use of this booklet.

Nissan Motor Co. (Australia) Pty. Ltd.
ABN 54 004 663 156

NOTE : Maintenance items

(1) Replace the drive belts if found damaged or if the auto belt tensioner reading reaches the maximum limit (If auto belt tensioner is equipped)
(2) Except VQ35HR engine models
(3) Use Eco filter or equivalent
(4) The propeller shaft should be re-greased after being immersed in water
(5) Use Genuine NISSAN Hyper-CVT fluid (NS-1) or exact equivalent
(6) Use NISSAN Genuine Engine Coolant, or equivalent in its quality, in order to avoid possible aluminum corrosion within the engine cooling system caused by the use of non-genuine engine coolant
After first replacement, replace every 40,000 Km (24,000 miles) or 24 months
(7) Fuel filters are located in LPG solenoid unit 1 and LPG solenoid unit 2 respectively
(8) Refer to owner's manual for more information regarding correct fluids
(9) Use only Genuine NISSAN CVT fluid (NS-2)
(10) Inspect the clearance between the brake pedal and the switches

Severe driving conditions

The maintenance intervals shown on the preceding pages are for normal operating conditions
If the vehicle is mainly operated under severe driving conditions as shown below, more frequent maintenance must be performed on the following items as shown in the table
(A) Driving in dusty conditions
(B) Repeatedly driving short distances
(C) Towing a trailer or caravan
(D) Extensive idling
(E) Driving in extremely adverse weather conditions or in areas where ambient temperatures are either extremely low or extremely high
(F) Driving in high humidity or mountainous areas
(G) Driving in areas which are high in salt or other corrosive materials
(H) Driving on rough and/or muddy roads or in the desert
(I) Driving with frequent use of brakes
(J) Frequent driving in water

Maintenance for off-road driving

Whenever you drive off-road through sand, mud or water as deep as the wheel hub, more frequent maintenance may be required of the following items:(For commercial vehicles)
Whenever you drive off-road through sand, mud or water, more frequent maintenance may be required of the following items:(For passenger vehicles)

▲ Brake pads and rotors
▲ Brake lining and drums
▲ Brake lines and hoses
▲ Wheel bearing grease
▲ Free-running hub grease
▲ Transfer oil and differential oil
▲ All-mode 4WD transfer fluid and automatic transmission fluid
▲ Steering linkage
▲ Propeller shaft and front drive shaft
▲ Air cleaner filter
▲ Clutch housing (Check water entry)

Severe
✓
✓
A
✓
A,B,C,D
A,B,C,D
A,E
✓
✓
A,E
✓

page M-72

		Normal	Severe
LPG ENGINE	Inspect air cleaner filter (Viscous paper type) (Taxi use)	✓	A
	Inspect torque of manifolds & exhaust tube nuts & cylinder head fixing nuts	✓	✓
	Inspect drive belts (Taxi use)	✓	✓
	Inspect positive crankcase ventilation (PCV) system	✓	✓
	Inspect LPG fuel pipes, connections (For gas leaks & damage)	✓	✓
	Inspect LPG cylinder & container connections (For loose connections & damage)	✓	✓
	Drain vaporizer tar (If large quantity of tar is drained, drain tar more frequently)	✓	✓
	Adjust ignition timing	✓	✓
	Inspect vacuum hoses & connections	✓	✓
	Inspect EGR control system	✓	✓

NOTE and Severe driving conditions: See page M-72 Inspect: Inspect and correct, or replace as necessary.

Continue Next Page

			Normal	Severe
DIESEL ENGINE	Adjust intake & exhaust valve clearance (Without HLA, Except YD & ZD engines)		✓	✓
	Replace air cleaner filter including pre-air cleaner filter (Dry paper type)		✓	A
	Replace fuel filter		✓	A,E
	Inspect idling speed (Except YD & ZD engines)		✓	✓
LPG ENGINE	Inspect torque of manifolds & exhaust tube nuts & cylinder head fixing nuts		✓	✓
	Replace fuel filters	See NOTE (7)	✓	A,E
	Drain vaporizer tar (If large quantity of tar is drained, drain tar more frequently)		✓	✓
	Inspect LPG cylinder & container connections (For loose connections & damage)		✓	✓
	Inspect LPG fuel pipes, connections (For gas leaks & damage)		✓	✓
	Inspect positive crankcase ventilation (PCV) system		✓	✓
	Replace spark plugs (Conventional type with catalyst)		✓	✓
	Inspect vacuum hoses & connections		✓	✓
	Inspect EGR control system		✓	✓

NOTE and Severe driving conditions: See page M-72 Inspect: Inspect and correct, or replace as necessary. Continue Next Page

Severe
✓
✓
A
✓
A
A,B,C,D
A,B,C,D
A,E
✓
✓
A,E
✓

		Normal	Severe
LPG ENGINE	Inspect air cleaner filter (Viscous paper type) (Taxi use)	✓	A
	Inspect torque of manifolds & exhaust tube nuts & cylinder head fixing nuts	✓	✓
	Inspect drive belts (Taxi use)	✓	✓
	Inspect positive crankcase ventilation (PCV) system	✓	✓
	Inspect LPG fuel pipes, connections (For gas leaks & damage)	✓	✓
	Inspect LPG cylinder & container connections (For loose connections & damage)	✓	✓
	Drain vaporizer tar (If large quantity of tar is drained, drain tar more frequently)	✓	✓
	Adjust ignition timing	✓	✓
	Inspect vacuum hoses & connections	✓	✓
	Inspect EGR control system	✓	✓

See page M-72

NOTE and Severe driving conditions: See page M-72 Inspect: Inspect and correct, or replace as necessary.

Continue Next Page

Appendix A – Access Economics Report May 2003

ALPGA
Information Paper 2

The Indirect Taxation of LPG in Australia

Quantifying the Costs and Benefits of the Current Differential Treatment

ACCESS ECONOMICS

May 2003

Australian Liquefied Petroleum Gas Association Limited

Access Economics Report:
The Indirect Taxation of LPG in Australia:
Quantifying the Costs and Benefits of the Current Differential Treatment.

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The Indirect Taxation of LPG in Australia: Quantifying the Costs and Benefits of the Current Differential Treatment

Report commissioned by the
Australian Liquefied Petroleum Gas Association Limited
and prepared by

ACCESS ECONOMICS

May 2003

Foreword from the ALPGA

The report, *The Indirect Taxation of LPG in Australia: Quantifying the Costs and Benefits of the Current Differential Treatment*, which follows this foreword, is the second in an ongoing series of Information Papers being published by the Australian Liquefied Petroleum Gas Association (ALPGA). The planned series of research reports and information papers relate to important policy and industry issues affecting the position of LPG in the Australian energy market.

This report also forms part of the ongoing policy, research and analysis program announced as part of the ALPGA's Autogas Industry Development Strategy released in April 2003.

Access Economics prepared this study. It was commissioned by the ALPGA's Autogas Task Force to undertake an analysis of the costs and benefits of the current taxation arrangements for LPG as a transport fuel.

LPG as an automotive fuel (Autogas) is the leading alternative transport fuel used in Australia. The ALPGA has argued that the current policy of exempting LPG from transport fuel excise is an effective, efficient and appropriate policy. The industry argues that the exemption is justified and should be continued.

The purpose of the Access Economics research report is to attempt to quantify the costs and benefits, in both long term and transition contexts, of the current excise concession for LPG and any move to eliminate it. The ALPGA believes that the scope and depth of analysis undertaken in this study is a significant contribution to informed debate on fuel taxation issues.

This study began some months ago and was completed just before the tabling of the 2003-04 Commonwealth Budget. Its importance as a contribution to the public debate on this issue has been heightened by the 2003-04 Commonwealth Budget announcement that the Government intends to remove the excise exemption from 2008 and to introduce an excise in incremental stages to 2012. This Government announcement is not supported by the LPG industry.

The Access Economics report highlights a number of important conclusions relevant to policy makers and the LPG industry:

- The properly-specified economic cost of the current LPG excise exemption is a fraction of the gross revenue foregone by government in providing the exemption.
- The long-run tax efficiency cost of the exemption is in the range of $30 to $100 million per annum.
- In the long-run, these tax efficiency costs and the Greenhouse abatement benefits provided by LPG as a transport fuel (in the order of $30 to $50 million per annum) are finely balanced.

- In the short-run, the benefit-cost equation clearly favours the retention of the excise exemption because of the significant infrastructure and vehicle investments made by the industry and consumers, and the economy would suffer a negative result were excise removed in the short-run (net negative transition costs of up to $110 million per annum).

The ALPGA believes that the analysis in this report has been prepared on a conservative basis as it takes account only of greenhouse emission reductions and investment transition costs. It has excluded the further benefits that are provided by LPG as a "joint product bonus" of the excise exemption policy with respect to urban air quality improvements and consequent health benefits as well as contributions by the fuel to energy security management and economic and regional development.

The transition costs have also been analysed on a conservative basis as claims for compensation from industry and consumers on the basis of policy change have been excluded.

The Association appreciates the work undertaken by the research team in Access Economics, Geoff Carmody, Rod Shogren, Robert Raether, John Sutton and Bonny Parkinson; as well as the co-ordination of this research project by Taskforce members, Ian Maloney and Ian Woodward.

Alan Beale
President ALPGA

Ray North
General Manager ALPGA

ALPGA Autogas Task Force Members:

Alan Beale, Taskforce Chairman (Elgas); Gary Ireson (Wesfarmers Kleenheat Gas); Ian Kennedy (ExxonMobil); Don Sargeant (BHPBilliton Petroleum); Ian Maloney (Elgas); Warring Neilsen (Elgas); Ian Woodward (Maestro Communication – Policy Strategy); Ray North (ALPGA); Bill Hazell (Wesfarmers Kleenheat Gas); Peter Israel (Origin Energy); Phil Westlake (ALPGA)

Contents

Executive Summary

This Report has been commissioned by the Australian Liquefied Petroleum Gas Association Limited (ALPGA) and prepared by Access Economics. Access Economics understands that it is a part of a program of policy and research activities being undertaken by the ALPGA's Autogas Task Force.

ALPGA argues that the current liquefied petroleum gas (LPG) excise exemption is justified and should be continued.

The purpose of this Report is to attempt to quantify the costs and benefits, in both long term and transition contexts, of the current excise concession for LPG and any move to eliminate it. In undertaking the analysis, Access Economics has focussed on two significant economic areas as the justification for the exemption. These are the environmental implications, specifically greenhouse gas abatement, in the long run, if there were to be a change in the excise regime; and the economy-wide transition implications in the short run arising from such a change.

In Access Economics' opinion, the long run case for the current LPG excise exemption rests on LPG providing greenhouse gas emission benefits relative to substitute transport fuels. Other benefits in relation to particulates and health effects are also linked with additional factors such as traffic congestion problems in urban areas. In general, these are better handled on a specific basis via congestion pricing and similar instruments. Nonetheless, such benefits could be regarded as 'joint products' with greenhouse gas benefits if they also arise as a result of the current LPG excise exemption. However, for the purposes of this Report, these other benefits are ignored.

The approach is conservative because the analysis excludes potential industry and LPG user claims for compensation if the current exemption policy were changed in the short run.

Key Points

The analysis in the Report shows that:

- The properly-specified economic cost of the current LPG excise exemption is significantly less than the gross excise revenue forgone by providing the exemption.
- The long run benefit-cost equation is finely balanced between greenhouse gas abatement benefits and tax system efficiency costs.
- Removing the current exemption generates net significant short-term, or transition, costs.

The Properly-Specified Cost Of The Current LPG Excise Concession

A major finding of this Report is that, even in the long run, where transition costs of removing the current excise exemption are ignored, the tax-efficiency cost of the current LPG excise exemption is but a fraction of the annual gross revenue forgone, when the analysis is properly specified.

Proper specification includes, importantly, the requirement that tax reforms be Budget-neutral.

Removal of the current LPG excise exemption provides revenue to finance (say) reduced income tax rates. Measured against the opportunity cost of lower income tax rates, the current LPG excise exemption involves greater reliance on less efficient taxes (income tax) and less reliance on somewhat more efficient taxes (excise on transport fuels). But the net efficiency sacrifice is relatively modest, because (i) both excise duty and income taxes are inefficient to some extent, and (ii) excise duty on transport fuels in Australia is a very pervasive tax on an important business input.

This cost also ignores any environmental and other related benefits from use of LPG as a transport fuel that has been induced by the excise exemption.

Long Run Modelling Results

In the long run, when all transitional costs and rigidities are assumed to be absorbed and/or overcome:

- The benefit-cost equation for the current LPG excise exemption is finely balanced.
- The status quo offers permanent greenhouse gas abatement benefits that might be of the order of, say, \$30 million to \$50 million per year, although it is noted that the value of greenhouse emission costs which affect that estimate is subject to ongoing research.
- But in terms of forgone tax-efficiency from the status quo, the economy suffers a permanent annual long run cost of between \$30 million and \$100 million.
- Allowing for the inevitable error margins around these estimates, we conclude that there is little net cost in retaining the current excise exemption, combining greenhouse gas abatement effects and tax-efficiency effects, and, equally, little net benefit in removing it.
- In general, the less price sensitive are transport fuels as a group, the more likely is the conclusion that there are net long run overall benefits from the current LPG excise exemption. This result flows from the importance of transport fuels as business inputs, and the inherent inefficiency of excise duties on business inputs. This is particularly relevant where the business transport customer is a high volume energy user.
- Measures that can be justified on the grounds of greenhouse gas emission benefits can, and usually do, have some impact on other problems (eg, particulates emissions and health effects) associated with concentration/congestion factors. While the latter might optimally be addressed using specifically-targeted congestion pricing instruments and the like, there is a 'joint product' effect on congestion related emission problems arising from measures primarily targeted at greenhouse gas emission benefits. As noted above, these effects have been ignored in the cost-benefit analysis in this Report.

Transitional Modelling Results

The current LPG excise exemption has been in place for some time. Considerable investment has been undertaken, in good faith, in response to it, by industry and motor vehicle users (both private and business users). Re-allocating resources in the event that the exemption is removed is not costless.

In the transition period, when we allow some (but not all) of the transitional costs and rigidities to operate:

- Removing the current exemption generates net significant short-term, or transition, costs.
- Removal of the concession is likely very quickly to remove greenhouse gas abatement benefits of the order of, say, $30 million to $50 million per year, although, as noted above, the value of greenhouse emission costs which affect that estimate is subject to ongoing research.
- In addition, net economy-wide transition costs of the order of $60 million per annum by the fifth year after the announcement of a policy change will be incurred.
- In total, therefore, net transition costs of between $90 million to $110 million per annum or more by the fifth year after the announcement of a policy change are likely.
- And these conclusions assume zero compensation to the industries and motor vehicle users directly affected by the removal of the current LPG exemption.

Reasons For Findings

Access Economics concludes that, in principle, there are two broad economic grounds for supporting the current LPG excise exemption:

- in the long term, if the environmental (greenhouse gas reduction) benefits outweigh or at least broadly match the economy-wide tax efficiency costs of retaining the current excise duty concession; *and*
- in the shorter term, if the economy-wide costs of transition to more uniform taxation of transport fuels are significant, and the cost of compensating those directly adversely affected by any change is large.

The following tests were developed to provide a framework for determining whether or not these economic grounds apply to the current LPG excise exemption.

Relevant Tax Design Tests: Long Term & Transition Contexts

In the long term context, the defensibility of the case for the current concession required the following tests to be met, preferably quantitatively:

I. A high differential tax impost on substitute fuels (petrol, diesel) as the fuel tax benchmark. Access Economics considers that this test is the better met if petroleum excise indexation is restored, and is eroded the longer that action is not taken.

II. Demonstrably better greenhouse emission characteristics for LPG relative to the high-taxed substitutes.

III. Demonstrable sensitivity of LPG demand to the LPG price relative to substitute fuel prices.

IV. Clear evidence that tax concessions are the most effective and efficient way to encourage LPG use.

V. Evidence that the *magnitude* of the current tax concession is warranted on a benefit-cost basis.

In the transition context, the defensibility of the case required the following tests to be met:

VI. Large industry and motor vehicle user investment in response to current concessions.

VII. A clear case for compensation if current concessions are changed.

VIII. Determination that, inclusive of compensation costs, changing current policy is not worthwhile.

Recent Government Policy Announcements

Since the completion of the analysis in this Report, as part of the 2003-04 Budget, the Commonwealth Government has announced its intention to change the system of fuel taxation from 2008 and progressively to remove the excise exemption from LPG and other alternative transport fuels by 2012.

At the time this Report was finalised, the full details of the new post-2012 fuel tax regime were not fully specified.

Full Report

1. INTRODUCTION

This Report has been commissioned by the Australian Liquefied Petroleum Gas Association Limited (ALPGA) and prepared by Access Economics.

1.1 BACKGROUND

At present, in Australia liquefied petroleum gas (LPG) is exempt from excise duty of up to 38 cents per litre that applies (some extra-urban business-related uses of some petroleum products, notably diesel, aside) to other petroleum fuels used in motor vehicles, such as petrol and diesel.

ALPGA argues that this concessional treatment is justified and should be continued.

Access Economics concludes that, in principle, there are two broad economic grounds for supporting this contention:

- in the long term, if the environmental (greenhouse gas reduction) benefits outweigh or at least broadly match the economy-wide tax efficiency costs of retaining the current excise duty concession; *and*
- in the shorter term, if the economy-wide costs of transition to more uniform taxation of transport fuels are significant, and the cost of compensating those directly adversely affected by any change is large.

The purpose of this Report is to attempt to quantify the costs and benefits, in both long term and transition contexts, of the current excise concession for LPG and any move to eliminate it.

1.2 STRUCTURE OF THIS REPORT

The remainder of this report is organised as follows:

- Section 2 briefly summarises the tests that, in Access Economics' opinion, should be passed if the current excise concession for LPG is to be retained.
- Section 3 presents an overview of approaches to measuring environmental benefits (greenhouse gas reductions) and how these might in principle be embedded in an economy-wide economic accounting framework such as the Australian National Accounts.
- Section 4 reviews currently-available estimates of the likely environmental benefits of LPG use as a transport fuel, relative to petrol and diesel.
- Section 5 outlines the tax efficiency costs that in principle would be expected to arise from the current LPG excise concession, and the nature of the tax-efficiency benefits that might be expected to be generated from removal of the concession.
- Section 6 presents Access Economics' quantitative assessment of these tax efficiency costs based on the application of its computable general equilibrium model, the *AE-CGE* Model, in its long-run solution mode.
- Section 7 explores the nature and scope of the transition costs that would be expected to arise from removal of the current LPG excise exemption.

- Section 8 attempts to quantify these costs, including from an economy-wide perspective, using the *AE-CGE* Model in a shorter-term solution mode (ie, allowing for adjustment rigidities assumed not to apply in the long term).
- Section 9 summarises Access Economics' conclusions.
- As necessary, more detailed material is presented in Attachments to the Full Report.

2. TAX DESIGN TESTS TO JUSTIFY THE CURRENT TAX TREATMENT OF LPG

While, in the case of taxation of products, there are practical reasons generally for adopting a 'no exemptions, uniform tax rate' approach, there are cases where differential tax treatment is defensible[1].

This section of the Report summarises the threshold tests, based on these cases, where we consider differential tax treatment might be justified. In Access Economics' opinion, the proponents of the current concessional treatment of LPG should be able to demonstrate that these tests are passed to sustain their support for the status quo.

Tests 1 – 5 deal with the long run or sustained case for concessional tax treatment for LPG. Tests 6 – 8 deal with the transition period in the event that consideration is given to abandoning the current tax concession for LPG.

2.1 THE LONG RUN CASE

In Access Economics' opinion, the long run case for the current LPG excise exemption rests on LPG providing greenhouse gas emission benefits relative to substitute transport fuels. Other benefits in relation to particulates and health effects are linked with additional factors such as traffic congestion problems in urban areas. In general, these are better handled on a specific basis via congestion pricing and similar instruments. Nonetheless, such benefits could be regarded as 'joint products' with greenhouse gas benefits if they also arise as a result of the current LPG excise exemption. However, for the purposes of this Report, these other benefits are ignored.

Accordingly, the relevant long run tests that the current LPG excise exemption must pass, in Access Economics' opinion, are the following.

2.1.1 Test 1 – The Benchmark For Taxation Of Petroleum Products

Taking petroleum products as a group (and perhaps especially when used in motor vehicles) several features are demonstrable based on empirical evidence:

- In aggregate, demand for such products can be shown to be relatively price inelastic (see sections 5 and 6 below).
- Use of such products generates adverse environmental effects, some of which are exacerbated where traffic congestion is evident.
- There may also be resource depletion concerns about use of such products, both overall and for particular components thereof.

1. For a brief discussion of these tax design principles see Attachment C: 'Good Tax Design' at the end of this Report.

- In general, production of petroleum within Australia is relatively concentrated (reflecting economies of scale relative to the size of the domestic market).

These features militate in favour of:

- Differentially *high* taxation, using excise duties high up the production chain, to maximise taxation revenue.
- Differentially *high* taxation, again using excise duties high up the production chain, to impose on users a charge reflecting the environmental costs of use of the product, and, albeit to a limited degree, to encourage conservation.

Such taxation treatment is Ramsey-efficient from a tax design perspective, relatively simple, and can be used as a vehicle to 'internalise' social costs due to environmental effects, if not greatly change demand for the product group.(Note that this benchmark approach, strictly speaking, should apply across all energy uses, including electricity. This is not pursued further in this Report, however.)

In short, a case can be made for differentially *high* taxation of petroleum products as a group.

From this perspective, some recent Commonwealth Government policy initiatives have been perverse:

- The *New Tax System* included reductions in petroleum product excise for some business uses of diesel, according use of such products partial or complete GST like treatment in respect of excise duty (there *are* good economic reasons for not taxing business inputs, however, especially using taxes that 'cascade' down the production chain).
- More importantly, the 2001 decision to abandon excise indexation to the CPI every six months sets in train a long-term real erosion in the tax burden on petroleum products, undermining the rationale for differential taxation and ultimately pointing to a case for removal of petroleum product excise completely and application of the goods and services tax benchmark – the GST.

These policy initiatives are important.

To the extent that there may be a case for concessional treatment for LPG, in Access Economics' opinion, there must equally be a case for differentially high taxation of 'less desirable' close substitutes. Encouraging use of LPG can be effected by increasing the tax burden on close substitutes as much as by reducing the tax on LPG. The fact that the tax burden on close substitutes to LPG is set to fall on a permanent basis under current Commonwealth Government policy itself undermines the rationale for the current concessional treatment of LPG, in Access Economics' opinion.

This policy initiative to abandon indexation also costs the Government substantial revenue – on our estimates as much as 1-1.5% of GDP per annum by 2040.

In short, if there is a case for a tax concession for LPG to encourage switching from other petroleum products, then, in Access Economics' opinion that concession should be relative to a differentially high tax burden on those other products. We therefore conclude that the proponents of the status quo for LPG should also support the equivalent of restoration of petroleum product excise indexation.

2.1.2 *Test 2 – Is LPG Less 'Bad' Than Other Petroleum Products?*

The case for a tax concession for LPG relative to other petroleum products requires evidence that:

- Use of LPG generates less harmful effects in terms of general environmental damage than close substitutes within the petroleum product group.
- Note that, to the extent that other close substitutes offer similar advantages, the same arguments apply to them. (In this context, there would in principle be a case for concessions for compressed natural gas (CNG) and for low-sulphur diesel relative to other diesel fuel.)

This is taken up in sections 3 and 4 below.

2.1.3 *Test 3 – Is LPG Price-Sensitive As A Substitute For Other Petroleum Products?*

The case for concessional tax treatment for LPG relative to other petroleum products – given evidence of its better consequences environmentally – also requires empirical evidence that demand for LPG is price sensitive:

- The relevant measure of price sensitivity must include the costs of the necessary vehicle conversion as well as the price of LPG versus close substitutes.
- Unless the evidence in this respect is clear-cut, the preferable option may be to treat LPG like other petroleum products (tax them highly, internalise the environmental costs of use and, at the margin, encourage reduced use). Passing test 3 is addressed in sections 5 and 6 below. Test 3 is a necessary, but not sufficient, condition for adopting concessional tax treatment for LPG. Test 4 below is also relevant.

2.1.4 *Test 4 – Is Concessional Tax Treatment The Most Effective Way To Encourage LPG Use?*

For completeness, it is necessary to demonstrate empirically that a tax concession, rather than some other form of encouragement, is the most effective way to encourage use of LPG rather than other petroleum products:

- If other forms of encouragement are similarly effective in encouraging a switch in demand, then it might be more efficient, and simpler, to apply the benchmark taxation treatment (see test 1 above) to all petroleum products, and use selective, non-taxation, incentives to encourage greater use of LPG.
- This is considered in section 6, and also in section 8 below.

2.1.5 *Test 5 – Is 100% Excise Exemption Warranted?*

The final test in the long run case for concessional tax treatment of LPG is probably the most difficult:

- Can it be demonstrated, using objectively verifiable data/evidence, that 100% excise exemption is warranted because of the relative benefits of using LPG *before* the introduction of the GST as part of the *New Tax System*?

- If so, has the introduction of the GST resulted in a sub-optimal incentive structure, because the tax concession for LPG does not extend to GST?
- Under current Commonwealth Government policy, if test 5 can be passed now, it will be inadequate over time (see discussion under test 1 above) and at some stage require the equivalent of petroleum product excise indexation to sustain the appropriate incentive structure.
- This test is effectively considered in section 9 below.

One of the problems with differential taxation is that technical changes – for example to motor vehicle engines and to petroleum products themselves – can alter the relative advantages of using particular fuels. These changes can alter the appropriate system of incentives as between different products.

Access Economics considers that all five of the foregoing tests should be passed convincingly to establish a principles-based, long run case for concessional treatment for LPG.

2.2 *THE TRANSITION CASE*

Regardless of whether or not LPG passes tests 1 – 5, there may be transition, or short run, tests that are relevant to how any change in current concessional treatment should be handled.

2.2.1 *Test 6 – Have Large Investment & Other Costs Been Incurred In Response To Current Concessions?*

Can it be demonstrated that substantial investment in the relevant equipment and distribution networks has been undertaken, specifically in response to:

- The tax concessions for LPG that existed prior to the introduction of the *New Tax System* and the subsequent abandonment of petroleum product excise indexation?
- The Government's stated rationale for the concession (inter alia, to encourage switching from other fuels to LPG)?

If the quantitative answer to test 6 is 'yes', then test 7 becomes relevant. Test 6 is considered in sections 7 and 8 below.

2.2.2 *Test 7 – If Current Arrangements Are Changed, Is There A Case For Compensation?*

If producers and consumers of LPG, acting in good faith in response to Government policy initiatives, have invested in ways favouring increased production and use of LPG, and the costs of doing so have been significant, there would be a solid *prima facie* case for compensation – and/or an appropriately long transition period – if it is decided to end the concessional tax treatment of LPG. Test 7 is considered in sections 7 and 8 below.

2.2.3 *Test 8 – What Would Compensation Cost? Is It Worth Incurring?*

If there is a case for compensation, the governments concerned will need to weigh up:

- the benefits of removing the current LPG concessions (primarily some net increase in tax revenue unless taxes are not reduced elsewhere); against
- the costs of removal (the cost of transitional compensation and, to the extent applicable, less favourable environmental outcomes).

Test 8 is considered in sections 7 and 8 below.

3. APPROACHES TO THE MEASUREMENT OF ENVIRONMENTAL BENEFITS

3.1 NATURE AND SCOPE OF THE ENVIRONMENTAL BENEFITS OF REDUCED GREENHOUSE GAS EMISSIONS

Greenhouse and other environmental and health impacts of reduced greenhouse gas emissions are hard to separate in practice, if not conceptually.

Emissions of various gases and particles can affect one or more of:

- productive capacity (e.g. reduced crop yields, deterioration of building materials)
- environmental amenity (e.g. impaired visibility due to smog, worse weather patterns)
- health (e.g. respiratory, toxic and carcinogenic effects).[2]

Conceptually, it makes sense to treat separately (i) greenhouse impacts from emissions of greenhouse gases by both consumption and by leakage, etc; and (ii) impacts on air quality through emissions of particle matter (which absorbs chemicals in the air), air toxics (poisonous chemicals) of various kinds, and other gases. The former in general are not geographically specific. The latter in general depend also on concentration/congestion factors and are therefore geographically specific. That said, in practice:

- Measures that can be justified on the grounds of greenhouse gas emission benefits can, and usually do, have some impact on other effects associated with concentration /congestion factors (eg, particulate and toxic emissions with health effects).
- While the latter might optimally be addressed using specifically-targeted congestion pricing instruments and the like, there is a 'joint product' effect on congestion-related emission problems arising from measures primarily targeted at greenhouse gas emission benefits only.
- Nevertheless, for purposes of the analysis in this Report, the 'benefit' part of the cost-benefit calculus conservatively concentrates only on greenhouse benefits, because, in Access Economics' opinion, it is only in this area that excise duty concessions for alternative fuels may have a role not better handled by congestion pricing and similar instruments.

2. Three classes of emissions may be considered:
   - Greenhouse gases, which comprise carbon dioxide, nitrous oxide, hydrofluorocarbons, methane, sulphur, hexafluoride, and perfluorocarbons.
   - Air pollutants, which comprise carbon monoxide, oxides of nitrogen, sulfur dioxide, non-methanic volatile organic compounds, and particles.
   - Air toxics, which include compounds such as benzene, aldehydes (formaldehyde and acetaldehyde), 1,3-butadiene, polycyclic aromatic hydrocarbons (PAH), toluene, and xylene.

The benefits of LPG use – or, equivalently, the costs of replacing its use by petrol or diesel fuels – are therefore taken to be generated by reduced production of greenhouse impacts compared with the corresponding impacts produced by use of petrol and diesel fuels.

Estimates of the relative impacts on greenhouse gases of LPG and other fuels used in transport can be produced by considering separately the damage caused by different fuel uses in:

- passenger cars
- light commercial vehicles
- medium trucks
- heavy/articulated trucks, and
- buses.

Differences in greenhouse impacts between these categories of vehicles are due to different average levels of fuel consumption, different types of fuel use (eg, petrol versus diesel, and the type of diesel), and different emission patterns (eg, due to different engine technologies).

3.2 QUANTIFYING THESE BENEFITS

In principle it is clearly desirable to assess the environmental costs of removing the LPG excise exemption in a manner consistent with the estimation of the tax-efficiency benefits.

In practice, this is easier said than done given the current state of the measurement art in relation to environmental effects.

At the very least this requires using a single unit of measurement such as dollars and a clear understanding of what economic variables are being estimated. However, as will be seen, this presents major practical problems.

3.2.1 Estimation Of LPG Excise Exemption Costs: Broad Approach

As a tax measure the current LPG excise exemption is automatically framed in financial and economic terms, i.e. in cents per litre, dollars of revenue forgone, etc.

The tax-efficiency benefit of removing the exemption – in terms of changes in the Commonwealth government's revenue mix and the flow-on effects throughout the economy – are consequently also able to be estimated directly in economic terms by use of a computable general equilibrium economic model (see sections 5 to 8 below). That is, a dollar amount can be assigned to the tax-efficiency benefit of removing the exemption.

That said, the estimation process is not easy or simple and relies on large amounts of data and knowledge of the economy, but any problems of measurement have already been solved, as far as they can be, in the construction of input-output tables, while the responsiveness of economic agents to changes in economic variables such as prices has already been incorporated in the model.

Any discussion of benefits must be in the context of some view about contributions to economic welfare or human utility; that is, about what it is that actually constitutes a benefit to the community.

In this analysis, the economy-wide tax-efficiency benefit is estimated as an increase in the scope for real consumption by Australian residents, the focus being on benefits to Australia and consumption being the economic activity that provides utility to people. Other economic measures such as production, income and investment are also included in this analysis – which considers the impact of removing the excise exemption on the economic well-being of the Australian community. But ultimately these are only of interest for the contribution they make to the community's ability to increase consumption, now and in the future.

The estimates presented in sections 6 and 8 below are derived in an ABS-based, national accounting/modelling framework that aims to capture the complex interactions between economic agents in their production of goods and services, earning and spending, saving and investment, etc, and ensures internal consistency.

3.2.2 Estimation Of LPG Exemption Benefits: Practical Pitfalls

When it comes to quantifying the environmental benefits of the current LPG excise exemption, the measurement story is much more difficult than modelling tax-efficiency costs. That said, a proper cost-benefit analysis must attempt both.

The principal benefits relate to reduced damage to the environment, specifically through reduced greenhouse emissions, and to human health, specifically through lower emissions of particulates and toxic gases. These benefits are typically expressed initially in physical rather than monetary terms, eg, in increases in crop production and reductions in illnesses. The scope of these physical impacts is enormous in terms of geographical extent, the time periods over which they are felt, and their pervasiveness across industry sectors and human activity.

But actually measuring the magnitude of these physical impacts is a huge task.

It involves judgements about what will happen well into the future (eg, in relation to global warming and changes in sickness and death rates) that require the application of many different scientific disciplines. Some of the impacts are directly economic in nature, such as changes in production and productive capacity, but even these may be difficult to measure and somewhat speculative because they result from a complex chain of events, eg, changes in rainfall and rises in sea levels.

Others, such as those related to environmental amenity and health, even if they can be measured, are not directly useable in economic models populated as they are at present by 'conventional' national accounting data sets that do not capture such effects very well, if at all.

In all cases, because we are dealing with an uncertain future – and not only are events uncertain but so is the science about how events are linked, and what causes will lead to what effects – risk ought to be brought into the analysis with the assignment of probabilities to various occurrences.

These difficulties relate to measuring *physical* environmental impacts. Once that hurdle is overcome, such measures must be translated into dollar effects.

Translating estimates of physical impacts into monetary units requires a whole further process of dealing with things that are undoubtedly of value but have no easily observed market values because they are not normally bought and sold. For example, environmental amenity and human life certainly have value but are not themselves the subject of transactions in markets, at least not directly (although some assets that provide environmental benefits may be bought and sold, and impacts on human health are typically estimated in terms of measures such as earning capacity).

In principle, it would be desirable to treat these environmental benefits within the same framework as is applied to the tax-efficiency costs, as described above. Ideally, this would involve using the same national accounting framework and accounting for the environmental benefits ultimately in terms of their impact on the community's capacity for real consumption. After all, the same logic that leads to using consumption as the measure of tax-efficiency costs applies equally to environmental benefits. Even if it may be conceded that not all benefits of the nature discussed above can be expressed in economic terms, many aspects of adverse environmental and health effects do impact on economic behaviour and are felt in reduced consumption.

An economic analysis of costs and benefits can in principle compare like with like, accepting that an economic analysis does not comprehend the whole set of impacts on human utility.

3.3 ENVIRONMENTAL IMPACTS IN A NATIONAL ACCOUNTING FRAMEWORK

A great deal of work has been done analysing the contribution of the environment to the economy and the impact of the economy on the environment.

A framework for doing this consistently is brought together in the revised United Nations *Handbook of National Accounting – Integrated Environmental and Economic Accounting* (commonly referred as SEEA, where the "S" stands for "System") currently in final draft and published jointly by the statistics agencies of the UN, the EU, the IMF, the OECD and the World Bank.

The ABS has discussed its work in this area in a feature article published with the September 2002 quarter national accounts.[3]

Traditional national accounts are criticised for including the value of goods and services produced and income generated through the use of environmental assets, but not the economic cost of depleting those assets or the environmental and other damage that arises from economic activity. This has long been recognised, along with other deficiencies such as the failure to capture the value of unpaid housework.

Much of the debate revolves around concepts of income and sustainability.

The Brundtland Commission defined sustainable development as ensuring that the needs of the present generation are met without compromising the ability of future generations to meet their own needs. This is closely related to the economic concept of income. Hicks defined income as the maximum amount an individual can consume during a period and remain as well off at the end of the period as at the beginning.

3. See Australian National Accounts: National Income, Expenditure and Product ABS Cat. No. 5206.0, September Quarter 2002, Feature Article – Accounting for the environment in the national accounts.

The acknowledgement that this definition applies as well to a nation or community as to an individual leads to an interpretation of sustainability in terms of different types of capital. That is, as development that ensures non-declining per capita national wealth by replacing or conserving the sources of that wealth; that is, stocks of produced, human, social and natural capital. Standard national accounting measures of income therefore fall short in terms of the Hicks definition when considered in the light of sustainability.

It is the capital approach to sustainability[4] that the SEEA addresses. Natural capital provides three types of contributions to the economy:

- Resources that can be converted into goods and services.
- Sinks that can absorb unwanted by-products of production and consumption.
- Services for survival, such as air and water, and to provide amenity contributing to leisure, such as pleasing landscapes.

If stocks of natural capital decline to the point where they are no longer able to provide any of these functions, the pattern of development relying on these contributions cannot be sustained – it must change so as to eliminate the need for the particular natural capital service or find a way of replacing the natural capital service with a service from produced capital (e.g. replacing a river as a natural sink for sewage with sewage treatment).

Of course, this leaves much room for debate about the degree of substitutability between natural and produced capital, with corresponding principles of weak and strong sustainability. Strong sustainability in particular leads to precautionary principles regarding use of natural resources.

The valuation of environmental stocks and flows is difficult because environmental assets are often not controlled by economic agents, are provided at no measured or measurable cost, and are not explicit (eg, via prices) in transactions.

The SEEA describes itself as dealing with a range of issues including:

- Physical and hybrid flow accounts in which physical data on environmental resources are aligned with economic classifications in a national accounts framework so that the use of environmental resources in the economic processes of production can be traced. Emissions accounts for greenhouse gases are an example, but, as currently presented they do not help with the question of deciding what damage greenhouse emissions do, or the degree to which they should be reduced.
- Measuring the impacts on the environment of economic instruments such as taxes, permits and expenditures.
- Asset accounts for natural resources, land and ecosystems, taking account of depletions and discoveries.
- Valuing degradation and bringing it explicitly into the national accounts.

4. Other approaches include the premise that economic, social and environmental systems must be simultaneously sustainable; or, alternatively, that sustainability of the environment is paramount and that the property to be sustained is the capacity of ecosystems to respond with resilience to external perturbations and changes.

It is primarily the last of these areas that deals with environmental externalities such as greenhouse emissions. Unfortunately this area is also the most difficult and least developed.

The SEEA distinguishes between cost-based and damage-based valuations and notes that generally only the costs, and not the benefits, of a given policy towards the environment can be determined with any confidence. Often acceptance of the concept of sustainability leads to a policy goal, with the issues then being adequately to quantify that goal and then to find the most efficient way of achieving it.

For emissions, cost-based methods concentrate on the alternatives of avoiding emissions, capturing them, or restoring the environment afterwards. Damage-based methods measure the relationship between exposure to emissions as a cause and specific outcomes as an effect, and then try to value the effect. Valuation may require use of willingness-to-pay techniques using market prices to the extent possible.

Degradation or damage is not generally captured in the national accounts, although land degradation is an exception and consequences such as health expenditures are included (though not separately identified). Going the final step of integrating damage estimates into national accounts could conceptually be done via a wealth approach or an income approach. The SEEA explains why these approaches are not easily made consistent.

The issues involved go far beyond ex-post accounting/reporting and enter into a realm that national accountants are uncomfortable with, dealing as it must with hypothetical situations and speculation/forecasting about future effects.

3.4 ALTERNATIVE APPROACHES TO MEASURING THE GREENHOUSE BENEFITS

With all the difficulties involved, and given the current state of the measurement 'art' in this area, treating the costs and benefits of removing the LPG excise exemption in a consistent national accounting framework is practically impossible.

Nevertheless, it is possible to make estimates of avoided greenhouse gas emissions (and other emission-related impacts). There are then basically two ways of translating these estimates into monetary units for comparison with the estimated tax-efficiency consumption costs of the current LPG excise exemption:

- The various forms of damage to the environment and the economy can be traced through, estimated in monetary terms and aggregated. This depends on having sufficient understanding of causes and effects across a wide range of economic activities and natural processes. Note that the environmental cost of removing the exemption is the same as the damage avoided (a benefit) by leaving it in place, in each case associated with a certain additional level of emissions caused by removing the exemption.
- Alternatively, the environmental benefit derived by leaving the exemption in place can be measured as the opportunity cost of choosing the exemption as the means to achieve the emission reduction. The opportunity cost of the exemption is the cost of the least expensive alternative way of achieving the same reduction in emissions. Thus, in principle, achieving a reduction in emissions should only

be given the value of the cheapest possible means of achieving that outcome[5]. (Note that this turns the question around: the greenhouse benefit of not removing the exemption is compared with the tax-efficiency cost of the exemption in forgone consumption.)

The second approach has the advantage that it requires comparison of the environmental cost of removing the concession not only with the tax-efficiency economic benefits of doing so (an increase in consumption) but also with the costs of alternative means of achieving the same policy outcome.

In one practical way the opportunity cost approach is far more complicated. In principle it requires a consideration of all possible alternative ways of achieving greenhouse gas emission reductions. On the other hand, for each such course of action, only the economic efficiency costs – typically economic costs fairly readily estimated, such as forgone consumption – of that action need to be estimated rather than the economic costs of physical damage, which as mentioned above is so difficult.

In this way of looking at the issue, a reduction in greenhouse emissions is taken as a given policy objective that could be achieved in various ways. The whole question of whether or not the reduction in emissions is worthwhile is begged. Nevertheless this may well be the way in which the issue can be practically approached from a policy perspective. For example, governments may be persuaded that the risk of global warming due to additional greenhouse emissions is substantial and that a reduction needs to be achieved, eg, to a previously prevailing level.

If good estimates of the greenhouse costs of removing the exemption are available and are no less than the tax-efficiency economic benefits of removal, the question would remain whether the current LPG excise exemption was the best means of achieving its objectives.

However, in this context, if it is:

- taken as given that the government seeks to achieve a reduction in greenhouse gas emissions; and
- given also that the LPG excise exemption is already in place and has been for many years, and industry and consumers have made investment and consumption decisions, in good faith, on the assumption that the exemption will remain; and
- if it is accepted that the current LPG exemption results in a reduction in greenhouse emissions, as sought by government policy

then it follows that the transitional costs in removing the current LPG excise exemption also come into the cost-benefit calculus.

In all cases, ideally, the costs and benefits should be capable of expression as forgone consumption equivalents.

5. Since greenhouse emissions have global impacts, and reductions in any location have the same beneficial effects, it could be argued that the opportunity cost alternative should be global in scope. That is, the relevant measure is the cheapest possible means of reducing greenhouse emissions anywhere in the world. This raises issues of where the marginal reductions occur and at what cost. Given that large reductions are sought, a practical approach may be to seek an estimate of the average cost of abatement. It is of course the issue of achieving reductions across various means at lowest cost that leads to proposals for emissions trading.

4. CURRENTLY-AVAILABLE ESTIMATES OF ENVIRONMENTAL BENEFITS OF LPG USE

4.1 *ASSESSING COST ESTIMATES*

Under either of the approaches set out in section 3 above, at the outset we note that Access Economics is not in a position independently to verify cost estimates. We must rely on the scientific and other expertise of others in this area.

In either of the approaches set out in section 3 the first steps involved are to estimate:

- the change in behaviour attributable to a hypothetical removal of the LPG excise exemption, e.g. the degree to which petrol consumption replaced LPG consumption; and
- the relevant physical impacts of the change in behaviour, eg, the increase in greenhouse emissions associated with substitution of petrol for LPG.

It is generally accepted that the LPG excise exemption has stimulated consumption of automotive LPG and that all or almost all of this consumption replaces petrol consumption. This is supported by claims that decisions about conversion of engines to LPG usage and of investment in engines designed for LPG use are price sensitive.

The facts that:

- excise exemption involves a very large price advantage for LPG at the pump – not just a marginal advantage; and
- users are prepared to pay the up-front capital cost for motor vehicle conversion;

seem to support this contention.

Estimates of the greenhouse emissions attributable to different fuels are readily available and, being determined by chemical composition, are not really in dispute. Estimates of the greenhouse emissions actually attributable to LPG substitution bring in considerations of engine technology, mainly efficiency.

Numerous studies show that for light vehicles LPG has a substantial greenhouse advantage over petrol. This advantage does not carry over to a comparison with diesel-powered heavy vehicles. Estimates of the advantage vary widely, but the ALPGA has taken the approach of using actual fuel consumption figures in Australia to make comparisons, which accounts only for the impact of tailpipe emissions through combustion. The ALPGA mentions an advantage of 10 per cent on this conservative basis – see further comments below on the full fuel life cycle approach.

For other than greenhouse emissions, the effects of engine technology and mode of driving are much more complex. However, it is understood that LPG produces much lower emissions of air toxics than petrol and diesel.

In the case of greenhouse emissions, the 'cost of damage approach' requires that the reduction in greenhouse emissions due to use of LPG (or the increase due to substitution back to petrol following removal of the excise exemption) be multiplied by an estimate of the marginal damage cost per unit of greenhouse emissions.

The hard part, as already discussed, is finding an estimate of the per unit damage cost.

This is another area where considerable research has been undertaken, including by governments in the context of possible carbon taxes, emissions trading and the Kyoto Protocol. Again, a wide range of estimates exists, depending on modelling approaches and assumptions. The ALPGA has used a figure of $40 per tonne of CO_2 sourced to a paper prepared for Environment Australia by The Allen Consulting Group[6]. The paper attributes the estimate to the authors. The basis on which the estimate is made is not spelled out in detail; it is described as a 'cost of carbon'. On the basis of inquiries of the authors, we understand that the estimate is in fact an estimate of CO_2 abatement costs.

Using this figure, the ALPGA estimates the greenhouse benefit of the LPG excise exemption, in terms of vehicle consumption, as $17.9 million per year for CO_2 alone and $43.1 million per year taking other greenhouse gases into account.

As explained by the CSIRO[7], in considering an issue such as the impact of substituting LPG for other fuels, it is desirable to consider the full fuel-cycle effects rather than just the emissions from transport vehicles. This includes emissions from the upstream processes of extraction, production, transport, processing, conversion and distribution. These upstream emissions should be added to the downstream, or tailpipe, emissions to obtain the full fuel-cycle (or 'well to wheel') emissions.

The CSIRO study found that, for light vehicles, the pre-combustion emissions from LPG are about 20 per cent lower than from unleaded petrol, and with a significantly greater advantage for LPG in the case of non-greenhouse emissions. (In an earlier study for heavy vehicles, the CSIRO also found that, on a full fuel-cycle basis, LPG had lower emissions than diesel for all pollutants studied.)

Adding this benefit to the tailpipe emission benefit estimated above would produce an annual estimated greenhouse gas emission benefit of more than $43 million or so per year in avoided greenhouse gas emissions if the abovementioned tailpipe-based estimates are correct[8].

In the case of health impacts, the cost of damage approach requires that the reduction in other emissions – particulates and toxic gases – be multiplied by estimates of the cost per unit of emission. This the ALPGA has done in its submission to the Commonwealth Fuel Tax Inquiry, using cost estimates attributed to various sources. We note that by far the greatest impact is due to PM_{10}; that is, particle matter less than 10 microns in size, with estimates ranging from $140,000 to $240,000 per tonne.

6. The Allen Consulting Group, *Fuel Quality Standards Liquefied petroleum Gas: Cost-Benefit Analysis of Options for Standard and Implementation*, September 2002. We understand that this estimate has been accepted as reasonable by Environment Australia, although, based on more recent information, its authors consider that it may be, if anything, on the high side, and an estimate of less than $40 per tonne of CO_2 might be more accurate.

7. Tom Beer, Tim Grant and Harry, Watson, *Life Cycle Analysis of Emissions from LPG Light Vehicles: Part 1 – Pre combustion Emissions*, pre-publication copy of a Report to the ALPGA, March 2003. We note that the CSIRO intends to augment this pre-combustion emissions study with a separate, subsequent study on combustion emissions. This should provide additional evidence for assessing the full life cycle analysis of relative emissions from LPG use in light vehicles.

8. Other evidence that this estimate may be conservative can be found in overseas full fuel life cycle analysis, quoted by the World LPG Association, giving ranges of emission reductions from Autogas compared to gasoline of from 7 to 33 per cent, with an average of 22 per cent.

The total health impact ranges between $137 million and $680 million per year. A more recent estimate cited in The Allen Consulting Group paper is $29,000 per tonne. This is sourced to the NSW EPA[9]. Even this much lower figure would give a minimum estimate of $36 million for the health benefit due to reduced particulates.

As pointed out in the ALPGA submission, the health impacts of vehicle emissions are not pervasive – like greenhouse impacts – and accordingly the estimates are calculated only for urban vehicle use.

A remaining question is what the opportunity cost of the LPG excise exemption might be as a means of achieving the non-greenhouse health-related emissions. That is, if these problems can be better addressed using other instruments, what is the net cost, *in relation to these problems*, of relying on the LPG excise exemption instead. This issue is not addressed in this Report.

4.2 PUTTING A DOLLAR VALUE ON GREENHOUSE BENEFITS OF LPG USE

The benefits of greenhouse emission abatement have been the subject of a very large body of work, both scientific analysis and economic modelling. Similarly, health effects of vehicle emissions are a specialised area. Access Economics does not have a view on the various estimates that are extant in these debates. The above discussion does, however, throw some light on comparisons of costs and benefits.

The estimated tax-efficiency economic benefit of removing the excise exemption is considered in sections 5 and 6 below.

There appears to be little doubt that LPG usage consequential on the excise exemption does result in lower greenhouse gas emissions, and that switching away from LPG to petrol and diesel would come at the cost of increased greenhouse gas emissions.

(Health costs associated with reduced LPG usage may bolster the argument for maintaining the exemption, in that they constitute 'joint costs' with increased greenhouse gas emissions, although these are not considered for this purpose in this Report. However, if they are so used, policy makers need to apply credible estimates. If significantly cheaper or more efficient means of achieving the reduced health-impacting emissions are available, the costs of doing so by those means should be used as the estimates of the health cost of removing the exemption.)

For the purposes of evaluating the greenhouse gas emission benefits of retaining the current LPG excise exemption, Access Economics assumes that:

- On a 'cost of carbon' full production/combustion fuel-cycle basis, the use of LPG instead of petrol or diesel in Australia might produce a greenhouse gas avoidance benefit of the order of, say, $30 to $50 million per annum at the present time.
- Strictly speaking, this dollar measure is not comparable with the 'forgone consumption' ideal. However, we make the further assumptions that:

9. NSW EPA, *Regulatory Impact Statement, Proposed Protection of the Environment Operations (Clean Air – Motor Vehicles and Motor Vehicle Fuels) Regulation 2002.*

- this greenhouse gas avoidance benefit is equivalent to the additional income that would have to be allocated to greenhouse gas abatement costs in the absence of the current LPG excise duty concession;
- this cost is economy-wide, and therefore fully accounts for, greenhouse abatement costs;
- in the long run, other investment continues, and, net of saving to finance that, all income is consumed;
- and therefore this estimate can be equated with forgone consumption if the current LPG excise concession is removed.

It is on the basis of these assumptions that the abovementioned estimates of greenhouse benefits of the current LPG excise concession are compared directly with the tax-efficiency costs of the concession in section 9 below.

We recommend that these greenhouse benefit estimates be revisited in the light of the results from the latest authoritative studies, including the forthcoming CSIRO study on the benefits in relation to fuel combustion in light vehicles using LPG relative to other fuels.[10]

Access Economics considers that there is clear evidence that test #2 set out in section 2 above is passed in a technical/scientific sense. Putting dollars on the net environmental benefits is more problematic for the reasons discussed above. These need to be regularly reviewed as part of an ongoing research program in this area.

5. TAX EFFICIENCY COSTS OF CURRENT LPG EXEMPTION: OVERVIEW

5.1 THE TWO CASES FOR DIFFERENTIAL PRODUCT TAXATION

As noted more fully in Attachment C below, in the case of indirect taxation, a practical rule of thumb is, as far as possible, to apply a uniform ad valorem tax rate to the broadest possible tax base. This allows the lowest applicable tax rate for any given revenue target.

There are two major cases where departures from this indirect tax design prescription may be warranted[11].

5.1.1 The 'Optimal Taxation' Case: Efficient Revenue Collection Via Unresponsive Demand

A case for differential taxation – including taxation applied to products – can be made in the interests of the efficiency criterion for good tax design. This case is based on:

- taxing products to raise the revenue required;
- but choosing the products to be taxed to minimise taxpayer responses – economic distortions – thereby helping to avoid the 'deadweight losses' associated with taxation.

10. We assume this Report will be entitled something like *Life Cycle Analysis of Emissions from LPG Light Vehicles: Part 2 – Combustion Emissions.*
11. The following material in sub-sections 5.1 and 5.2 is extracted from Attachment C.

Optimal commodity taxation was first proposed by Frank Ramsey in 1927. The theory suggests that the efficiency cost (or 'excess burden') of taxation is minimised if taxes on products are levied such that the quantity demanded of each good or service is reduced by the same percentage. In practice, the rate of tax on each product should be inversely proportional to the price elasticity of demand. For goods insensitive to price movements, a high rate of tax would be applied, as quantity demanded does not move significantly in response to price changes, and conversely.

Ramsey pricing suggests that higher taxes be levied on goods and services that are not sensitive to price changes, with lower taxes on those products sensitive to price changes.

The practical application of Ramsey pricing would require detailed and accurate information on own-price elasticities and cross-price elasticities (a measure of the extent to which goods are complements or substitutes) for goods and services. This is difficult and costly to obtain and update, at best.

Note also that in some cases a Ramsey taxation approach appears to be the *antithesis* of what is required in the context of proposals to discourage use of 'bad' products and encourage use of 'good' products[12]:

- the whole focus of high, differentially-applied, Ramsey-optimal taxes is on products whose consumption will *not* be altered much as a result of such imposts;
- that is, the purpose of optimal taxation is to maximise tax revenue, *not* to alter taxpayer behaviour.

5.1.2 'Market Failure' Cases: Correcting Market Distortions

An alternative case for differential taxation exists where there is some problem ('market failure' or 'negative externality' in the economists' jargon) that is amenable to correction via the imposition of a particular selective tax measure.

In this case the object of the exercise may be twofold:

- to ensure the social costs arising from consumption or use of a 'bad' product are paid for by those using that product; or, going further than that
- seeking to 'distort' – that is, alter – taxpayer behaviour in a way that reduces or eliminates the use of the product causing the externality, thereby producing an 'optimal' outcome.

The Government currently imposes differential (higher) excise and other taxes on goods such as alcohol and tobacco products ostensibly to account for the social costs of their use. It is also often suggested that the relatively high indirect taxation of fuel is motivated by a desire to accommodate the (otherwise uncaptured) social costs of fuel use. While the actual level of tax on these products may reflect other motivations (such as a desire to raise more revenue) the economic case for imposing a volumetric excise or other tax on particular products is often claimed to rest on this 'negative externality' argument.

12. This difference may be more apparent than real in some cases. For example, if the object of the differential tax is simply to ensure that social costs are fully paid by the agent producing them, then an appropriately high tax rate on the product whose consumption generates the social costs could be applied to ensure that the purchaser pays for such social costs. It is where the policy objective goes further, seeking to *reduce* consumption of a specific 'bad' product, that the conflict arises.

Externalities refer to 'spillover' costs (or benefits) that accrue to third parties/society in addition to the direct, private costs borne by the consumer. The direct consumer does not take these externalities into account when deciding what quantity to consume. In such cases, consumption will tend to be larger than is optimal from society's point of view. An externality tax seeks to eliminate the difference between the private and social cost facing the consumer.

More generally, we note that, where the 'externality correction' strategy is aimed at reducing use of the product involved, it:

- requires taxpayers to be price-sensitive in demand, so that tax-induced price differentials, significantly affect demand and encourage a switch in demand away from the higher-taxed products; and
- is the antithesis of the 'optimal taxation' approach; and
- is not designed to raise tax revenue; and
- like optimal taxation, it will inevitably add to the complexity – reduce the simplicity – of the tax system.

5.2 THE POTENTIALLY-CONFLICTING ROLES FOR DIFFERENTIAL PRODUCT TAXATION

The preceding two sub-sections of this Report expose the potential conflict between the revenue objective of the optimal taxation approach and the ability to actually change behaviour.

If behaviour doesn't change, then, while the social cost of fuel consumption may be covered (and incorporated into decision making) there would not be a reduction in the ill effects of fuel use, such as respiratory disease and CO_2 emissions.

5.3 THE TAX-EFFICIENCY CASE FOR REMOVING THE CURRENT LPG EXCISE EXEMPTION

Sections 3 and 4 effectively dealt with the market failure case for differential taxation of LPG, where the focus was on applying a tax concession to LPG relative to a high excise burden on petrol and diesel in order to encourage a switch in demand to LPG.

The externality being addressed was greenhouse gas emissions and associated environmental damage.

In sections 5 and 6 we deal with the alternative case for differential fuel taxation: apply a high and uniform rate of tax to all fuels used in transport to raise tax revenue more efficiently.

Under this perspective, the current LPG exemption constitutes a policy-induced 'hole' in an otherwise-efficient tax base, the plugging of which would generate net benefits to the economy.

5.3.1 Is High Uniform Taxation Of Transport Fuels Tax-Efficient?

The reasons why high excise taxation of transport fuels may be regarded as tax efficient are as follows:

- Demand for these products as a group is relatively (own) price-inelastic: raising price induces relatively small reductions in total quantity demanded. Behaviour is not much affected by the imposition of the tax, especially in a transport dependent country like Australia.
- The taxation points for an excise on fuel production, especially in Australia, are very few. Australia has a handful of refineries (and arguably still too many), and a relatively small number of bulk product importers (which pay a 'revenue' customs duty matching the local production excise). For this reason, the costs of collection, administration and compliance with the excise duty regime are relatively low.

Note that, in one sense, these features of transport fuel demand and the operational characteristics of fuel excises allow a (sort of) 'win-win' outcome:

- In general, tax-efficiency dictates high rates of tax on transport (and other) fuels.
- Within this high-tax environment, differential taxation of close substitutes – like LPG – can generate powerful demand substitution effects towards the favourably-taxed substitute.
- That is, while the *own-price* elasticity of demand of transport fuels as a group may be low, cross-price elasticities of demand between close substitutes *within* the group can be very high.
- So high taxation of the fuels group as a whole, plus low (or no) taxation of environmentally-preferable substitutes within the group, can:
  - generate high revenue collections, at least initially; and, over time
  - shift demand in environmentally productive ways and in so doing provide an externality offset to the loss of efficiency in the fuel tax system.

The question is: how large are the tax-efficiency losses from allowing the current LPG fuel excise exemption?

5.3.2 *Constructing The Correct Long Term Simulation*

The first point to be made in response to this question is that the losses should not be measured simply by reference to the annual revenue forgone.

Notwithstanding this 'revenue forgone' short term Commonwealth Budget treatment of tax concessions[13], in the long term, the appropriate measurement of the tax-efficiency losses of a given tax concession requires a model simulation that:

- is 'general equilibrium' in nature – that is, takes into account all the market and resource constraints within which an economy must operate; and
- assumes that any given change in tax rates is offset by other changes, including other tax rates, to ensure a sustainable public sector budget position.

This is a crucial point.

If we wish to construct a model simulation that looks at the tax-efficiency benefits

13. See, for example, The Treasury, *Tax Expenditures Statement* issued annually.

(exclusive of environmental costs) of removing the LPG excise exemption, we need to generate net community benefits by using the revenue so gained to finance similar reductions in (less efficient) taxes. So the net gains to the community (in a tax efficiency sense) come from:

- removing the current LPG excise exemption
- reducing another Commonwealth tax – realistically, post-GST, income tax – to preserve long term Budget balance.

This leads to the point that the *net* tax efficiency gains from removing the current LPG excise exemption are likely to be substantially less than the revenue cost (tax expenditures) associated with this concession:

- the proper long term model simulation involves shifting the revenue-raising effort at the margin from a less efficient tax base to a more efficient tax base;
- but all real-world taxes are inefficient to a greater or lesser degree;
- our modelling does indeed suggest that excise duty, in general, is a more efficient tax than income taxation (a little more than *twice* as efficient, in terms of associated 'deadweight' economic losses);
- but the net gain to the community from switching from income tax to excise duty is likely to be more closely linked to the *tax-efficiency differential* between the two taxes than to the annual cost to the revenue of the current LPG excise exemption.

And even this efficiency gain needs to be modified.

5.3.3 Some Inefficient Features Of Fuel Excises

While operationally quite efficient, fuel excises have features that make them undesirable as well:

- They apply to a widely used, pervasive, business input.
- In general, taxation of business inputs is inefficient and undesirable: this is a major selling feature of the GST, which usually provides input tax credits (ITCs) for GST paid by businesses when they purchase goods and services for business use.
- In general, excise duties do not come with ITCs for business use of the products involved (some diesel use aside).
- As a result, the excise duty burden on fuels 'cascades' – accumulates and compounds – down the value-added production chain.

Ironically, this exposes an Achilles' heel of fuel excise:

- if demand for fuel as a group is own-price inelastic;
- then customers do not switch away from fuel as a group use very much when prices rise;
- so removing the current LPG exemption increases the distorting, inefficient, cascading effects of the current excise regime applying to other products; and

- conversely, when demand for fuels as a group is more own-price sensitive, these efficiency-damaging effects of fuel excise are reduced because demand switches away from fuel to a greater extent.

5.4 THE MODELLING: WHAT SHOULD WE EXPECT?

Based on the comments in sub-section 5.3, Access Economics concludes that general equilibrium modelling of the tax-efficiency costs of the current LPG excise exemption:

- is likely to produce net community benefits substantially less than the annual budget cost of the current LPG excise exemption;
- from a purely consumer 'deadweight loss' perspective, the community gains are likely to rise as the assumed own-price elasticity of demand for fuels *as a group* approaches zero;
- but, allowing for the producer inefficiency features of fuel excise, the tax efficiency community gains might be compromised as fuel demand becomes less responsive to price as a *business input* as well;
- the net effect of consumer deadweight losses and producer inefficiency effects is an empirical matter: either could dominate.

6. QUANTIFYING ECONOMY-WIDE COSTS OF THE CURRENT LPG EXCISE EXEMPTION

6.1 SETTING UP THE AE-CGE MODEL

Access Economics has used its computable general equilibrium model *(AE-CGE)* to estimate the economic impact of eliminating the current LPG excise exemption completely.

The *AE-CGE* model is an industry-level model of the Australian economy developed by Access Economics utilising advanced microeconomic theory. The standard version of *AE-CGE* models 26 broad industries, including details of production, profit, employment, trade and consumption within these industries.

Information on the model and the assumptions used in the modelling is provided in Appendix A. The model is based on Australian Bureau of Statistics input-output data, updated to include the 1 July 2001 version of the *New Tax System.* The *AE-CGE* model contains no time dimension, and is designed for 'comparative statics' analysis. The results can therefore be regarded as potential impacts in the 'long run'.

6.1.1 The Data

We use as our starting point a table, derived from ALPGA data and confirmed by ABARE, of the supply of LPG from refineries, natural sources (oil and gas) and imports, and its use as autogas and for traditional purposes (cooking, heating, etc). Although the focus of the study is on autogas we felt it necessary to include both types of LPG because they are both mixes of propane and butane that are produced jointly, and there was the possibility that we would have to allow for switching product from autogas to traditional LPG use.

The following table summarises the situation in 2002.

Table 6.1.1 Production And Consumption Of LPG In 2002, Kilotonnes

	Autogas	Traditional LPG uses	Exports	Total	Share of domestic production
Domestic refinery	700	100	0	800	25%
Domestic natural oil and gas	425	345	1630	2400	75%
Imports*	75	255	0	330	
Total	1200	700			
Share of domestic consumption	63%	37%			

Source: ALPGA

* Imports are required to manage local supply logistics, but all imports are offset by corresponding exports from a national perspective.

We assume that, following the removal of the current LPG excise exemption, the same amount of crude oil is processed in Australian refineries, but the composition of the refined products and/or the demands for the refined products may change. Replacement of 1.00 tonne of autogas would require about 1.07 tonnes of petrol to provide the same energy content (derived from ABARE, *Energy Projections to 2014-15,* page 65). We assume that 1.00 tonne of this petrol would be provided from domestic refineries and the shortfall of 0.07 tonnes from imports.

6.1.2 Autogas, Propane And Butane

LPG consists of propane and butane. The mix of propane and butane varies across oil and gas fields and, in the case of refineries, varies across crude oil supplies and the settings for the refining process (with different amounts of adjustment available at different refineries). The gases are traded separately internationally as propane and butane. Australia tends to import mainly propane, especially into eastern Australia, and export propane and butane. Note that there are both exports and imports of autogas components because, when the cost of coastal shipping is taken into account, LPG wholesalers on the east coast find it cheaper to import LPG than to ship it around the coast from Western Australia.

LPG used for traditional purposes is 97% propane. LPG used as an automotive fuel can be either propane or a mix of propane and butane. Autogas allowed under Australian fuel specifications ranges from a mix of 40% propane and 60% butane, up to 100% propane. It is generally supplied as a 50:50 mix or 100% propane. For the purpose of this Report we have assumed that autogas consists of 60% propane and 40% butane. Natural gas producers separate the gas into propane and butane streams that are then mixed to produce autogas. However, refinery LPG is used for autogas without any separation, although there is some lesser processing to remove impurities and to achieve regulatory standards.

The production and consumption data in tonnes were converted to dollar values in 2002 using average world prices for propane (A$463/tonne) and butane (A$435/tonne) from the DITR LPG Fact Sheet. Using a mix of 60% propane and 40% butane for autogas gives an average price in 2002 of $452/tonne, while a mix of 97% propane and 3% butane for LPG used for traditional purposes gives an average price of $462/tonne. Prices in 2002 are assumed to be a reasonable representation of prices after the Iraq situation stabilises.

We scaled the 2002 values back to 1996-97 using the ratio of nominal GDP in the two periods. This takes account of general rates of growth in prices and quantities. Its purpose is to insert the 2002 LPG data into the 1996-97 input-output (IO) framework. In terms of the relationships between the various entries in the IO table it is equivalent to scaling all values in the IO data, other than for LPG, from 1996-97 to 2002. This process leads to LPG dollar values in 1996-97 that are similar to those in the 1996-97 IO commodity detail data, in spite of significantly greater use of autogas in 2002.

6.1.3 Selection Of Industries

In its standard configuration, AE-CGE uses about 26 industries that are formed by aggregating the 106 industries in the ABS input-output (IO) tables. Petroleum products and alcoholic beverages plus tobacco products are treated as separate industries because of the excise arrangements for these industries in the *New Tax System*. We then create separate industries as appropriate for each project.

LPG occurs in two separate places in the ABS IO tables. Natural LPG is a component of the coal, oil and gas industry in the mining sector, while refinery LPG is part of the petroleum products industry. Conceptually, we have combined these two sources of production into one LPG industry. We have then split the LPG industry into separate industries according to use – autogas and traditional LPG.

Petrol that substitutes for autogas after the removal of the LPG excise exemption is included in the autogas industry which becomes the autogas/petrol industry.

We have thus created an artificial set of petroleum products and LPG industries where there is really joint production. Petrol is in fact produced in only one industry but for our purposes it occurs in both the petroleum products and autogas/petrol industries. The LPG components (whether propane and butane, or autogas and traditional uses) are really produced jointly in the coal, oil and gas and petroleum products industries, but for our purposes they are produced separately in the autogas/petrol and traditional LPG industries.

Excluding petrol substitute, AE-CGE as configured in this Report used 28 industries.

6.1.4 Forming The AE-CGE Database

The sales patterns across industries and household consumption for autogas were derived from ALPGA quantity shares of private use (47%), taxis (22%), business light commercial vehicles (LCVs) (15%), and business cars (16%). We then mapped these into the AE-CGE industries, giving preference to business services (leased vehicles), communication (couriers) and construction (trades).

The sales pattern for traditional uses of LPG is based on 2002-03 energy consumption data in Table C1 of *Australian Energy: Market Developments and Projections to 2014-15*, ABARE Research Report 99.4. We exclude the ABARE value for transport which covers all use of autogas, whether by the transport sector, households or other users. We split the ABARE total value for service industries with some help from the IO commodity details for LPG (natural plus refinery) in 1996-97. The sales derived for the new industries were then subtracted from the mining and petroleum products industries from which they were derived.

Total quantities supplies for the new industries are set equal to total sales less imports. The compositions of quantities supplies are appropriately weighted sums of the mining and petroleum products industries. These quantities supplies are then subtracted from the mining and petroleum products industries from which they were derived.

The IO data contain entries at basic values, together with commodity taxes, subsidies and margins of various types associated with each basic value cell. For the ALPGA CGE database we have aggregated the margins into three types – wholesale and retail, road transport, and other transport. Margins data are stored separately for households and exports so that they can be used to generate values at purchasers' prices that are required for behavioural relationships.

An important parameter of the model is the own-price elasticity of demand for LPG and petrol as a group. We have investigated solutions using –0.1, –0.3 and –0.5. This elasticity is assumed to affect both private consumption and business use. Imposition of an excise on autogas increases the price of autogas (and/or its replacement by petrol) leading to reduced demand for autogas/petrol as a group.

6.2 MODELLING APPROACH AND SCENARIOS

6.2.1 The Long Run Modelling Approach

Starting from an initial equilibrium solution, the AE-CGE Model computes a new equilibrium solution as a result of changes applied to the model. The values in the database correspond to annual flows.

Important assumptions underlying the long run modelling results include the following:

- The exchange rate for the $A adjusts to maintain a fixed balance of trade.
- Income tax rates for individuals and businesses adjust to ensure that government revenue equals government current expenditure plus transfers. The public sector budget remains in balance. An increase in excise duty initially increases government revenue (although this is partly offset by decreased demand) which is then offset by reduced income tax rates and hence increased household disposable income.
- Aggregate employment is held constant with wages adjusting to clear the labour market.

6.2.2 The Taxation 'Shock'

The driving force behind the modelling is the introduction of an excise on autogas at a rate of 38 c/litre.

The ALPGA advises that we should use pump prices (purchasers' prices) of 40c/litre for autogas and 80 c/litre for petrol as likely retail prices after the war in Iraq. These are close to the prices in 2002. Noting that the energy content of 1 litre of petrol is the same as that of 1.28 litres of autogas, the cost of autogas that is equivalent in energy to 1 litre of petrol is really 40 x 1.28 c/litre = 51.2 c/litre.

Introduction of an excise of 38 c/litre on autogas increases this price to 78 x 1.28 = 99.8 c/litre. We assume all users would switch to petrol at 80c/litre.

We understand that it is Government policy to give five years' warning of any change to the excise concession for autogas, and that this five years rolls forward every day. Assuming this policy is sustained, there is no question of an unexpected change literally over night (although an *announcement* of a future change could so occur). Demand would switch totally from autogas to petrol from the time the excise on autogas applied, and much of the switch would occur earlier. The demand for the substitute petrol would be lower than original equivalent demand for autogas because of the price increase for petrol/LPG as a group, with the response depending on the own-price elasticity of demand for the petrol/LPG fuel group.

The initial domestic supply of autogas is 62% from refineries and 38% from natural sources. The quantity supplied from natural sources is assumed to be diverted to exports. In the transition period (see sections 7 and 8 below) the refinery supply of autogas would be diverted to exports. In the long run the refineries would change their output mix to produce petrol in place of autogas. In all cases imports are determined as a residual equal to domestic consumption plus exports less domestic production. Imports of petrol are smaller in the long run because refineries replace autogas production with petrol production.

Elimination of the demand for autogas would result in zero imports of autogas. We assume that all autogas supplied by domestic oil/gas producers would be diverted to exports in the form of propane and butane.

The situation for refineries is quite different. We are advised that they convert crude oil to gasoline, diesel, fuel oil, jet fuel and LPG in essentially fixed proportions. The proportions, and in particular the proportion of LPG, can be changed by using a different type of crude oil or by adjustments to the refining process. The range of adjustment for existing Australian refineries is insufficient to accommodate a large reduction in LPG production in the short term. (Thirty years ago the refinery mix did not include LPG but we are advised that adjustments since then have made it impossible to turn back the clock without significant new investment.)

We are advised that refineries are not permitted under environmental laws to flare excess gases. Neither are they currently in a position to export additional excess LPG profitably. Firstly, refineries do not currently have suitable means of transporting such quantities of LPG to ports and/or do not have large LPG storage facilities at ports. Secondly, refineries receive considerably reduced revenues for exports where tanker loads are less than about 45,000 tonnes, and LPG production at individual refineries is insufficient to supply such loads. Total Australian refinery production of autogas is 700,000 tonnes per year, distributed over eight refineries around the coast, whereas extracted autogas exports are twice as big and concentrated at three sites.

In the short term, up to five years, we assume that the level of production and output mix of refineries is unchanged. The ability to adjust varies across refineries according to differences in technologies. It also depends on the type of crude oil refined.

In the long run we assume that refineries adjust their mix of outputs so that all production of autogas is replaced by an equal weight of petrol.

After five years, under the tax/price assumptions used in this Report, all dual-fuel autogas vehicles would switch to petrol. Existing dedicated autogas vehicles would either reach the ends of their lives (e.g., taxis or vehicles with large annual kilometres) or be converted to petrol. Dual use vehicles would 'flick the switch' and probably retune the engine to petrol at minimal cost. Some would remove the LPG tank in order to provide more storage space.

We model results at five years (section 8 below) and also in the long run (in this section). In both cases, the modelling shock involves the following steps/assumptions:

- Increase the rate of tax on autogas/petrol so that its purchasers' price increases by a factor of 80/51.2, or 1.56 relative to the GST-inclusive starting value.
- Increase exports of autogas/petrol from zero to the natural gas share of the original autogas domestic production.
- Calculate the imports of 'autogas/petrol' as total demand (domestic demand plus exports) less domestic production. Imports consist entirely of petrol.
- Prices of autogas and petrol are determined in world markets
- Write off the autogas distribution network and fixed capital associated with autogas, production, conversion and repair and maintenance, although these are treated differently for the short term and the long run.
- Factor in new investment in the petrol distribution network, although this is treated differently in the short term and the long run.

In calculating the changes in quantities it must be noted that one tonne of autogas has the same energy content as 1.07 tonnes of petrol. Thus every tonne of autogas demanded has to be replaced by 1.07 tonnes of petrol. Given the constraint on refinery production, this corresponds to additional imports of petrol, but this is offset by the reduced demand as a result of the higher price.

6.2.3 The Long Run Modelling Scenario

In the long run we assume that refineries would adjust their mix of outputs so that all production of autogas is replaced by an equal weight of petrol. Adjustments would differ between refineries and this result might include the closure of some refineries. The adjustment would involve considerable investment. The changes imposed on the model are:

- Domestic production of autogas/petrol is set equal to the natural gas share of the original autogas domestic production, plus 1/1.07 x refinery share of original autogas domestic production. (The factor of 1/1.07 allows for the reduced energy production, and hence value, as a result of the switch in production from autogas to petrol).

- Exports of autogas/petrol are set equal to the natural gas share of the original autogas domestic production.
- Imports of autogas/petrol are calculated as domestic consumption plus exports less domestic production.
- Refineries absorb costs of new investments and write-offs through reductions in profits if they want to stay in business.

6.2.4 Fuel Demand Responses To Excise Duty/Price Changes

The demand for autogas/petrol depends, inter alia, on the price for the product. The demand for autogas/petrol is assumed to be relatively insensitive to price.

Based on various studies, we have run the AE-CGE Model using values of -0.1, -0.3 and -0.5 in our simulations, with a smaller value in this range favoured for short term purposes and a larger value in this range favoured for long run purposes.

Although AE-CGE normally uses intermediate inputs into production in fixed proportions, we allow the demand for autogas/petrol used in intermediate usage to respond to price in the same way as for final consumption.

GST applies to both autogas and petrol, but businesses effectively receive it GST free because they can claim an input tax credit on the GST paid.

Care is required to specify the changes to the autogas industry so as to accommodate a combination of changes to both autogas and petrol.

The changes examined have involved complete replacement of autogas by petrol. This seems sensible given the very large relative price increase for LPG involved in removal of the current LPG excise exemption.

6.3 LONG RUN MODELLING RESULTS

The economy-wide effect of the change in taxation is influenced by the petrol/LPG split of demand between intermediate usage (53%) and household consumption (47%).

Increased prices for households change the household consumption bundle, in particular shifting demand (slightly) away from the petrol/LPG fuel group.

Increased prices for intermediate usage have considerable flow-on effects to other industries because of the pervasive influence of the industries that use autogas/petrol, especially light commercial vehicles (LCVs) in road transport.

The long run modelling results for the removal of the current LPG excise exemption are summarised in the following table.

Table 6.3.1. Tax-Efficiency Benefits From Removing Current LPG Excise Exemption ($m, 2002 Dollars)*

Own-Price Elasticity of Fuel Demand	-0.1	-0.3	-0.5
Final Consumption	29	66	101

* Expressed in 2002 prices to allow comparisons with estimates of greenhouse gas benefits.

At first blush, these results appear odd:

- The smaller the assumed demand response to increased petrol/LPG prices as a group, the more efficient, *a priori*, a tax on such fuels might be expected to be.
- But the consumer benefit shown in the long run model results increases as demand responsiveness to fuel prices *increases*.
- The explanation is that the use of such fuels as an important and pervasive business input (more than half of total fuel demand), combined with the inherent inefficiency of taxing business inputs, especially via a cascading excise duty on production high up the value added chain, reverses the ranking. While not as pervasive as other transport fuels such as diesel, an increase in tax on LPG directly increases costs in the road transport sector (such as taxis and LCVs) and other industries that use automotive LPG intensively. These higher costs are then passed along the value chain, increasing the cost structure of goods and services across the economy.
- Accordingly, the greater the assumed scope for business to substitute away from the taxed fuel input, the less the damaging efficiency impact of business inputs, and conversely.
- This business input effect outweighs the consumer surplus effect, reversing the expected consumer benefit ranking.

This finding serves to remind us that:

- While from partial equilibrium and administration/compliance perspectives fuel taxation might be seen as relatively efficient, an economy-wide perspective, including proper allowance for its effects on business inputs, can substantially modify this perception.
- The inherent inefficiency of excise duties as taxes on business inputs is highlighted by the ranking of final consumption benefits shown in table 6.3.1.

Finally, the modelling confirms the expectation set out in sub-section 5.4 above.

There are indeed net tax-efficiency benefits from removing the current LPG excise exemption.

But the net tax-efficiency benefits of substituting excise duty on LPG for income taxation is likely to be a fraction, and possibly a very small fraction, of the annual revenue 'cost' – as measured in the Treasury's *Tax Expenditures Statement* – of the current LPG excise exemption[14].

The modelling results suggest some support for tests #1 and #3 (at least for the case where the current LPG exemption is completely removed) in section 2 above.

14. The Treasury, *Tax Expenditures Statement*, issued annually. In total, the LPG and other alternative fuels tax expenditure estimate is currently running at just under $700 million per annum.

7. NATURE & SCOPE OF TRANSITION COSTS OF LPG EXCISE EXEMPTION REMOVAL

The long run tax-efficiency benefits from removing the current LPG excise exemption arise only after all of the transitional adjustments to resource allocation, and the costs thereof, have been made/absorbed.

In effect, the long term solution mode for the *AE-CGE* Model assumes away all adjustment costs:

- Capital and labour are perfectly flexible and can be used in any industry.
- There are no unused resources.
- Markets 'clear' as a result of perfectly flexible wages, prices, the exchange rate, and tax rates.

In reality, the long run results are really *very* long run in nature:

- They effectively require the replacement of the existing capital stock – a large portion of which is set up specific to particular industries.
- They require enough time for resources unemployed as a result of the removal of the current LPG concession to shift to other industries. This will require time, retraining, new investment in new industries, and so on.
- And they require wage and price adjustments to provide the appropriate resource allocation signals. Where reductions in wages are required, this is difficult at best given the downwards inflexibility of wage rates that still pertains in Australia despite a degree of labour market deregulation.
- In reality, the long run modelling results for the tax efficiency gains are very much a 'best case', far into the future, scenario.

To be sure, the annual long run tax-efficiency benefits of removing the current LPG excise exemption presented in section 6 above are permanent, as are any annual greenhouse gas benefits from retaining the current concession.

But the transition period between the status quo and the long run – which will take many years – is a period where the net tax efficiency benefits have not yet emerged, where the costs of resource adjustment are dominant, *and where most of the benefits of greenhouse gas emission reductions are already lost because the bulk of the demand adjustment will have already occurred.*

The next section of this Report presents an attempt to model the transition period where:

- This is characterised as the situation five years after the announcement of the termination of the current LPG excise exemption.
- The *AE-CGE* Model is modified in various ways to introduce adjustment rigidities to prevent optimal resource allocation. (In fact, these adjustments are almost certainly extremely conservative relative to real-world adjustments. For example, we do not assume increased unemployment of labour, and we allow wages to be sufficiently flexible to clear the labour market.)

8. QUANTIFYING TRANSITION COSTS OF REMOVAL OF LPG EXCISE EXEMPTION

There is more to this study than just the effects on consumers of the introduction of an excise on autogas and the associated substitution of petrol for autogas. There are major implications for the producers of autogas and also for the distribution of autogas. There are also implications in the motor vehicle industry for providers of conversions and for the production of dedicated vehicles.

8.1 SPECIFYING THE TRANSITION RESOURCE ADJUSTMENT CONSTRAINTS

As noted above, we understand that it is Government policy to give five years' warning of any change to the excise on autogas, and that this five years rolls forward every day. Under these conditions there is no question of an unexpected change over night. Demand would switch totally from autogas to petrol from the time the excise on autogas applied, and much of the switch might occur earlier.

As noted above, the initial domestic supply of autogas is 62% from refineries and 38% from natural sources.

We assume that the supply from natural sources would be diverted to exports. In the transition period the refinery supply of autogas would be diverted to exports as well. In the long run the refineries would change their output mix to produce petrol in place of autogas. In all cases imports are determined as a residual equal to domestic consumption plus exports less domestic production. Imports of petrol are smaller in the long run because refineries replace autogas production with petrol production. Elimination of the demand for autogas would result in zero imports of autogas. We assume that all autogas supplied by domestic oil/gas producers would be diverted to exports in the form of propane and butane.

The situation for refineries is quite different. They convert crude oil to gasoline, diesel, fuel oil, jet fuel and LPG in essentially fixed proportions. The proportions, and in particular a reduction in the proportion of LPG, can be changed by using a different type of crude oil or by adjustments to the refining process. The range of adjustment for existing Australian refineries is insufficient to accommodate a large reduction in LPG production in the short term. Refineries are not permitted under environmental laws to flare excess gases. Neither are they currently in a position to export additional excess LPG profitably. Refineries do not currently have suitable means of transporting such quantities of LPG to ports and/or do not have large LPG storage facilities at ports. Refineries receive considerably reduced revenues for exports where tanker loads are less than about 45,000 tonnes, and LPG production at individual refineries is insufficient to supply such loads.

In the short term, up to say five years, we assume that the level of production and output mix of refineries is unchanged. This may not be exactly correct. The ability to adjust varies across refineries according to differences in technologies. It also depends on the type of crude oil refined. In the long run we assume that refineries adjust their mix of outputs so that all production of autogas is replaced by an equal weight of petrol.

After five years, we assume all dual-use autogas vehicles would switch to petrol. Existing dedicated autogas vehicles would either reach the ends of their lives (e.g., taxis or vehicles with large annual kilometres) or be converted to petrol. Dual use vehicles would 'flick the switch' and probably retune the engine to petrol at minimal cost. Some users would remove the LPG tank in order to provide more storage space.

8.1.1 The Scenario After Five Years

In the short term (five years), demand for autogas is replaced by demand for petrol of equivalent energy content, but the model reduces the quantity of total fuel demand because of the increased price.

All the required additional petrol is assumed to be imported. Both the refinery and natural gas parts of the autogas industry continue production at original levels, but all output is exported. ALPGA indicated that refineries expected their margin on the sale of autogas to fall by $100/tonne to $200/tonne. We have used a reduction of $150/tonne, composed of a lower price received for small export loads together with additional costs for separation of refinery gas into propane and butane, transport from the refinery to the port, and storage at the port. Costs of separation would not apply if there were a market for unseparated refinery gas, but in this case the received price would be correspondingly lower because the purchasers or their customers are assumed to undertake the separation at their cost.

The changes imposed on the long run version of the *AE-CGE* Model are as follows:

- Exports of autogas/petrol are set equal to the total domestic production of autogas.
- Imports of autogas/petrol are calculated as domestic consumption plus exports less domestic production.
- The world price for exports of autogas is set at 84% of the original domestic autogas value, corresponding to about 90% for the natural gas share and about 80% for the refinery share.
- Additional costs associated with refinery exports are equivalent to 3.5 c/litre, all of which is applied, for simplicity, in the form of a road transport markup.
- Autogas replacement investment is eliminated and new investment associated with petrol distribution is installed uniformly over five years.
- The current depreciation rate for autogas capital stock is replaced by a complete write-off spread uniformly over five years, and there is additional depreciation of the new required petrol capital stock.

8.2 FIVE YEAR MODEL: THE POLICY SHOCK

We take as our transition scenario the situation where whatever changes may be possible during a five-year lead-in from the announcement of the policy change to its implementation will be effected, but otherwise the model will face rigidities assumed away in the long term mode of operation.

We start from prices of 40 c/litre for autogas and 80 c/litre for petrol. Given that 1.28 litres of autogas have the same energy content as 1 litre of petrol, the price of autogas that has the same energy content as 1 litre of petrol is 51.2 cents (40 x 1.28). Introduction of an excise of 38 c/litre would increase the price of autogas to 78 c/litre or 99.8 c/litre in petrol equivalents. Over five years we assume that there would be an almost total switch from autogas to petrol. About 95% of vehicles that can use autogas can operate on either petrol or autogas. Only 5% of autogas vehicles are dedicated to autogas use only. Over a period of five years, we assume that essentially all vehicles operating solely on autogas would be either retired (e.g. taxis and other vehicles with large annual kilometres) or switched/converted to petrol, especially as the decline in numbers of autogas service stations accelerated after about two years.

8.3 ASSUMPTIONS FOR THE TRANSITION (AT FIVE YEARS): VALUES IN 2002 DOLLARS

- All autogas is replaced by petrol.
- The autogas conversion business, including manufacture of autogas parts, disappears. This is currently valued at about $30 million annually (12,000 conversions at $2,500 each). The industry advises that the annual incremental repair and maintenance cost for autogas equipment is about $200 per vehicle. For about 500,000 vehicles this corresponds to about $100 million per year. Closure of these activities would result in redundant capital valued at about $93 million. Over five years, we assume displaced labour would be absorbed within the repair industry or elsewhere in the economy. During the transition period, autogas related activity would be replaced to some extent by conversions from autogas to petrol, removal of LPG tanks and retuning of engines to petrol, but we have neglected such expenditure as small.
- Factory production of dedicated and dual cars ceases. It costs an additional $1,000 to produce a dedicated autogas car. For, say, 15,000 vehicles per year, this corresponds to annual production valued at about $15 million. We estimate the value of the redundant capital at about $6 million. We assume displaced labour would be used elsewhere in the motor vehicle industry.
- The distribution chain would have redundant fixed capital that could not be used for petrol or other purposes. The current value of this fixed capital is about $721 million, consisting of service station storage tanks, pumps and bowsers ($475 million), autogas tanker trailers ($36 million), depot/terminal investment ($200 million), and refinery terminal investment ($10 million). We are advised that replacement of autogas with petrol would require new investment in tanker trailers and approximately 60% of the redundant service station equipment. Service stations with high turnover would replace autogas facilities with petrol facilities while those with lesser turnover would not. There would be negligible change in labour – we assume that the number of service station operators would not change and truck drivers would switch from delivering autogas to delivering petrol.
- Natural production of autogas would be unchanged. Excess natural autogas would be exported at the world price which averaged about $452/tonne in 2002.
- Refinery production maintains its present mix of products. (In practice there could be small adjustments at some refineries for little additional cost.) Excess

refinery autogas would be exported at, say, $407/tonne. This includes an estimated discount for small ship loads. Refiners would have the additional separation, transport, storage and handling costs of transporting LPG from the refineries to the port. We have assumed additional costs of 3.5 c/litre and for simplicity have applied all of these to road transport costs.

- Domestic production of petrol is constrained to the general growth in the economy. The switch from autogas to petrol results in a shortfall in petrol supply that is satisfied by imports.
- No additional storage facilities are required to receive increased imports of petrol.

The dominant differences from the long run version of the *AE-CGE* Model are increased imports of petrol, the redundancy of fixed capital for autogas distribution and its part-replacement by fixed capital for petrol distribution, and increased costs and reduced returns from exports of propane and butane from refineries. We calculate the impact of the changes by their effect on the equilibrium configuration of the model in the fifth year compared with the current New Tax System-adjusted equilibrium.

We model the redundant autogas fixed capital by setting the associated replacement investment to zero and depreciating the value of the existing capital uniformly to zero over five years, with an associated increase in income tax deductions. The replacement fixed capital for petrol is assumed to be installed uniformly over five years, building up to its full value after five years. Depreciation at normal replacement rates is allowed on this new capital.

8.4 THE TRANSITION MODELLING RESULTS

The economy-wide effect of the change in taxation is influenced by the petrol/LPG split of demand between intermediate usage (53%) and household consumption (47%). The transition modelling results for the removal of the current LPG excise exemption are summarised in the following table.

Table 8.4.1. The Economy-Wide Transition Costs Of Removing Current LPG Excise Exemption ($m, 2002 Dollars)*

Own-Price Elasticity of Fuel Demand	-0.1	-0.3	-0.5
Final Consumption	-65	-62	-59

* Expressed in 2002 prices to allow comparisons with estimates of greenhouse gas benefits.

The estimated net economy-wide transition costs rise very slightly as the own-price elasticity of demand for fuel as a group approaches zero:

- As for the long run results, this reflects the larger adjustment costs when producers are less able to switch away from transport fuel which are large enough to offset consumer surplus benefits as fuel demand becomes less price sensitive.

From an economy-wide perspective, the adjustment costs during the transition period, on the (conservative) assumptions used in this section of the Report, are large enough to outweigh the tax-efficiency benefits of eliminating the current LPG exemption and generate net costs of a similar order, on average.

The adjustment costs faced by those businesses directly affected by the policy change, as set out in this section of the Report, are of course much larger still.

The assumptions underpinning the transition model set-up, and the modelling results, suggest support for tests #6, #7 and #8 in section 2 above:

- There is evidence of sizeable industry investment in response to the current LPG excise exemption.
- There may be a case for industry compensation should current policy be changed.
- The cost of that compensation would be larger than the net community cost estimated by our modelling during the transition period.

The impact of that cost has not been factored into the transition modelling summarised above: the results effectively assume such costs are absorbed by the affected industries and motor vehicle users, both for business and private use. This is a very conservative approach which probably understates the true magnitude of the transition costs of removing the current LPG excise exemption by a considerable margin.

9. ACCESS ECONOMICS' CONCLUSIONS

Based on the modelling framework set out above, this section of the Report very briefly summarises Access Economics' conclusions.

9.1 THE COST OF THE CURRENT LPG EXCISE CONCESSION

A major finding of this Report is that, even in the long run, where transition costs of removing the current excise exemption are ignored, the tax-efficiency cost of the current LPG excise exemption is but a fraction of the annual gross revenue forgone, when the analysis is properly specified.

Proper specification includes, importantly, the requirement that tax reforms be Budget-neutral.

Removal of the current LPG excise exemption provides revenue to finance (say) reduced income tax rates. Measured against the opportunity cost of lower income tax rates, the current LPG excise exemption involves greater reliance on less efficient taxes (income tax) and less reliance on somewhat more efficient taxes (excise on transport fuels). But the net efficiency sacrifice is relatively modest, because (i) both excise duty and income taxes are inefficient to some extent, and (ii) excise duty on transport fuels in Australia is a very pervasive tax on an important business input.

This cost also ignores any environmental and other related benefits from use of LPG as a transport fuel that has been induced by the excise exemption.

9.2 LONG RUN MODELLING RESULTS

In the long run, when all transitional costs and rigidities are assumed to be absorbed and/or overcome:

- The benefit-cost equation for the current LPG excise exemption is finely-balanced.
- The status quo offers permanent greenhouse gas abatement benefits that might be of the order of, say, \$30 million to \$50 million per year, although it is noted that

the value of greenhouse emission costs which affect that estimate is subject to ongoing research.

- But in terms of forgone tax-efficiency from the status quo, the economy suffers a permanent annual long run cost of between $30 million and $100 million.
- Allowing for the inevitable error margins around these estimates, we conclude that there is little net cost in retaining the current excise exemption, combining greenhouse gas abatement effects and tax-efficiency effects, and, equally, little net benefit in retaining it.
- In general, the less price sensitive are transport fuels as a group, the more likely is the conclusion that there are net long run overall benefits from the current LPG excise exemption. This result flows from the importance of transport fuels as business inputs, and the inherent inefficiency of excise duties on business inputs. This is particularly relevant where the business transport customer is a high volume energy user.

9.3 TRANSITIONAL MODELLING RESULTS

The current LPG excise exemption has been in place for some time. Considerable investment has been undertaken, in good faith, in response to it. Re-allocating resources in the event that the exemption is removed is not costless.

In the transition period, when we allow some (but not all) of the transitional costs and rigidities to operate:

- Removing the current exemption generates net significant short-term, or transition, costs.
- Removal of the concession is likely very quickly to remove greenhouse gas abatement benefits of the order of, say, $30 million to $50 million per year, although, as noted above, the value of greenhouse emission costs which affect that estimate is subject to ongoing research.
- In addition, net economy-wide transition costs of the order of $60 million per annum by the fifth year after the announcement of a policy change will be incurred.
- In total, therefore, net transition costs of up to $90 million to $110 million per annum or more by the fifth year after the announcement of a policy change are likely.
- And these conclusions assume zero compensation to the industries and the relevant motor vehicle users directly affected by the removal of the current LPG exemption.

ATTACHMENT A – THE AE-CGE MODEL

Broad Description of the AE-CGE Model

The *AE-CGE* model is a small, long-run, non-linear, computable general equilibrium (CGE) model of the Australian economy. *AE-CGE* was initially developed by Access Economics for the Economic Planning and Advisory Council, Bureau of Industry Economics, Industry Commission and Business Council of Australia in 1992.

The standard version of *AE-CGE* models employment, profit, production, consumption, investment, imports and exports for 26 separate industries. Interactions between industries are modelled using input-output data, a measure of the various inputs required by each industry to produce its output. Changes in each industry are then aggregated to provide estimates of macroeconomic variables. The strategy underlying the design of *AE-CGE* was to construct a CGE model of manageable size where interactions within and between industries could be modelled in reasonable detail. At the same time, the number of industries in AE-CGE can be increased readily to provide necessary detail in particular applications.

AE-CGE, unlike many other CGE models (such as ORANI), solves in levels rather than percentage deviations. This non-linear approach maintains the complex detail of the equations describing supply and demand. This full impact, particularly for consumption and production technologies, can be blurred by the linearisation commonly employed in solving larger models.

Within the business sector of *AE-CGE*, profit maximising firms are assumed to demand labour, capital and the output of other firms, to produce output. This output is disposed of through domestic or export markets (which are imperfect substitutes). Production supplied to domestic markets is combined with imports (which are imperfect substitutes for domestic supply) to satisfy total demand. Australia is assumed to be a price taker in import markets. Total demand consists of private consumption, intermediate input demand, investment and government consumption.

The model distinguishes Commonwealth and overall state/local government sectors. For each, the government sector imposes a series of direct and indirect taxes. In the standard version of the model, the rates of indirect taxes are determined from input-output data while direct tax rates are assumed to adjust to maintain budget balance. Governments maintain real government current expenditure in each industry (again determined from input-output data) irrespective of price changes.

The long-run snap-shot nature of the *AE-CGE* model is reflected in the assumptions about market behaviour. In the standard long-run closure of the model, nominal gross national expenditure (GNE) is taken as 'numeraire' relative to which other nominal variables adjust. The exchange rate is assumed to adjust to keep the overall trade balance unchanged.

Capital and labour are assumed to be fully mobile between sectors. The total supply of labour is assumed to be fixed in the standard version of the model, with the wage adjusting to equate supply and demand. The capital stock is assumed to be flexible, with expansion/contraction in each industry sufficient to maintain a fixed, economy-wide, rate of return to capital.

The current implementation of *AE-CGE* models the Australian economy as reflected in ABS input-output data but scaled up inter alia to reflect the implementation of the *New Tax System* as at 1 July 2001.

Consumption expenditure is wages and profits less the sum of taxes (which equal government spending) and the resources – saving – needed for gross investment. This expenditure is allocated between the outputs of the various industries using a Klein-Rubin (or Stone-Geary) utility system. This system allows consumption of each industry's output to reflect sensitivity to changes in the industry's output price, as described by their own-price elasticities. For each commodity there is a fixed or 'autonomous' level of consumption and a 'discretionary' level. The discretionary levels of consumption adjust, subject to the constraints imposed by the model, so as to maximise utility.

A more detailed description of the model is available in *Access Economics Computable General Equilibrium (AE-CGE) Model Documentation.*

Modelling Changes in Indirect Taxes

The *AE-CGE* model allows for taxes on labour, output, final consumption, investment, exports, imports and inputs to intermediate usage. The input-output data include taxes by input-output industry for 11 CTLS categories (commodity taxes less subsidies) and 11 ITLS categories (other indirect taxes less subsidies), as well as total commodity taxes on each of the input-output table cells. From ABS 5506.0, *Taxation Revenue*, we obtain control totals for the different types of State taxes, some of which are at a finer level than the input-output data.

ATTACHMENT B – MEASUREMENT OF ECONOMIC WELFARE

Standard Measures of Economic Welfare: A Short-Cut Summary

Measures of economic welfare are commonly used concepts in economic analysis. Their precise definition is somewhat complicated for non-economists. As a practical, observable approximation, total household spending on consumption of goods and services is a reasonable approximation to economy-wide economic welfare.

For modelling purposes in this Report, the change in Australian consumer spending is a good summary measure of the change in welfare caused by removal of the current LPG excise exemption.

Standard Measures of Economic Welfare: A Little More Detail

The AE-CGE model generates estimates of a wide range of aggregate and sectoral variables - covering production, incomes, expenditure, trade and prices. An important issue is how to measure the improvement in economic welfare that results from a change, such as a change in an indirect tax.

Standard microeconomic texts[15] identify the welfare impact of an indirect tax in terms of a 'dead-weight loss' – that is the sum of the reduction in consumers' and producers' surplus on the introduction of the tax. However, this is a partial measure, focussing only on the particular market in which the tax is imposed. It does not take account of changes induced elsewhere in the economy. Nor does it allow for the possibility that the marginal utility of income may vary as a result of the imposition of the tax.

A general equilibrium model, such as AE-CGE, has markets for all the goods and services in the economy. It also contains an explicit household utility function, allowing us to estimate the utility associated with particular consumption bundles. We are therefore in a position to provide more sophisticated estimates of the overall impact of a tax change on economic welfare – based on the 'compensation principle'[16].

In practice in the AE-CGE model, welfare measures based on the compensation principle are usually close, numerically, to the change in aggregate real consumption caused by a shock to the model. It is this latter measure that is emphasised in this Report.

15. See for example H.R. Varian *Microeconomic analysis*, New York, Norton, 1978 or R.S. Pindyck and D.L. Rubinfield *Microeconomics*, New York, MacMillan, 1989

16. See for example Johansson, P-O, *An introduction to modern welfare economics*, Cambridge University Press, 1991. Two closely related welfare measures based on the compensation principle are the Compensating Variation and the Equivalent Variation. The former is the amount of money that consumers would have to be given (or pay) after the change, to keep them at the same level of utility in the event that the change were subsequently reversed. The latter is the amount of money that consumers would have to be given *before* the change that would make them as well off as they would be if the change were in fact to proceed.

ATTACHMENT C – 'GOOD' TAX DESIGN

It is too easy to forget that the tax system in any country has one unique function: that is, to raise general revenue to finance general government activity. There is a well-established group of tax design principles that is intended to promote this objective (although real-world experience suggests political pressures see these principles observed as much in the breach as otherwise).

BASIC TAX DESIGN PRINCIPLES

Public finance policymakers – if not others – make judgements about the adequacy or otherwise of taxes and tax systems using three criteria: economic efficiency; equity; and simplicity. These three criteria encapsulate the key areas through which people and businesses can be affected and are an accepted part of tax policy debates around the world.

For example, these three criteria were used by the recent Ralph Review of business taxation at the Commonwealth level as the basis for suggesting three national objectives for business tax design:

- optimising economic growth through enhanced efficiency;
- ensuring equity; and
- facilitating simplification.

These three criteria for evaluating particular taxes and charges are discussed briefly below.

Economic Efficiency and Economic Growth

In simple terms, a completely efficient tax system is one in which the imposition of tax does not get in the way of – that is, distort – decisions made by businesses and individuals. If the tax system were perfectly efficient, decisions would not be affected by tax considerations at all. An investment that would proceed based on its before-tax rate of return would also proceed on the basis of its after-tax rate of return.

In the real world, all taxes are more or less inefficient, although, as discussed below there is sometimes a case for imposing taxes to improve efficiency where social costs of production or consumption diverge from private costs.

Sometimes economists and policymakers fall into the trap of thinking that improved economic efficiency is an end in its own right. In fact, improvements in efficiency are a means to an end; a means to stronger economic growth. That, too, is not really an end in itself, but rather a means to generate higher living standards.
In essence, improved efficiency is the same as improved productivity: that is, bringing together a given amount of investment and of labour in a way that produces more than would otherwise be the case.

The critical link between efficiency and economic growth was recognised by the Review of Business Taxation[17]:

17. Review of Business Taxation (1998) *A Strong Foundation*, Discussion Paper, AGPS, Canberra, November, p.61.

In raising revenue for the Commonwealth the business tax system should interfere to the least extent possible with the best use of existing national resources, with the efficient allocation of risk and with national economic growth in the longer term.

The rationale for this objective springs from broader social goals. Irrespective of taxation arrangements, Australia's economy and resources – including its market structures and its complementary institutional arrangements – need to be marshalled with the objective of ensuring that investment funds are allocated in such a way as to optimise economic growth.

Equity or Fairness

Equity or fairness is a seemingly simple concept, but there are different types of equity. Horizontal equity – treating taxpayers in similar circumstances in a similar way – in many circumstances may be almost synonymous with efficiency.

Vertical equity – requiring those who earn more to pay higher rates of tax – is largely a function of the Commonwealth personal tax system and (more to the point) targeted welfare systems. It can be partly in conflict with efficiency concerns.

Administrative and transitional equity – the fair application of the tax law, including in terms of transitions related to tax changes – are also important objectives. However, there is often a trade-off between this type of equity and both efficiency and simplicity.

Simplicity

Simplicity is a straightforward concept. It includes *administrative* simplicity (minimising the taxation authority's costs of running the tax system) and ease of compliance with the tax system by taxpayers, minimising their time and money costs as well.

Simplicity is a laudable objective and – to the extent that it aids the understanding and administration of the tax system – can help to improve economic efficiency (and hence economic growth).

Balancing the Three Principles

To some extent but not completely, these principles are inconsistent. For example:

- a single-minded effort to ensure an economically efficient tax system might end up being inequitable (eg, in the vertical equity sense). Replacing personal income tax with a fixed lump-sum tax on all taxpayers, regardless of their income, might make the tax system less distorting, but at the expense of broad-based violation of the equity principle;
- an alternative approach to efficiency, the so-called 'optimal taxation' approach (see below), might require a large number of different tax rates on individuals and products, depending upon their particular sensitivities to the imposition of tax. This might be both unfair ('necessities' might be taxed more than 'luxuries') and require an extremely complex tax structure, violating the simplicity principle;
- pushing too far to promote equity may generate large efficiency costs. For example an extremely progressive personal income tax, with a top marginal rate of, say, 90%, is likely to induce large changes in taxpayer behaviour, with strong incentives to avoid and evade tax (including by taking up residence in another country);

- in many cases, simplicity may require rough 'rules of thumb' to translate concepts that are hard to quantify into operational tax rules. These 'rough justice' approximations undermine efficiency and equity, at least a little.

A *balancing* of the three principles therefore is needed for a workable tax system. *There is no objective basis by which this balancing can be determined.* Some will assign a high weighting to equity principles. Others will effectively assign a higher weighting to efficiency criteria. Others – especially the beneficiaries – will advocate retention of tax concessions or loopholes for obvious reasons even if their retention undermines the efficiency of the overall tax system. So, even if people agree precisely on the meaning of efficiency, equity, and simplicity, there is still plenty of scope for argument about the appropriate *balance* between the three.

Other Tax System Objectives

Raising revenue efficiently, fairly and simply should be the determining principles for any good tax system.

Pursuit of other objectives that clearly violate these principles should be avoided. Introducing 'loopholes' in the tax system to cater for particular interest groups is inherently distorting and unfair, and encourages 'me too' lobbying for further changes to the system to benefit other groups, further undermining the revenue base and increasing the distortions in the system.

This is not to say that, in some circumstances, taxes and charges cannot be used for other purposes, such as to change behaviour. In some cases distorting behaviour (eg, discouraging drink-driving) is the object of the exercise. But in general taxes and charges should be designed to do the job they are primarily designed to do – raise revenue – without introducing avoidable distortions, unfairness and complexity.

THE TWO CASES FOR DIFFERENTIAL PRODUCT TAXATION

In the case of indirect taxation, a practical rule of thumb is, as far as possible, to apply a uniform ad valorem tax rate to the broadest possible tax base. This allows the lowest applicable tax rate for any given revenue target. This is the basis for Treasurer Costello's prescription on indirect tax, which is to 'broaden the base and lower the (tax) rate'.

There are two major cases where departures from this indirect tax design prescription may be warranted.

The 'Optimal Taxation' Case: Efficient Revenue Collection Via Unresponsive Demand

As noted above, a case for differential taxation – including taxation applied to products – can be made in the interests of the efficiency criterion for good tax design. This case is based on:

- taxing products to raise the revenue required;
- but choosing the products to be taxed to minimise taxpayer responses – economic distortions – thereby helping to avoid the 'deadweight losses' associated with taxation.

Optimal commodity taxation was first proposed by Frank Ramsey in 1927. The theory suggests that the efficiency cost (or 'excess burden') of taxation is minimised if taxes on products are levied such that the quantity demanded of each good or service is reduced by the same percentage. In practice, the rate of tax on each product should be inversely proportional to the price elasticity of demand. For goods insensitive to price movements, a high rate of tax would be applied, as quantity demanded does not move significantly in response to price changes, and conversely.

Ramsey pricing suggests that higher taxes be levied on goods and services that are not sensitive to price changes, with lower taxes on those products sensitive to price changes.

The practical application of Ramsey pricing would require detailed and accurate information on own-price elasticities and cross-price elasticities (a measure of the extent to which goods are complements or substitutes) for goods and services. This is difficult and costly to obtain and update, at best.

Note however that this 'optimal taxation' design approach:

- can be inconsistent with some notions of equity or fairness – especially vertical equity – because, for example, it would suggest taxing 'necessities' (which typically are less price sensitive) more heavily than 'luxuries' (which can be more price sensitive);
- and is certainly very complex to design, and even more complex to apply, thereby violating the simplicity criterion.

Note also that in some cases a Ramsey taxation approach appears to be the antithesis of what is required in the context of proposals to discourage use of 'bad' products and encourage use of 'good' products[18]:

- the whole focus of high, differentially-applied, Ramsey-optimal taxes is on products whose consumption will not be altered much as a result of such imposts;
- that is, the purpose of optimal taxation is to maximise tax revenue, not to alter taxpayer behaviour.

'Market Failure' Cases: Correcting Market Distortions

An alternative case for differential taxation exists where there is some problem ('market failure' or 'negative externality' in the economists' jargon) that is amenable to correction via the imposition of a particular selective tax measure.

In this case the object of the exercise may be twofold:

- to ensure the social costs arising from consumption or use of a 'bad' product are paid for by those using that product; or, going further than that
- seeking to 'distort' – that is, alter – taxpayer behaviour in a way that reduces or eliminates the use of the product causing the externality, thereby producing an 'optimal' outcome.

18. This difference may be more apparent than real in some cases. For example, if the object of the differential tax is simply to ensure that social costs are fully paid by the agent producing them, then an appropriately high tax rate on the product whose consumption generates the social costs could be applied to ensure that the purchaser pays for such social costs. It is where the policy objective goes further, seeking to reduce consumption of a specific 'bad' product, that the conflict arises.

The Government currently imposes differential (higher) excise and other taxes on goods such as alcohol and tobacco products ostensibly to account for the social costs of their use. It is also often suggested that the relatively high indirect taxation of fuel is motivated by a desire to accommodate the (otherwise uncaptured) social costs of fuel use. While the actual level of tax on these products may reflect other motivations (such as a desire to raise more revenue) the economic case for imposing a volumetric excise or other tax on particular products is often claimed to rest on this 'negative externality' argument.

Externalities refer to 'spillover' costs (or benefits) that accrue to third parties/society in addition to the direct, private costs borne by the consumer. The direct consumer does not take these externalities into account when deciding what quantity to consume. In such cases, consumption will tend to be larger than is optimal from society's point of view. An externality tax seeks to eliminate the difference between the private and social cost facing the consumer.

However, there are substantial difficulties in determining the private and external costs of consumption. For example, excessive consumption of certain foods has been linked to increased risk of heart disease, diabetes or other health problems. There is a health cost borne by the consumer as well as a cost to the broader community in terms of higher health care costs.

The presence of an externality does not necessarily justify the imposition of a specific tax above a general revenue raising tax like the GST. Many activities generate positive and/or negative externalities that are not fully captured in market prices. Externalities are difficult to measure, and in most cases, new taxes and subsidies, while costly to implement, are likely to create new distortions as well as correcting existing ones.

However, if the purpose of the tax is to target the negative externality, then it should be directly targeted at, and vary in proportion to, the amount of the external 'bad'. For example, alcohol is generally taxed per litre of pure alcohol. Fuel is taxed in a similar way under the current excise duty regime (albeit just by volume, rather than on energy content). This would rule out the imposition of ad valorem taxes such as the wholesale sales tax (WST) and GST (or other value added taxes) which tax the total price or value, rather than the external 'bad'.

More generally, we note that, where the 'externality correction' strategy is aimed at reducing use of the product involved, it:

- requires taxpayers to be price-sensitive in demand, so that tax-induced price differentials, significantly affect demand and encourage a switch in demand away from the higher-taxed products; and
- is the antithesis of the 'optimal taxation' approach; and
- is not designed to raise tax revenue; and
- like optimal taxation, it will inevitably add to the complexity – reduce the simplicity – of the tax system.

THE POTENTIALLY-CONFLICTING ROLES FOR DIFFERENTIAL PRODUCT TAXATION

The preceding two sub-sections of this Attachment expose the potential conflict between the revenue objective of the optimal taxation approach and the ability to actually change behaviour.

If behaviour doesn't change, then, while the social cost of fuel consumption may be covered (and incorporated into decision making) there would not be a reduction in the ill effects of fuel use, such as respiratory disease and CO_2 emissions.

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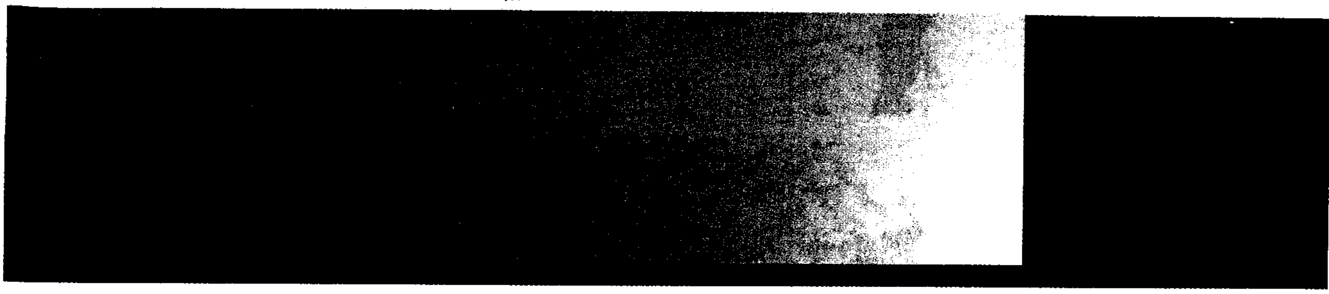

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