TRANSPORT FUELS IN AUSTRALIA

THE FOLLY OF AUSTRALIA'S INCREASING RELIANCE ON IMPORTED CRUDE OIL

Submission To:

THE AUSTRALIAN SENATE RURAL AND REGIONAL AFFAIRS AND TRANSPORT COMMITTEE INQUIRY INTO AUSTRALIA'S FUTURE OIL SUPPLY AND ALTERNATIVE TRANSPORT FUELS

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1 THIS SUBMISSION

This document presents a submission to an inquiry into Australia's future oil supply and alternative transport fuels being conducted by the Regional Affairs and Transport Committee of the Australian Senate.

The provision of sustainable, secure, and economically stable transport fuel options in the medium to long term looms as a vitally important challenge for this nation.

This short paper explores the very worrying scenario that Australia is currently poorly prepared for this challenge, and increasingly vulnerable to the vagaries of an increasingly stressed and volatile international crude oil market.

The premise examined in the pages that follow is that Australia is a country with limited and declining reserves of crude oil, and with a growing dependence on increasingly expensive petroleum imports from the international market.

Yet Australia is a country with a land mass similar to continental USA and China, but with a population of only 20 million, concentrated in city and regional centres separated by very significant distances.

It is a country that has developed a very high - maybe dangerously high - level of dependence on road transport for the movement of both people and goods.

This submission views the reality that Australia is a country with relatively generous per capita indigenous reserves of natural gas, certainly in comparison with declining crude oil reserves. It is also a country with the capacity to produce a range of other viable alternatives to the petrol and diesel that currently dominate our road transport sector.

Here, surely, are the perfect conditions for the emergence, in viable and critical mass terms, of natural gas and other alternative transport fuels and technologies. Here, surely, is a country with an urgent need for just this outcome.

But think again. Natural gas and other alternative fuels play an insignificant role in the Australian transport sector. This runs in the face of significant increases in the use of natural gas and other alternatives to petrol and diesel internationally.

In fact, Australia increasingly exports its natural gas at relatively low prices, while increasing its imports of crude petroleum at ever increasing prices. A strange paradigm.

Alternative fuels and technologies are also struggling to gain traction in a marketplace dominated by crude petroleum and its derivatives.

This submission presents the view, no doubt provocative and perhaps unfashionable in contemporary economic terms, that Australia urgently needs a combination of government intervention and private market action to overcome its current, narcotic like, dependence on oil.

A combination of political courage, innovative policy settings, and the delivery by the marketplace of efficient and cost effective outcomes is needed to return Australia to a secure and sustainable transport fuel pathway, and reverse the risks and vulnerabilities associated with our current circumstances.

2 ENERGY SECURITY

2.1 INTRODUCTION

One of the underlying premises of this submission is that Australia is becoming increasingly captive to the international crude oil market, and increasingly vulnerable as a consequence. The following data provides a brief background to that concern.

2.2 GLOBAL OIL RESERVES

Estimates of global crude petroleum reserves vary according to source, and often according to the political or economic agenda of the source, or source organisation. The Organisation of Petroleum Exporting Countries (OPEC) estimates global crude oil reserves at approximately one trillion barrels [1] (refer Table 1), of which slightly more than eighty percent is controlled by the eleven OPEC nations.

Geosciences Australia (an Australian Government Department) lists a slightly more bullish estimate of 1.2 trillion barrels.

This submission has adopted the OPEC estimates as indicative.

Table 1 – Global Crude Oil Reserves and Production

	Reserves		World Supply		
	Crude Oil Reserves		Crude Oil Production		
	Billion barrels proven	Million barrels per day	Million barrels per day	Million barrels per year	% of World Prod-uction
OPEC					
Saudi Arabia	264.2	26%	8.73	3,186	12.8%
Iraq	112.5	11%	2.45	894	3.6%
U.A.E.	97.8	10%	2.42	883	3.5%
Kuwait	96.5	10%	2.15	785	3.1%
Iran	89.7	9%	3.82	1,394	5.6%
Venezuela	77.7	8%	3.07	1,121	4.5%
Libya	29.5	3%	1.44	526	2.1%
Nigeria	22.5	2%	2.26	825	3.3%
Qatar	15.2	2%	0.81	295	1.2%
Algeria	9.2	1%	1.45	529	2.1%
Indonesia	5.0	1%	1.79	653	2.6%
TOTAL OPEC	**820**	**82%**	**30.4**	**11,092**	**44.4%**
NON OPEC					
U.S.	22.0	2%	9.02	3,292	13.2%
Russia	50.0	5%	7.29	2,661	10.7%
China	10.0	1%	3.30	1,205	4.8%
UK	10.0	1%	2.59	945	3.8%
Norway	10.0	1%	3.41	1,245	5.0%
Mexico	10.0	1%	3.59	1,310	5.2%
Canada	10.0	1%	2.80	1,022	4.1%
Argentina	10.0	1%	1.00	365	1.5%
Brazil	10.0	1%	1.00	365	1.5%
Other	30.0	3%	4.00	1,460	5.8%
TOTAL NON OPEC	**172**	**17.2%**	**38.0**	**13,870**	**55.6%**
GLOBAL TOTAL	**991.8**	**99.2%**	**68.4**	**24,962**	**100.0%**

[1] "barrel" is a unit of volume used in the petroleum industry. One barrel equals 159 litres.

2.3 THE GLOBAL SUPPLY/DEMAND REALITY

HOW LONG WILL THE WORLD'S OIL LAST?

Total global production of crude petroleum in 2005 was approximately 80 million barrels per day, or 29 billion barrels annually. Continued production at this level, based on total global reserves of one trillion barrels, and without any increase to accommodate increasing annual demand, would mean that global oil reserves equate to **approximately thirty five years** supply.

However, the demand question is critical. Between 1988 and 1994, global demand for crude petroleum fluctuated within a narrow band of between 66 and 68 million barrels per day, or approximately 25 billion barrels per annum. This lead to a widespread view that oil demand may have plateaued, and that the "pressure" was to some extent "off" in terms of the longevity of the world's oil supplies. Figure 1, however, tracks the growth in global oil demand between 1995 and 2004. Global demand exceeded 70 million barrels per day (bpd) for the first time in 1995, and over the subsequent decade grew to approach, and exceed, 80 million barrels per day – equivalent to an annual demand of 29 billion barrels.

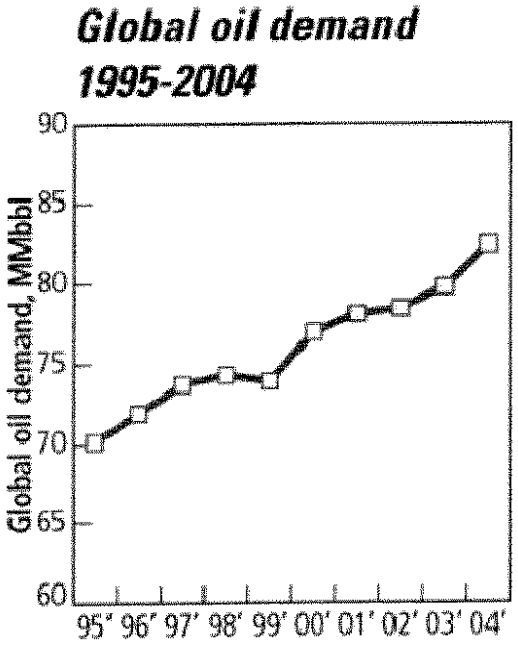


Figure 1 – Global Oil Demand
Note: Units are Millions of Barrels per Day

While demand generated by the rapidly expanding economies of China and India is clearly a major contributor, this surge in demand for energy, and therefore for oil, also has a broader international base. The consumption of oil in OECD countries from 1995 through 2004 rose almost 5 million bpd. Non-OECD use grew even faster, expanding by 7.7 million bpd. China was a big contributor but represented only 39% of this non-OECD growth.

Contrary to popular perception, the pressures that have resulted in demand for crude oil outgrowing supply did not develop overnight, and do not involve China alone. This was a global phenomenon, the basis of which had been building for many years. Prosperous developed economies throughout the world, led by the United States, have enjoyed strong economic growth in recent years - despite increasing oil prices. In climatic terms, recent northern hemisphere winters have not been as mild as in prior years – contributing further to the general surge in demand for oil, and its derivative products.

While the sustainability of the current rate of growth in demand for oil is highly questionable, the emergence of nations from poverty to prosperity, at whatever point on individual development scales, would appear to be irreversible.

There seems no basis to doubt that the global demand for crude petroleum will continue to increase.

As recently as February 2006, the President of Shell Global Solutions indicated in a presentation to an international oil industry conference that "demand for oil is set to grow at least 50 per cent between now and 2030".

The obvious implications of these higher demand scenarios is that the global crude oil "inventory" of thirty five years supply - calculated above on the basis of current reserves and current consumption – is likely to either be reduced to a lower figure, or the price of crude oil will increase even more significantly than in the past, or both.

This observation remains valid, even if available source data in relation to global crude oil reserves is conservative, and current global reserves are higher than the level of one trillion barrels used in this analysis. The most optimistic assessment of global crude oil reserves would only have the effect of extending the life of global reserves by a few years, and at most a decade.

SUPPLY/DEMAND CONSIDERATIONS

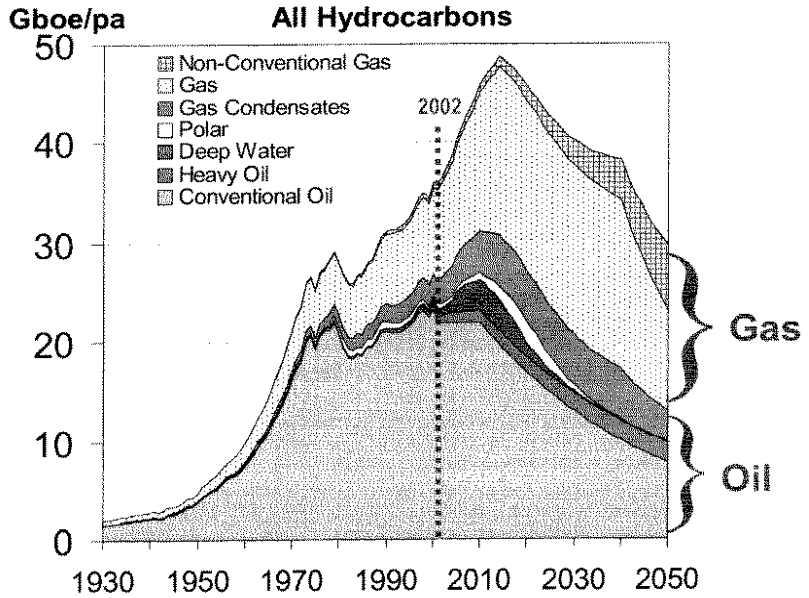
Forecasts of global hydrocarbon supply, like the estimates of global oil reserves discussed earlier, also vary considerably – depending on the source. However, there appears to be a general consensus on several key issues.

Firstly, crude petroleum is a finite resource, and global reserves are limited;

Secondly, that a "peak" will emerge, at which time demand for crude petroleum starts to outstrip supply; and

Thirdly, if that "peak" or tipping point has not yet been reached, it will be reached within a matter of a few years.

Figure 2 presents an analysis prepared by the Association for the Study of Peak Oil and Gas (ASPO), which appears to reflect a "mid range" position. This analysis sees the global supply of oil from "conventional" sources as having already peaked, and forecasts peaks for more expensive oil, including oil from deep water sources, within the next ten years. It is important to note that this analysis, consistent with the general energy industry view, presents a significantly longer time frame for the availability of natural gas.



Source: ASPO "Statistical Review of World Oil and Gas, June 2002"

Figure 2 – Global Oil and Gas Production Forecasts
Note: Gboe = billion barrels

Closer consideration of the circumstances of global oil supply is important.

Promoters of a status quo approach to energy and transport energy policy have long put the view that increases in price of oil will inevitably trigger new and additional sources of production and supply. This convenient hypothesis now appears highly dubious.

Over the course of the last decade, global supply of non-OPEC oil grew by 7.6 million bpd. But the Former Soviet Union's (FSU) unexpected supply increase accounted for 4 million bpd, or more than 50% of the total estimated demand change.

Over the past five years, non-OPEC/ non-FSU oil supply has remained virtually static.

In reality, it is hard to find oil producing countries that can add significant quantities to the global supply in the near to medium term future, and the list of key oil producers that appear to have reached a production plateau or even moved past their peak oil output is becoming quite lengthy

A TIPPING POINT IN GLOBAL CRUDE OIL SUPPLY/DEMAND

For many years, analysts and futurists in the petroleum industry have projected the emergence of a "tipping point" or "rollover", marking the point at which the global supply of crude oil is overtaken by aggregate global demand, and beyond which point demand began to exceed supply.

Figure 3 provides a typical illustration of this scenario, based on figures presented and sourced earlier in this paper.

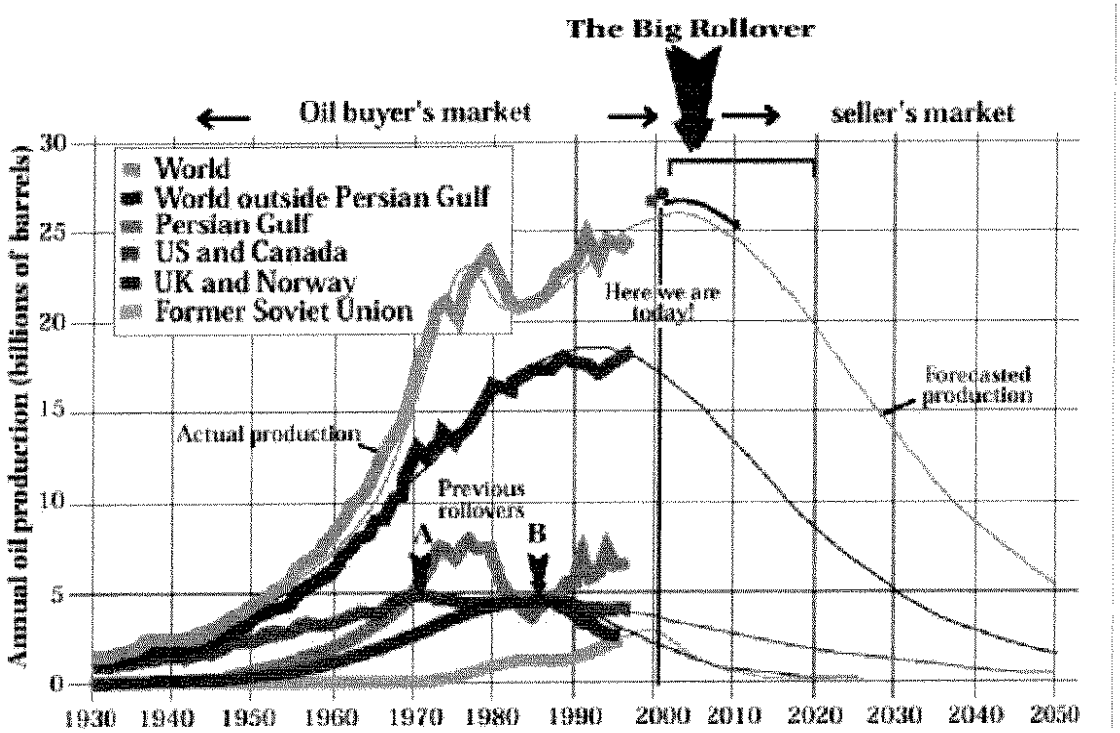


Figure 3 - Past and Forecast World Conventional Oil Production

(Source: Magoon, USGS 2000, and AEN 2001, after Campbell and Laherrère, 1998)

The trend in Figure 3 show an alarming tendency to follow the bell shaped curves of statistical reality.

We appear to be approaching, or to some extent at, a tipping point between global crude oil supply and demand.

WILL MARKET FORCES SAVE THE DAY?

It is sensible at this point to pause and reflect. Are the gloomy supply/demand projections presented above real – or are they some sort of latter day Malthusian aberration, painting an unduly pessimistic vision of the future?

Market forces will certainly solve part of the problem. As prices increase, demand for oil will level out and production will—for a while—increase slightly as it becomes profitable to drill in marginal fields that are currently lying fallow. Higher prices will also underwrite the recovery of crude oil from existing sources by more expensive production techniques.

But this obscures the fact that high prices, as bad as they are for an economy addicted to cheap oil, aren't the worst prospect facing us. The real problem is spare capacity.

In crude oil production terms, spare capacity is pumping capacity that is currently unused but can be turned on immediately if needed in a crisis. Saudi Arabia, for example, was able to open the taps on its wells practically overnight during the 1979 Iranian crisis, and then again in 1991 during the first Gulf War. If that immediate spare capacity hadn't been available, oil prices wouldn't have just spiked, they would have skyrocketed.

But the days of spare capacity in the global crude petroleum industry are gone. Two to three decades ago, OPEC had spare production capacity of about 15 million bpd. That spare capacity has now dropped to virtually zero.

What this means is that arguments over the exact timing of peak oil, and the precise shape of the associated supply/demand curves, are increasingly academic. No matter who's right, **what we can say with some certainty is that even if oil production continues to grow, it will grow slowly, which means that supply will barely if at all keep up with rising demand.**

The most prudent and reasonable conclusion is that the world is now in a permanent state of near zero spare capacity, which in turn will lead to an increasingly unstable world. As we enter an era in which even Saudi Arabia has no spare capacity to smooth out supply disruptions elsewhere in the world, any disruption in supply, whether triggered by political unrest, terrorism, or natural events, will cause prices to fluctuate wildly. We have reluctantly embraced a world in which crude oil might cost US$100 per barrel.

We may well be far less comfortable with a world where a single terrorist event, or a single natural disaster, could cause prices to surge to US$200-300 per barrel for a few months, and then perhaps return to a more "comfortable" base figure.

In real terms, this latter world appears to be the one in which we now live.

2.4 THE SITUATION IN AUSTRALIA

It is important to quantify the Australian situation in the context of the international figures presented above.

Geosciences Australia, an Australian Commonwealth Government organisation, has provided an indication of the Australian crude oil supply/demand situation in its report "*Oil and Gas Resources of Australia 2003 – Updated: 12 April 2005*".

Geosciences Australia estimate Australian crude oil plus condensate production in 2005 at between 490,700 bbl/d and 674,700 bbl/d, and forecast that these levels will decline to between about 157,000 bbl/d and 341,000 bbl/d by 2025.

In its report, Geosciences Australia further indicated that oil and condensate reserves in 2003 could have sustained production of 575,000 bbl per day, or 210 million bbl per year, for 13 years.

This average production level was calculated for the period 1993 to 2003.

Geosciences further noted that the consumption of crude oil and condensate in 2004 could be sustained by remaining economic reserves for only 9.3 years.

These figures, generally unheralded in the media and broader community, paint an alarming picture.

They suggest that Australia's appetite for petroleum products is rapidly outstripping our indigenous production sources.

This equates to a remorseless increase in Australia's dependence on the international crude oil market place described and quantified in previous sections of this paper.

The underlying decline in petroleum self-sufficiency, and the associated increase in reliance on international sources, is further illustrated in Figure 4.

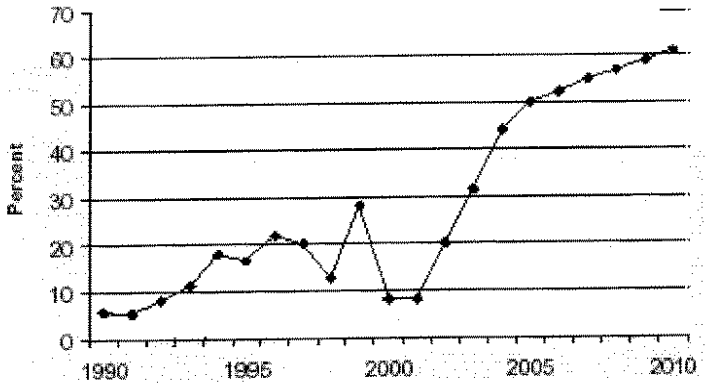


Figure 4 – Australia's Oil Import Dependence

The graph shows the percentage of Australia's liquid hydrocarbon demand which has been, and is expected to be, met by imports.

Liquid hydrocarbons are defined as crude oil, condensate, naturally occurring LPG and liquid petroleum products.

Self sufficiency is expected to decline from an average of 80-90% over the past decade to less than 40% by 2010 (Akehurst, 2002, APPEA 2002).

2.5 IMPLICATIONS FOR AUSTRALIA

Sections 2.1, 2.2 and 2.3 of this paper have presented a realistic and objective assessment of current circumstances, based on a review of information generally available.

The implications for Australia are simple, and alarming.

As a country very highly dependent on road transport for the movement of both goods and people, and as a country currently committed almost entirely to the use of products derived from crude oil to fuel that transport, Australia is in a position of great vulnerability.

That vulnerability is exacerbated by the fact that Australia's indigenous reserves of crude petroleum are lower than the global average, and the rundown of Australia's oil reserves is occurring at a faster rate than the global average.

These circumstances suggest that Australia is particularly exposed to likely future constraints in the global price and supply of petroleum. These circumstances further suggest that Australia needs an urgent shift to policy settings that can effectively facilitate a shift in demand from conventional fuels such as petrol and diesel to more sustainable alternatives, and thereby trigger commercially and socially viable corrections.

3 ENVIRONMENTAL ISSUES

The prime thrust of this submission is the vulnerability of Australia and Australia's largely petroleum fuelled transport sector to the not so tender mercies of an increasingly stressed global crude petroleum market.

It is relevant, however, to provide an indicative snapshot of the impacts that petroleum based transport fuels can have on our urban environments, particularly those of our major cities, and the potential benefits that alternative transport fuels can have in this area.

Alternative transport fuels are not presented as a total panacea or "magic bullet' in this regard, but as a potentially valuable contributor to the better and more sustainable management of our urban environments, and particularly of urban air quality in our major cities.

Air quality in Sydney has been used as an example.

3.1 AIR QUALITY IN SYDNEY

Sydney is a large, sprawling city, with a very heavy dependence on private motor vehicle transport. Sydney is also a city located within a classical "pollution basin", where air pollutants from transport and other sources tend to be trapped by prevailing geographic and meteorological conditions. Elevated levels of air pollution are known to cause unacceptable increases in the incidence of many illnesses, including respiratory, coronary and other very serious conditions.

Sydney already experiences regular exceedances of established air quality goals, largely as a consequence of the city's high and increasing dependence on private road transport, coupled with the natural tendency of the Sydney basin to "trap" and retain air pollution.

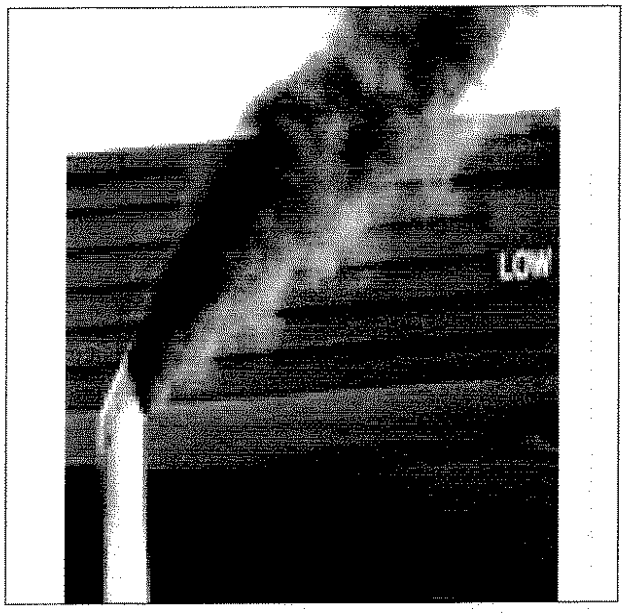


Figure 5 – Motor Vehicle Sourced Pollution

OZONE AND FINE PARTICLE POLLUTION LEVELS

Ozone is a harmful urban air pollutant, generated by the collective impact of other air pollutants in what is known as photochemical smog.

Ozone also causes increases in respiratory and other illnesses, and is an effective "marker" for urban air pollution and smog levels.

Fine particle pollution, generated to a large extent by road transport sources, is of increasing concern internationally.

It has been identified as a cause of respiratory and coronary conditions, and cancer.

The New South Wales State of the Environment Report 2003 shows that Sydney experiences regular exceedances of established air quality goals and regulations for both ozone and fine particle pollution. These exceedances are illustrated in Figures 6 and 7 below, both sourced from the 2003 State of the Environment Report, prepared by the NSW Government.

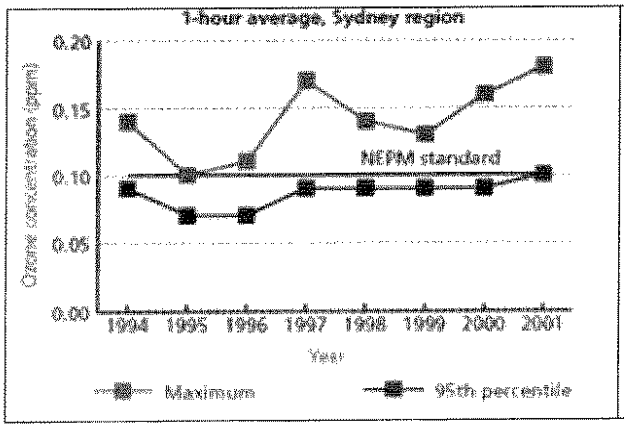


Figure 6 – Ozone Pollution Levels

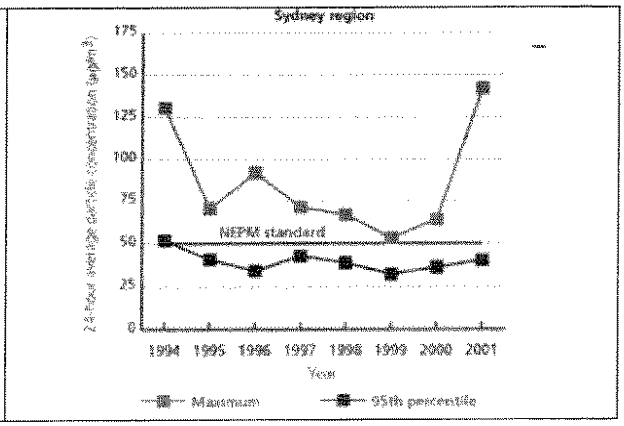


Figure 7 – Fine Particle Pollution Levels

The worst impact of air pollution in Sydney is felt in the western and southwestern suburbs. Figure 8 below, based on information presented in the 2003 NSW State of the Environment Report, shows typical concentrations of ozone within the Sydney basin.

The graphic used is reproduced with the generous permission of the Sydney Morning Herald, and Fairfax Newspapers.

The NSW EPA's current air quality guideline for ozone, on a four hour average basis, is 8 parts per hundred million (pphm). Areas shown in the deeper orange and red colours in Figure 8 involve ozone concentrations at, or above, this health risk based guideline or limit.

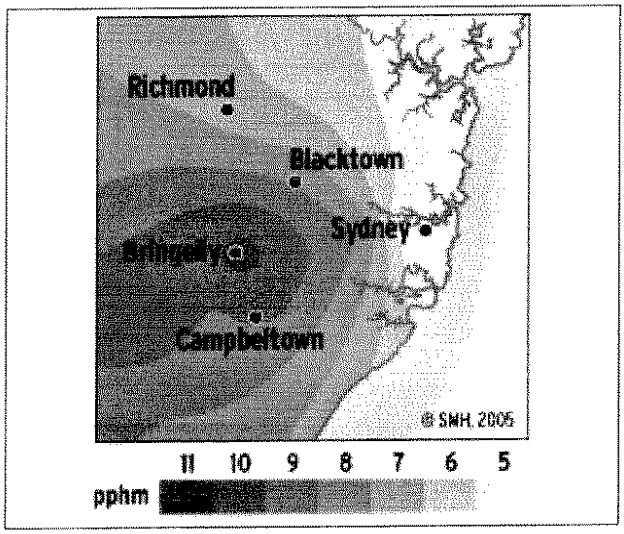


Figure 8 – Ozone Distribution in Sydney

This air pollution "footprint" is particularly alarming given that plans recently released by the NSW Government for the provision of some 160,000 new houses, to accommodate projected population growth over the next twenty five years or so, rely on development of land in north western, western and south western Sydney that is subject to the peak air pollution impacts illustrated in Figure 8.

Existing air pollution is very largely caused by motor vehicle exhaust emissions, and the use of alternative fuels and engine technologies that reduce the existing levels of harmful exhaust emissions would be of very significant benefit to the community, and no doubt to the national health budget.

3.2 IMPLICATIONS

Sydney has an existing air quality problem, and this problem has its origins in no small part in exhaust emissions form motor vehicles fuelled by "conventional" crude petroleum derivatives such as petrol and diesel. Current efforts to manage the problem rely on changes in the formulation of fuels, and in the design and technology used in motor vehicle engines.

Many alternative fuels, including in particular natural gas, generate significantly lower levels of harmful exhaust emissions than petrol and diesel, and therefore offer very real advantages in terms of urban air quality, community health, and the very significant cost reduction to government and therefore the community that would result from reductions in air pollution.

4 ALTERNATIVE FUELS & TECHNOLOGIES

4.1 INTRODUCTION

This paper argues for policy change at the federal level that will "drive" the introduction of alternative fuels and technologies in Australia through activity and competition in the commercial marketplace.

This paper also includes a particular focus on the role of natural gas as an alternative fuel, and the very significant advantages offered by natural gas. However, the general concept being promoted is that an increased emphasis be placed on the role of alternative transport fuels and technologies generally.

For this reason, it is appropriate to present a brief overview of the major alternative fuel and technology options available to the Australian transport sector.

4.2 AN OVERVIEW OF ALTERNATIVES

For several generations transport fuels in Australia, and elsewhere, have been dominated by products such a petrol and diesel, derived from the refining of crude petroleum. In recent years, this paradigm has been called into increasing question for several reasons, including:

- the increasing contribution of petroleum based fuels to greenhouse gas emissions, and global warming;
- the environmental and health impact of petrol and diesel exhaust emissions, particularly in urban areas; and
- the acknowledged run down in global crude petroleum reserves, and related economic and sustainability issues.

In response to these challenges, a number of alternative fuel and technology options have been developed, and are being evaluated and implemented to varying extents in Australia, and internationally. The major alternative fuel and technology options currently available or emerging in Australia include the following:

NATURAL GAS

Natural gas is made up primarily of methane, and is the lightest of all the hydrocarbons. For this reason, natural gas has the lowest carbon to hydrogen ratio of all the hydrocarbon fuels, and therefore generates lower quantities of the greenhouse gas carbon dioxide on combustion.

Natural gas is an efficient transport fuel in both compressed and liquefied forms, and produces lower greenhouse gas emissions than petrol, diesel or LPG. The use of natural gas in passenger cars has been constrained in Australia by an absence of public refueling infrastructure, although its use internationally has increased very significantly in recent years. Natural gas is currently being evaluated and used in a number of Australian truck fleets, and as described earlier in this paper Australia has significant reserves of natural gas, compared to limited and declining indigenous reserves of crude petroleum.

LPG – LIQUEFIED PETROLEUM GAS

LPG is primarily liquid propane, and is produced in conjunction with crude oil production and refining, and also from natural gas production. LPG is an efficient fuel, and currently provides between 8 and 10 percent of the passenger fuel used in the Sydney market, where an extensive public distribution network has been developed. The overall use of LPG in Australian transport applications is probably less than 5 percent, but it remains the most widely used alternative to petrol and diesel in the passenger and small commercial vehicle sector. LPG offers a greenhouse advantage in that it is less "carbon dense" than petrol and diesel, and therefore generates lower emissions of the major greenhouse gas carbon dioxide.

LPG is not particularly well suited for heavy vehicle use, and few applications have developed in this area. The pricing and availability of LPG are both closely tied to the petroleum industry. The supply of LPG is limited, and as a fuel it sits somewhere between natural gas and the traditional fuels with respect to ease of handling and storage, and in terms of environmental advantages.

BIO-DIESEL

Bio-diesel is produced from either virgin or used vegetable oils by removing the glycerine naturally present in these products.

The product has been extensively promoted as an alternative to diesel, and is currently being evaluated by a number of fleet users, including local government fleets in Camden and Newcastle in NSW, and in other local government fleets elsewhere.

ETHANOL/PETROL BLENDS

Ethanol, or alcohol, is an efficient fuel, and can be used as a blendstock or "extender" in petrol. The economics and life cycle environmental performance of ethanol depend on its production source. Ethanol produced from grain generates significantly lower overall greenhouse gas emissions, taking production into account, than ethanol produced from sugar.

Some controversy has surrounded the use and performance of ethanol as a petrol blendstock, but an objective assessment of available data suggests that ethanol can be safely used at levels up to ten percent without any undue impact on the vast majority of passenger vehicles currently commercially available, and without engine modification.

SYNTHETIC LIQUID FUELS

There are a number of other materials that can be synthesised by various chemical means and processes, and that can perform efficiently as liquid transport fuels.

Methanol, which like ethanol is an alcohol, can be synthesised by various processes, often from methane, and like ethanol can be used as an "extender" for petrol, or with appropriate engine modifications as a fuel in its own right.

There is an underlying concern, however, that methanol and its various combustion by-products are significantly more toxic and environmentally harmful than ethanol, and its combustion by-products.

It is also possible to synthesise or manufacture other viable liquid fuels. Such synthetic liquid fuels include di-methyl ether (DME), and others that can be produced from feedstocks such as natural gas (methane) by means referred to generically as "gas to liquids" (GTL) processes.

To this point in time, the relatively high cost of gas to liquids options has precluded commercial applications. While these economics will obviously be subject to ongoing review with increases in the price of crude oil, gas to liquids options will still need to be able to deliver an end product that is more cost effective than the methane, or natural gas, that is used as a feedstock for their production, and which itself can be used as a viable and efficient fuel without chemical modification.

ELECTRIC VEHICLES AND BATTERY TECHNOLOGY

Concerns about the long term sustainability and environmental impacts of conventional petroleum based fuels have led to the consideration of electrically powered vehicles, using storage batteries re-charged from the electricity grid, or from solar or other sources.

Thus far, the commercial availability of electrical power in vehicles has primarily been through the use of hybrid vehicles, using internal combustion engines to support on board electrical systems. Further development of storage battery technology is continuing.

HYBRID ELECTRIC-HYDROCARBON FUEL SYSTEMS

Hybrid petrol/electric passenger cars have been developed and are now commercially available. Options are available from manufacturers such as Toyota, Honda and others.

Energy efficiency is optimised by storing electrical energy generated during the fuel cycle of the engine in on-board batteries, and then using this energy through an electric motor to minimise the consumption of hydrocarbon fuels. The fuel used in hybrid systems can be petrol, diesel, natural gas, or any of the other alternatives described in this paper. The purchase cost of hybrid vehicles is currently higher than equivalent petrol vehicles, but costs can be expected to decline with increased market demand and production.

Similar hybrid systems are being developed for use in the "medium" truck market. A hybrid diesel/electric truck is currently being demonstrated by Hino in Australia. Other manufacturers, including Isuzu, are developing similar options.

HYDROGEN & FUEL CELLS

Hydrogen appears certain to become a viable transport fuel in the future, either as a direct fuel in internal combustion engines, or as a fuel source for power cells. A significant amount of research is being conducted into relevant technologies, and a number of prototype hydrogen and power cell vehicles are currently being evaluated.

Hydrogen is a very clean fuel compared to all the hydrocarbon fuel options – the only combustion byproduct being water. However, the realities of providing distribution infrastructure and developing commercially viable engine and vehicle options probably mean that the widespread use of hydrogen as an alternate fuel is still at least a generation away.

4.3 THE ECONOMICS OF ALTERNATE FUELS

One of the reasons for the great success and longevity enjoyed by crude petroleum and its derivatives petrol and diesel is economic. For generations, these products have provided a convenient, energy "dense" and relatively safe transport fuel option.

The success, and particularly the historic cost advantages, of petroleum based fuels have not only underwritten there own success, but have acted as a bulwark to the entry of alternative fuel to the marketplace.

Regardless of unit production costs, the cost of supply and distribution infrastructure has proved limiting in most cases.

It is likely in fact, other than for the supply/price pressures now emerging, and summarised earlier in this paper, that crude petroleum and its derivative products petrol and diesel would continue to dominate the transport fuel market, and that associated environmental issues would be resolved by technological means.

It now seems inevitable, however, that the virtually unchallenged reign of crude oil, petrol and diesel in the Australian transport sector will be supplanted not because of issues of inherent efficiency and convenience, but by the grind of supply limitations and associated cost pressures. For this reason, it is relevant to place some scale on the current cost of alternatives.

The main alternative fuels currently available in Australia are natural gas, LPG, biofuels such as ethanol and biodiesel, and hybrid engine technologies using a mix of petrol or diesel engines, and electrical energy stored in on-board batteries. Other potentially available alternative options in the medium term include synthetics such as di-methyl ether and methanol, and in the longer term hydrogen and various power cell technologies.

The Australian Government has issued an assessment of the costs of various transport fuel options, exclusive of tax or excise. This cost summary is provided in Figure 9.

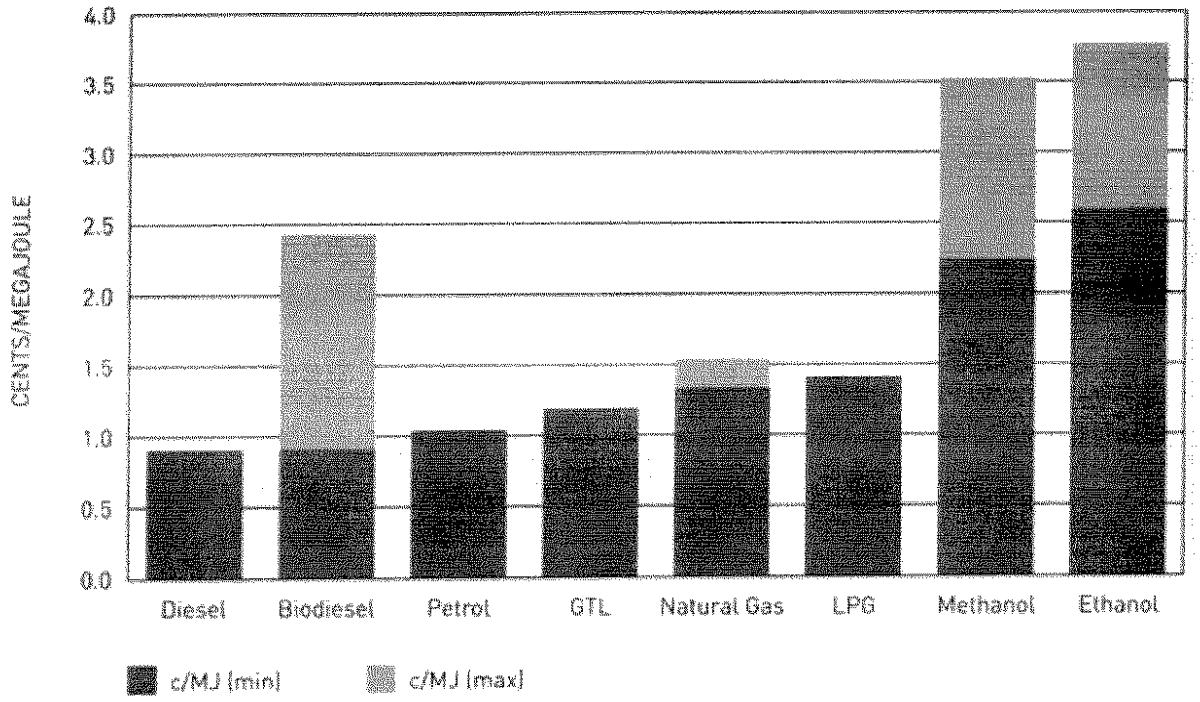


Figure 9 – Unit Fuel Costs in Australia (Exclusive of Excise or Tax)

Source: Australian Government estimates

Note: Prices of petroleum fuels vary with international oil prices and exchange rates. Minimum and maximum prices for biofuels and natural gas-sourced fuels reflect large variations in feedstock prices and/or throughput volumes. Based on an oil price of US$35 per barrel and an exchange rate of A$1 = US70cents

It should be noted that these figures have been based on a crude oil price of US$35 per barrel – approximately half the price prevailing at the time of this submission.

It is also important to note that the unit price used for natural gas in these Australian government estimates appears to be conservative, and high. Based on actual data presented later in this submission (Table 2, page 15), the current price of gas in the Australian market is in the range 0.5 to 1.0 ¢/MJ.

The flow on effect of the doubling of the base crude oil price, and the lower actual price of natural gas, would have the effect of making the unit cost of diesel and petrol significantly higher than that of natural gas, but still lower than the price of methanol and ethanol.

On this basis, natural gas would in fact appear to be one of the most, if not the most, cost effective transport fuel options available in Australia at the present time.

EXCISE CONSIDERATIONS

No effective excise will apply to currently untaxed alternative fuels until 1 July 2011. Effective excise will then be introduced in five equal annual steps to a final rate on 1 July 2015. The phased introduction of excise recognizes the need for effective transitional arrangements to give fuels that are currently effectively untaxed an opportunity to establish their place in the market. Alternative fuels entering the excise net will also receive a discount of 50 per cent on the full energy content excise rate.

5 NATURAL GAS AS A TRANSPORT FUEL

5.1 INTRODUCTION

The purpose of this submission is to stimulate thought and consideration of Australia's current vulnerability to increasing reliance on imported crude oil, and refined products such as petrol and diesel derived from imported oil.

If the vulnerability of Australia's current position is accepted, then consideration of alternative transport fuels and technologies follows as an obvious consequence.

In this regard, the question of "what alternatives" remains, and should remain, an open question. However, the authors of this paper have some considerable collective experience in the natural gas field, and in the use of natural gas as a transport fuel. For these reasons, this section of the submission presents a brief overview of the characteristics and capabilities of natural gas as a transport fuel.

5.2 NATURAL GAS AS A TRANSPORT FUEL

Natural gas is a high quality transport fuel. Some of its important characteristics as a transport fuel are:

ENERGY CONTENT

One cubic metre (uncompressed) of natural gas has a typical energy content of between 38 and 40 megajoules – similar to the energy content of one litre of diesel (approximately 38.5 megajoules), and about 12% higher than the energy content of one litre of petrol (approximately 34 megajoules).

COMPRESSION & LIQUIFICATION

To facilitate its use as a transport fuel, natural gas distributed through existing gas pipeline networks can be compressed. Typically, one cubic metre of gas can be compressed to a volume of between 4 and 5 litres – meaning that between four and five times the volume of storage capacity, compared to petrol and diesel, is needed to provide the same range. Natural gas can also be liquefied, a process that largely delivers equivalent on board fuel storage volumes to those required by petrol and diesel. However, the liquefaction process involves refrigeration as well as pressure, and therefore involves higher costs than simple compression.

GREENHOUSE CHARACTERISTICS

Natural gas is composed primarily of methane, which is the simplest hydrocarbon and which has the lowest carbon : hydrogen ratio of all of the fossil fuels, that is of coal, crude oil and its refined derivatives including petrol, diesel and LPG, and of course natural gas itself. As a result, when an energy equivalent quantity of natural gas is burned, less carbon dioxide is released than for LPG, petrol and diesel. **Natural gas is intrinsically the most greenhouse friendly of the fossil fuels.**

OCTANE RATING

Natural gas has a high octane rating. The Research Octane Number (RON) of natural gas is approximately 130, compared to various petrol blends between 92 and 98 RON, and ethanol at approximately 104 RON. This high octane number permits high compression ratios to be used in spark ignition engines running on natural gas, allowing for potentially higher engine efficiency.

HIGH QUALITY COMBUSTION CHARACTERISTICS

Natural gas as the name implies, is a gas at all atmospheric temperatures and pressures and mixes readily with air or oxygen ensuring more complete combustion within the cylinders of an internal combustion engine (ICE), with resultant comparatively lower emissions of pollutant exhaust products caused by incomplete fuel combustion, particularly compared to petrol and diesel.

5.3 THE ECONOMICS OF NATURAL GAS AS A TRANSPORT FUEL

An indication of the unit cost of natural gas compared to conventional fuels, and other alternative fuels, was provided in 4.3 above.

The price of natural gas varies fairly widely in global terms due to a variety of factors, ranging from location, quality, production and transportation through to government taxing regimes.

To compare natural gas prices it is worth bearing in mind, as pointed out in 5.2 above, that a cubic metre of natural gas contains approximately 39 megajoules of energy, equivalent to about 1.5 litres of LPG, 1.1 litres of petrol and 1.0 litre of diesel. The following table summarises the basic cost equivalents of LPG, petrol and diesel to natural gas at a range of natural gas prices per gigajoule (GJ), on an energy equivalent basis.

Table 2 - Comparison of Fuel Prices (Energy Equivalent Basis)

Natural Gas Price	LPG	Petrol	Diesel
($A per GJ)	(A¢ per litre equivalent)		
5.00	19.3	14.3	12.8
10.00	38.5	28.6	25.6
15.00	57.8	42.9	38.4
20.00	77.0	57.2	51.2

Table 2 indicates, that, for example, a Melbourne domestic gas user who, typically, has gas delivered to the door for $8.65 per GJ, is paying the equivalent of around 25¢ per litre of petrol and a sizeable Adelaide industrial user, receiving gas delivered for say $7.50 per GJ is paying the equivalent of 19.2¢ per litre of diesel.

This data presents an even more attractive price profile of natural gas in comparison to other fuels than the Australian Commonwealth indicative data previously presented in Figure 9.

Both data sets paint a very attractive position of natural gas, as an alternative transport fuel, in economic terms. It is important to note, in this respect, that natural gas is an indigenous Australian resource, subject to domestic controls not applicable to the (potentially runaway) global price of crude petroleum, and its refined derivatives petrol and diesel.

5.4 NATURAL GAS AS A PATHWAY TO HYDROGEN TECHNOLOGIES

There is a broad, and probably reasonable, view that hydrogen will be the transport fuel of the future. As in so many other things, however, timing is likely to prove critical, and limiting.

A view appears to be emerging, even among the staunchest proponents of hydrogen as a fuel of the future, that a significant shift toward natural gas in the interim would pave the way for the future use of hydrogen on a widespread basis, by helping develop practical systems, technologies and infrastructure for the supply, distribution and delivery of hydrogen.

The development of storage and refuelling equipment, globally, over the past twenty years has resulted in viable and available systems that can operate safety and efficiently at 20 megapascals (MPa) and, at this pressure, store enough gaseous fuel onboard a vehicle to allow a reasonable range. To be practical, hydrogen refuelling and storage equipment would need to operate at around 60 megapascals of pressure (MPa), which is significantly higher than the upper operating limits of current technology. Hydrogen also has a significantly lower ignition temperature than natural gas, and a much broader explosive range. All these important issues need to be considered, and resolved, before hydrogen can be used widely and safely as a transport fuel.

The natural gas vehicle industry has, by now, developed a comprehensive range of standards and codes of practice, whereas there are virtually none for hydrogen.

Considering the need to devise environmentally friendly processes for producing hydrogen and the need to advance the technology, there is much to be said for developing the NGV industry relatively quickly and the hydrogen industry in its wake.

5.5 NATURAL GAS VEHICLES GLOBALLY

Natural gas vehicles, and natural gas fuelling systems, have been widely embraced internationally over the past twenty years, as many nations come to grips with cost and supply pressures associated with conventional petroleum sourced fuels.

A brief overview of the use of natural gas in transport applications globally is as follows:

NORTH AMERICA

Taxes on petrol and diesel in North America, and in particular in the United States, are low. For this reason, the introduction of natural gas as an alternative to petrol and diesel was originally driven by environmental concerns. More recently, the United States in particular has developed increasing levels of concern regarding its reliance on imported petroleum products, and therefore its exposure to an increasingly volatile global oil market.

Commuter bus fleets in many major North American cities have embraced NGV as have other depot based medium and heavy duty vehicles.

It is estimated that there are about 150,000 natural gas vehicles (NGVs) on the roads of the USA and Canada, which is not a high proportion of the perhaps 200 million vehicles in use in these countries.

EUROPE

The European Union is made up of many demographically different countries, and the use of natural gas in transport applications varies widely within them.

In general however, the European nations, especially the major ones, e.g. UK, France, Germany, Italy and Spain, are characterized by high tax and excise regimes, and as a consequence by high petrol and diesel prices.

The EU, generally, has adopted a proactive approach to the reduction of greenhouse gas emissions, and has targeted transport fuels and emissions as an area where gains in greenhouse gas emissions can be achieved.

The EU, like the United States, has developed increasing concerns about the volatility of global oil markets.

The European Union, which is the policy making body for the member nations of the European Common Market countries (but does not draw up legislation for any of them) has developed an energy policy which recognizes the need, for environmental, economic and supply security reasons, to broaden the range of fuels needed for transportation.

In effect, Europe, through the EU, is leading the world in questioning the status quo and by putting forward the policy which would see 20% of transportation energy supplied by fuels other than petrol and diesel, by the year 2020 (the so called 2020 policy). Half of the 20% supplied by alternatives, i.e. 10% of the total, is expected to be natural gas.

At the present time, it is estimated that there are some 575,000 natural gas vehicles operating within the EU. Beyond road transport applications, natural gas is also being used as a fuel in European canal cruise boats, in railway applications, and in heavy duty ferries.

ASIA AND THE MIDDLE EAST

Geographically, crude oil distribution has not generally been kind to Asia whereas natural gas is abundant in countries such as Indonesia, Thailand, Malaysia and Australia, and even in parts of China.

Over the past decade, and particularly over the past five years, there has been very significant growth in the number of natural gas vehicles in Asian countries. Current numbers are Pakistan (500,000), India (225,000), China (80,000), Egypt (55,000) and Bangladesh (30,000).

Beyond these existing activity levels, many Asian and Middle eastern countries have committed to further major programs for the use of natural gas in transport applications. The Iranian government expects to have 1.5 million vehicles operating on natural gas by the year 2010, growing to six million vehicles in the longer term. The prime motivation in Iran is economic. Iran, although a major exporter of crude oil, has no oil refineries, and must therefore import petrol and diesel. Natural gas can be produced and distributed widely at low cost, and as a totally internal operation.

China currently uses natural gas to supply just 3% of its primary energy, but with the completion of the 4,200 km northwest to southeast, one metre diameter gas pipeline commissioned in September last year, and a series of CNG terminals along China's south eastern coastline, this figure is expected to rise to around 10% by 2010 and to 15% by 2020. The new pipeline will facilitate gas delivery to 100 major inland cities.

The Chinese Government has nominated 16 cities, including Beijing and Shanghai, which must convert buses and taxis to alternative fuels as a matter of priority. In Beijing, 18,000 buses and 65,000 taxis must be operating on alternative fuels by the time that City hosts the Olympic Games in 2008 and it is expected that at least 90% will utilise natural gas. There are currently 50 natural gas refuelling stations in Beijing, and all but alternative fuel vehicles are prohibited from access to the inner city area defined by Beijing's 3rd ring road. Shanghai has a similar requirement for the conversion of 20,000 buses and 40,000 taxis to alternative fuel operation – primarily natural gas – prior to the 2010 World Expo.

It is somewhat ironic that China's march towards more sustainable transport fuels is being based in large part on relatively low cost imports of liquefied natural gas from Australia, exports which at least in part increase Australia's own exposure and vulnerability to increasing levels of imports of crude oil and refined petroleum products.

Japan and Korea, both importers of virtually all transport fuel, have positive plans for the increased use of natural gas in transport applications, and both countries are manufacturers of natural gas vehicles. Korea has committed to and partly implemented an 8,000 unit natural gas bus program in Seoul, and in Tokyo, like London, Beijing and other cities, access to the CBD is restricted to alternative fuel vehicles.

India is of special interest. The High Court of India has declared that the Cities of Delhi and Mumbai must convert all buses, taxis and tricycle cabs to natural gas.

Another country of particular interest is Egypt, where a major program for the use of natural gas has been implemented on both environmental and economic grounds. The increased use of natural gas will maximise the amount of crude oil sold on the market, and will also contribute in a significant way to resolving the very serious air pollution problems currently experienced in major cities such as Cairo.

SOUTH AMERICA

Argentina and Brazil are the two leading NGV countries in the world, operating natural gas vehicle fleets of 1.3 million and 0.8 million respectively, with additional vehicle conversions to natural gas of approximately 100,000 annually. In Argentina, this equates to between 25% and 30% of all vehicles. The rate of conversion of vehicles to natural gas in Brazil is such that Brazil expects to have overtaken Argentina in terms of the number of NGVs within about three years.

5.6 NATURAL GAS VEHICLES IN AUSTRALIA

An estimate of natural gas vehicle use in Australia is provided in Table 3.

Table 3 - Natural Gas Vehicles in Australia (Estimated – November 2005)

	NSW	ACT	VIC	QLD	SA	WA	TOTAL
Buses (Government)	405	20	20	110	215	100	**870**
Buses (Private)	0	0	0	0	0	0	**0**
Cars & Station Wagons	40	5	20	10	5	5	**85**
Fork Lift Trucks	650	20	200	50	150	0	**1070**
Light Commercials (<4.5 tonnes)	25	5	5	5	5	0	**45**
Trucks (>4.5 tonnes)	25	0	30	5	10	20	**90**
TOTAL	**1145**	**50**	**275**	**180**	**385**	**125**	**2160**

(numbers rounded to the nearest five)

These figures are best estimates – but serve to illustrate the current situation. Natural gas has enjoyed good success in the bus and forklift truck markets, and there are a number of highly promising programs involving natural gas trucks throughout Australia, mostly supported by Commonwealth Government alternate fuel programs. These programs provide a real foundation for future growth in the NGV truck market.

However, progress in the mainstream car, light commercial and truck markets has been virtually non-existent – certainly in terms of critical commercial mass.

An estimate of the aggregate natural gas used by all of the vehicles listed in the above table amounts to about 1500 terajoules - about 0.15% in energy terms of the total fuel used by road transport in Australia - an insignificant figure.

Government bus fleets currently account for more than 80% of the natural gas that is used in the Australian transport sector. The 405 natural gas buses in the NSW Government fleet in Sydney account for more than 1% of the total amount of natural gas consumed in New South Wales – a commercially significant outcome. These buses have contributed to a cleaner environment, and given the current gap between gas and diesel prices, should also be generating significant cost savings for the taxpayers of New South Wales.

Somewhat inexplicably the NSW Government announced in June 2004 that future bus purchases would be diesel. The NSW Government currently has a tender out for the purchase of 505 buses. Maybe the implications an increasingly uncertain global oil market will prompt a reconsideration of the natural gas option.

6 WHERE TO FROM HERE?

6.1 THE CURRENT SITUATION

It seems appropriate at this point to draw some general conclusions based on the material presented thus far in this submission.

Without seeking to identify a particular timeframe, it appears inevitable that global demand for crude petroleum and associated refined products such as petrol and diesel will grow to exceed the finite supply of these resources at some point in time.

It also appears to be a matter of simple fact that Australia's indigenous reserves of crude petroleum are in relatively rapid decline, and that the rate of that decline is greater than the overall average run down in global reserves.

Against this background, Australia is a country with a very high level of dependence on road transport for the movement of both people and goods; with a current reliance of greater than 95% on products derived from crude petroleum to fuel that road transport sector, and a rapidly escalating dependence on imported crude oil and refined products to provide that fuel.

It is the very considered view of the authors of this submission that that transport energy balance involves very significant risks for the future security and stability of this country and its underlying economy.

The irony has been emphasised earlier in this submission that Australia continues to expand its exports of natural gas – itself a very viable alternative transport fuel – while increasing our imports of crude oil and related petroleum products.

The basic circumstances seem clear enough, even if the precise quantum and timing of the challenge remain subject to debate. The fundamental premise of this submission is that Australia has a serious and rapidly emerging problem in the area of transport fuel security and economics.

The real question is what should be done, and by whom.

6.2 THE DUAL ROLE OF GOVERNMENTS AND MARKETS

We live in an age where intervention by government in commercial matters is at best unfashionable, and at worst unacceptable.

For many years the Australian Government has, through the Australian Greenhouse Office, provided a range of programs intended to stimulate the use of alternative fuels. However, these programs themselves present an interesting dilemma.

At face value, government support for the alternative fuels is positive, and should be welcomed.

However, perhaps a more lateral analysis is required.

Current government programs in Australia are based on achieving reductions in greenhouse gas emissions. While many alternative fuels and technologies, including in particular natural gas, offer net greenhouse advantages compared to more carbon dense conventional fuels such as diesel and petrol, it may be that greenhouse, however important, is not the most relevant or important driver for the significantly increased use of natural gas and other alternate fuels in Australian transport applications.

Based on the analysis presented in this submission, the most powerful drivers for alternates in Australia are resource security and resource and transport economics. In the absence of a significant and urgent increase in the aggregate use of alternative fuels and technologies, this nation may well be over-exposed, and over-vulnerable, to the not so tender mercies of the global oil market.

The Commonwealth has attempted to stimulate a shift in the nation's fuel habits by a limited range of environmentally based incentives and subsidies.

There is an emerging risk that such subsidies, however well intentioned, may prove to be a dangerous policy narcotic. That some suppliers of alternative fuels and technologies, seeing subsidies as a potential revenue nirvana, apply less rather than more attention to market competitive and market real placement and pricing of their products.

The time may well have come for alternative fuels to occupy a nominated proportion of the Australian transport market, but for alternative fuels and technologies to rise or fall within that proportion of the overall transport fuel market on the basis of the inherent strengths and weaknesses of individual options – in an open market scenario.

The outcome of such an approach may be surprisingly positive.

6.3 BALANCED STEWARDSHIP

Australia has developed as a modern market economy, and Australians have generally benefited from that situation.

But Australia, in both the public and private sectors, is inherently conservative – and slow to change established and successful practices. This applies to transport fuel – an area in which petrol and diesel have ruled for generations, and have provided relatively cheap, safe and convenient options.

The petroleum industry can be expected to use its not insignificant lobbying strength to prolong the use of petrol and diesel. However, it is the Australian economy that is vulnerable to escalating oil prices - not the pocketbooks of the oil majors.

The Australian transport sector is in effect an established monopoly in terms of fuel type – shared with increasing comfort and profit by the petroleum industry. This is an arrangement that has in effect served both the country, and the industry, well over past years.

The petroleum industry has, however, emerged through this process as an enormously well established and stable industry, with a controlled system of product supply storage, distribution, and a minimum of competition. Fundamental change to this system is unlikely to occur incrementally.

But whether we like it or not, however, the global energy balance is changing. Crude petroleum is a finite resource, subject to dramatically increasing demand pressure, particularly from emerging economies such as China. Over time, and in a pattern of peaks and troughs, the price of crude oil – and therefore of petrol and diesel – is almost certain to rise faster than other key inputs to the Australian economy.

The Australian transport sector appears to cry out for a managed but significant shift, at least in an interim sense, to a basket of immediately available and viable alternative fuels and technologies. Other transport fuel alternatives – including power cell and hydrogen technology – provide a tantalising panacea for some, but in practical and commercial terms are still a significant time away.

The great challenge confronting the Australian government, assuming an acceptance of the scenario presented in this paper, is not whether to drive change, but how to drive change.

7 CONCLUSIONS & RECOMMENDATIONS

This paper has presented an analysis of a range of factors pertinent to Australia's future oil supply, and alternative transport fuels.

The basic conclusions of this submission are that:

The Australian transport sector is highly, and overly, dependent on products such as petrol and diesel, derived from crude petroleum;

Australia's indigenous reserves of crude petroleum are in relatively rapid decline, and as a consequence our transport sector, and to a significant extent our economy more generally, relies on imports of crude petroleum and refined products from international sources;

The international petroleum market has reached, or is approaching, a point where demand for crude petroleum and associated refined products such as petrol and diesel exceeds supply;

This situation exposes the Australian transport sector, and the economy more generally, to significant vulnerability in terms of both untenable escalations in fuel costs, and unmanageable constraints in fuel supply; and

This situation warrants appropriate policy intervention by the Australian government.

The recommendations of this submission are:

That existing Australian government programs and incentives for the increased use of alternative fuels be retained, but that consideration be given to shifting the basic thrust of these programs and incentives from an environmental base to a resource security base;

That the imposition of excise on alternative fuels not currently subject to such excise proceed as planned over a progressive five year period between 2011 and 2016;

That the Australian government considers the introduction of a policy requiring that a nominated proportion of Australia's transport fuel requirements is supplied by fuels and technologies other than petrol and diesel;

That the quantum of this alternative fuel proportion be twenty percent by 2020; and

That the alternative fuels to meet this nominated proportion of the Australian transport fuel sector be determined by inherent supply viability and technical suitability, and by performance in a competitive marketplace.

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Ollie Clark AM is the recently retired former Managing Director of Envestra Limited, a major Australian energy company, and is Chairman and Director of a number of commercial and community based organisations. Ollie has a very detailed understanding of the energy industry throughout Australia and globally, based on his forty nine years involvement in the Australian gas and energy sector. HE is a former Chairman of the International Association for Natural Gas Vehicles, the Australasian Natural Gas Vehicles Council, and the Asia Pacific Natural Gas Vehicles Association. Ollie has been awarded membership of the General Division of the Order of Australia ..."for service to the gas industry, particularly through promoting natural gas as a clean and reliable energy source and the development of technical codes and standards, and to educational and community organizations."

Simon Humphries is Manager Product Planning and Engineering Support for Isuzu Australia Limited, one of the leading suppliers of trucks to the Australian transport sector, and through this role has had considerable experience with a range of alternate fuel and engine technologies, in Australia and internationally. Simon is a former Director of the Australasian Natural Gas Vehicles Council, and has been closely involved in the evaluation of natural gas trucks in the Australian transport marketplace. He as a personal and professional interest in, and commitment to, the future sustainability of the Australian truck and general transport sectors.