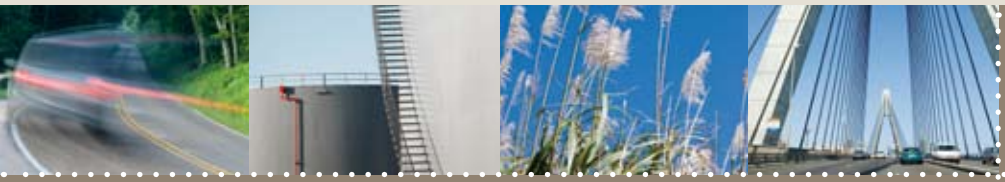
A Roadmap for Alternative Fuels in Australia:
Ending our Dependence on Oil



Report of Jamison Group to
NRMA Motoring & Services
July 2008

Jamison Group:
Mark Diesendorf
David Lamb
John Mathews
Graeme Pearman

The Jamison Group

The Jamison Group was established by the NRMA Motoring & Services following the company's Alternative Fuel Summit in 2006 and comprises four eminent scholars in the fields of energy and transport – David Lamb, Mark Diesendorf, John Mathews and Graeme Pearman.

Mark Diesendorf

Dr Mark Diesendorf has contributed to this project under his business name, Sustainability Centre. Previously, at various times, he has been a Principal Research Scientist in CSIRO, Professor of Environmental Science at University of Technology Sydney, and President of the Australia New Zealand Society for Ecological Economics. He is author of many scholarly papers, consulting reports, popular articles and media items on ecologically sustainable development, including the recent book 'Greenhouse Solutions with Sustainable Energy'.

David Lamb

David Lamb worked for 28 years in the motor industry in Australia and around the world. From 1992 to 2003 he was Chief Executive of the CSIRO Australian Automotive Technology Centre and was responsible for the CSIRO Low Emission Vehicle project that resulted in two hybrid electric show cars. The aXcessaustralia car was exhibited around the world to carmakers. He was also responsible for the collaboration between CSIRO and Holden Australia to produce the Holden ECOommodore Hybrid electric car, first shown publicly in May 2000. Now retired from CSIRO, David consults on automotive technology and strategy.

John Mathews

John Mathews is Professor of Strategic Management at Macquarie Graduate School of Management, Macquarie University in Sydney. He is the author of the books Strategizing, Disequilibrium and Profit (2006), Dragon Multinational: A New Model of Global Growth (2002), Tiger Technology: The Creation of a Semiconductor Industry in East Asia (2000). Specialising in technology and innovation, John has published papers on the renewable energy industries, alternative fuels and biofuels industries. He has worked internationally with UNCTAD, UNIDO and with the World Bank, and was a Visiting Scholar at the Rockefellar Foundation Study Center at Bellagio, in Italy, in September 2004.

Graeme Pearman

Dr Graeme Pearman joined CSIRO, in 1971 where he was Chief of Atmospheric Research, 1992–2002. He contributed over 150 scientific journal papers primarily on aspects of the global carbon budget. Graeme went onto help establish the new Monash University Sustainability Institute. Graeme's work has been internationally recognised with numerous distinctions and medals. As leading science advisor, including for Hon. Al Gore in 2006 and 2007, he was voted in the 100 most influential Melbournians by The Age newspaper in 2007 and was selected as a participant in Prime Minister Kevin Rudd's 2020 Forum, April 2008.

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Foreword

Australian motorists, of which more than two million are members of NRMA Motoring & Services, are responsible for eight percent of greenhouse gases. For the sake of the environment we can and must bring that figure down.

If we don't reduce our reliance on fossil fuels our economy – as well as our environment – will suffer. Australia's oil imports have grown by 30 percent in the past four years alone and our trade deficit in oil could more than double in just a few years – unless alternatives are found.

In October 2006 the NRMA held its Alternative Fuel Summit to kick-start a debate about Australia's Transport Energy future. After the Summit the NRMA invited four leading experts in the field of transport and energy to form the Jamison Group.

They were asked to develop a roadmap to guide Australia to a transport energy future that will ensure Australia ends its dependence on imported fossil fuels.

The NRMA thanks David Lamb, Mark Diesendorf, John Mathews and Graeme Pearman for their enormous contribution to this critical debate. This is their roadmap – the Jamison Report.

Alan H. Evans
President, NRMA Motoring & Services

Executive Summary

Australia's oil dependence must end

Australia is entering a period of intense national debate over energy issues and the contribution that burning fossil fuels, together with other topics such as land use changes, is making to the country's emissions of greenhouse gases.

The transport sector provides one of the keys to reducing our carbon footprint. As a country, Australia is almost entirely dependent on oil – increasingly on imported oil – for our transport fuel.

Hand in hand with the environmental concerns of burning fossil fuels are concerns surrounding security of supply of transport fuels and self-sufficiency in these fuels. World demand for crude oil is at record highs and, unsurprisingly, oil prices are also at record levels.

Currently the demand for oil is outstripping supply.

Making up this shortfall in supply will not be possible in the short term and there are questions as to whether the world's current energy mix will be able to supply global energy needs in the medium to longer term.

Fossil fuels will continue to be the default fuel source for the transport sector, however, we are now in a position where it is necessary to examine alternatives to oil for our transport fuels.

This document seeks to shed light on some of the options available to us to decrease our reliance on oil and take us into a carbon constrained future.

Developing an Alternative Fuels Sector

While Australia has been one of the few countries lucky enough to be an oil producer, much of this has been exported. Our nation's reserves are dwindling and, as a result, we are growing increasingly dependent on imported oil.

Now is not a good time for any country to be reliant on imported oil, especially one as dependent on imported goods as Australia.

In the past four years Australia's oil imports have grown by 30 percent. Australia's oil trade deficit has already reached $10 billion, and it could swell to an alarming $25 billion in just a few years unless alternatives are found.

Record crude oil prices – reflected by sky-rocketing prices at the bowser – have driven home to Australian families and the economy the volatile nature of the world's crude oil supplies. The crippling impact on family budgets and the economy has been widely publicised.

In many ways the suffering endured today is the result of decades of inaction by previous governments and the private sector.

Now is the time to embrace transport fuel alternatives, and conveniently, many of the technologies for reducing our dependence on oil-based transport fuels are already available. Industries in biofuel technologies, natural gas processing and conversion and smart vehicle manufacture already exist in other parts of the world.

Australia can learn from these examples and we can develop industries of our own, which are particularly relevant to the local situation. This could be done with relatively small seed funding and with intelligent incentive frameworks.

Development of such industries will serve Australia in two ways: firstly, they will provide a local capability in alternative transport fuels, creating jobs and a skill base which can be transferred across to other sectors not as quick to take up the low-carbon challenge; secondly, the development of such industries will address the three related issues of reducing transport fuel emissions, enhancing energy security, and promoting energy self-sufficiency.

Given that almost $13.5 billion is invested in maintaining existing fossil fuel infrastructure, and almost $10 billion is provided to the industry in government subsidies each year, it is reasonable that seed funding contributions to an alternative fuels sector should be made.

In recognition of the current energy situation, and in particular, the rising dependence of transport fuels on imported oil, NRMA Motoring & Services held its Alternative Fuel Summit in Sydney in 2006. From this it established the Jamison Group – a committee of four leading scholars tasked with developing the nation's roadmap to a greener, less volatile and cheaper transport energy future.

This report outlines the Jamison Group's proposed 12-step roadmap for Alternative Fuels in Australia. The Jamison Group recognises that given the complex nature of the issues involved, the proposed steps will require ongoing review and development to hone strategy options for policy and action.

The Jamison Group 12-step roadmap

The following roadmap is designed to steer Australia towards a greener, more sustainable and more secure transport energy future. Some of the steps may be implemented immediately while others will require us to expand our own research and development into alternative fuels that are suitable for the Australian context.

The roadmap consists of 12 steps which we put forward in a spirit of inviting debate and further research, leading to decisive action.

Step 1

Reduce oil dependence in Australia by 20 percent by 2020; 30 percent by 2030; and by 50 percent by 2050

A critical problem calls for bold solutions that go to the root of the problem. This is what we propose to deal with Australia's dependence on oil. These goals would provide the over-arching framework to guide policies right across government as well as strategic planning in the private sector. A plan for achieving these goals could be prepared by a specially chosen cross-representative group, reporting by 2009. It would attack the problem of Australia's oil dependence head-on and would complement the proposed National Emissions Trading Scheme that should cover all fossil fuels and ensure we reduce oil imports and have a pathway to greener transport energy future.

Step 2

Promote and develop alternative fuels

We define 'alternative fuels' to be those that do not derive from oil or coal. They include fuels derived from natural gas, biomass, and from electricity generated from renewable sources. These are the alternatives that need to be promoted by government to reduce our oil imports, in place of continuing to expand our dependence on oil-based fuels. Policies need to focus on expanding the use of these alternatives, while reducing oil and fossil fuel usage. A key part of expanding the uptake of alternatives is for comprehensive research to consider in an integrated and robust way the social, economic, engineering and environmental aspects of each option.

Step 3

Compulsory fuel consumption and carbon dioxide standards

Reducing fuel consumption is the first priority. This can be achieved through adopting similar fuel consumption standards to those set by the European Union and Japan for new passenger vehicles of less than five litres for every 100 kms travelled (a cut of three litres/100km travelled) in staged increments from 2010 to 2012 to 2015. Even a cut of 2 litres/100 km travelled (similar to China) would produce fuel consumption savings of 5.3 billion litres a year and would place Australia amongst the best-practice nations internationally, whereas currently we are amongst the worst.

Step 7

Tax incentives for alternative fuels and infrastructure

Tax incentives should be provided to any company that develops alternative fuels or provides the infrastructure needed to grow the industry. Fuel tax exemptions for alternative fuels can be extended indefinitely into the future, as part of the government's reorganisation of the tax system. These changes would reinforce the direction needed, moving away from fossil fuels. In addition, tax or other incentives are needed to encourage owners of older high-fuel consuming motor vehicles to trade them in for wrecking. The import duty on energy-intensive SUVs should be raised to match that on other imported cars.

Step 8

Wind back subsidies that reinforce oil dependence

A raft of subsidies, amounting to about $10 billion per year, supports the production and use of fossil-based transport fuels in Australia. These must be ended. Subsidies include fossil fuel tax concessions, fossil fuel energy research and development, oil exploration, tax benefits on company cars and reduced excise on energy-intensive imported sports utility vehicles (SUVs). These need to be wound down while the incentives favouring alternatives are wound up.

Step 9

Use of Green Car Fund

The federal government made a pre-election commitment to create a Green Car Fund to rebuild Australia's automotive industry and committed $35 million to Toyota in June 2008. The rules of the fund should be clarified to support innovative small and medium-sized components producers in Australia that move the industry towards oil independence.

Step 4

Further compulsory emissions standards

Australian emissions standards for carbon monoxide, nitrogen oxides and particulates lag behind those of the Euro 5 and (proposed) Euro 6 standards, and behind Japanese standards, and need to be brought abreast of world best practice. This will safeguard public health, and force-march innovation and catch-up in the Australian automotive industry.

Step 5

Alternative fuel market mandates

Voluntary targets for alternative fuels will not work. Mandatory targets will ensure that we reduce our dependence on oil and prevent a balance of payments crisis. Mandated targets of five percent in 2010; 15 percent in 2015; and 20 percent in 2020 should be set. We can cut oil consumption by 20 percent in just 12 years. These targets are needed to break the grip on the market of a handful of oil companies, and provide some financial certainty for investments in alternative fuel industries. Mandates beyond 20 percent will not be needed as market forces will take over beyond that point.

Step 6

Tax incentives for vehicles running on alternative fuels or propulsion systems

Tax incentives should be provided to manufacturers who develop greener cars while those that perform at current levels or worse should be penalised. This should also be applied on the consumer side, with purchasers of greener cars receiving tax rebates. This carrot and stick approach will help Australia catch up to the rest of the developed world.

Step 10

State governments to play their role

State governments need to adjust their tax and tariff arrangements. This is particularly relevant for vehicle registrations, which should be adjusted so that drivers of lower fuel consumption vehicles pay lower registration fees. Feed-in tariffs need to be extended or introduced to allow renewable sources to sell electricity generated direct to the grid, thereby accelerating the swing towards renewable sources for electricity generation and moderating the greenhouse impact of electric vehicles.

Step 11

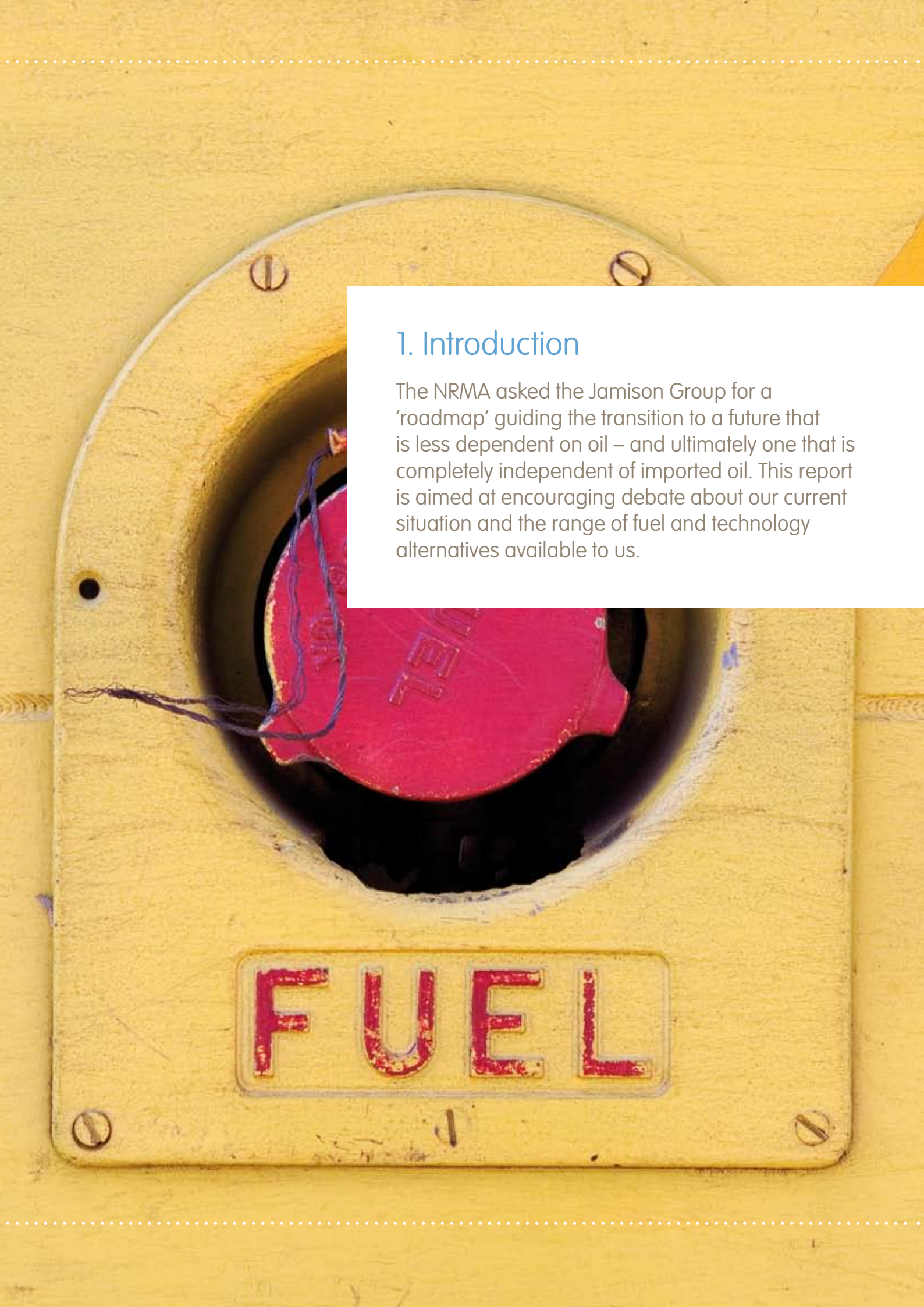
Allow carbon credits to grow alternative fuel industries

While the proposed Emissions Trading System will build a market for carbon trading, the government can also allow carbon credits to be awarded to the alternative fuels industry to encourage growth. This will provide a financial incentive to farmers, producers of bio-fuels and other alternative fuels businesses as the carbon markets on which such credits can be traded develop.

Step 12

Foster urban public transport and sustainable mobility options

Eighty percent of Australians live in cities. The demand for private motor vehicle transport in cities should be reduced by improving public transport infrastructure and operations and by providing better facilities for sustainable mobility options such as cycling and walking. The bias against public transport in Australia has been allowed to run for too long, and now threatens our economic security, energy security and environmental security.



1. Introduction

The NRMA asked the Jamison Group for a 'roadmap' guiding the transition to a future that is less dependent on oil – and ultimately one that is completely independent of imported oil. This report is aimed at encouraging debate about our current situation and the range of fuel and technology alternatives available to us.

If Australia were thrown back on its own oil resources tomorrow it would have enough supplies for just nine years and four months. Sometime in 2014 the heavily transport-dependent economy would literally grind to a halt.

The bare nine-and-a-bit years of self-sufficiency is the new figure from Geoscience Australia, based on known reserves. The previous figure was 11.1 years, but reserves are dwindling. In the post-9/11 world, such a sobering calculation should inject a note of urgency into energy policies. To be fair, the federal government is reviewing fuel emergency procedures, examining ideas to encourage dual-fuel conversion petrol with LPG of essential services such as police, ambulances and fire brigades, as well as part of the food-distribution system. But this is a sidelight. The main energy game – Australia's reliance on imported oil, its petrol and diesel economy, and its failure to develop alternative and perhaps renewable fuels – remains largely ignored.

Alan Fels and Fred Brenchley, 2005[1]

These words, penned in 2005 in protest at the inattention paid by the then-government to fundamental national security issues stemming from excessive oil dependence, remain true today.

Petrol prices have been very much in the news. Suddenly, energy issues occupy central stage in political debate. Yet the debate is superficial and wrong-headed. It is not petrol prices that need to be reduced in Australia, but *oil dependence that needs to be reversed*.

For years there has been discussion in Australia around moving to alternatives to oil-driven private transport. There was a brief flurry around natural gas vehicles – but in the end only a few buses seem to be using this source. There was a brief moment when ethanol seemed a likely possibility, particularly based on our once-mighty sugar industry – but then it too disappeared. Biodiesel then had its moment in the sun, before being set back by taxation changes.

Meanwhile concern grew over the global consequences of relying on fossil fuels to drive our transport systems.

The result is that we are ill-equipped as a nation to deal with the sudden impact of rising oil prices. Political parties seem unable to address the real issue, which is that our transport system nationally is more dependent on fossil fuels now than it was ten years ago, when natural gas was making inroads.

Today the country consumes just over 38 billion litres of fuel annually for road and off-road vehicles – of which 19.3 billion litres comes from petrol, 2.3 billion litres from LPG (some of which comes from natural gas and counts as an alternative), and 17.0 billion litres from diesel. A tiny amount – just 0.3 billion litres of E10 blend – can be counted as an alternative from biological sources. This is less than one percent of fuel sales (with the ethanol itself accounting for only a tenth of this, or 0.1 percent of total road transport fuel sales).

This is the situation of total dependence on fossil fuels that successive governments have allowed to come to pass.

1 Fels, A. and Brenchley, F. 2005. It's no time to be over a barrel, *Australian Policy Online*: http://www.apo.org.au/webboard/comment_results.chtml?filename_num=12068

Reduced petrol prices would simply postpone the real issue, which is to reduce our dependence on imported energy, particularly on crude oil.

The very real economic consequences of rapidly increasing oil prices is unfolding in Australia and globally, due to increasing world demand (particularly from China and India) and to supplies getting harder and harder to reach. Combine our total dependence on fossil fuels with the total domination of our retail fuels market by a handful of oil majors – and you have a recipe for pain.

In this setting, NRMA Motoring & Services (NRMA) has decided to do something practical and long-lasting for its members. It has decided to tackle once and for all the neglect of alternative fuels policy in Australia. The NRMA has invited a group of us – energy and transport experts – to come up with a 'roadmap' for fuel independence in Australia. We have accepted this challenge, and present this report as a first step in what promises to be a long but exciting journey.

The journey starts with recognition that the current political debate in Australia over how to reduce petrol prices, completely misses the point. Reduced petrol prices would simply postpone the real issue, which is to reduce our dependence on imported energy, particularly on crude oil.

A secondary strand in the current discussions in Australia is that we step up our expenditure on oil exploration – in a forlorn quest to enjoy oil self-sufficiency. This too misses the point, which is that oil is the problem, not the solution.

Our approach

In this report we take a completely different perspective. We focus on how this 99.9% dependence on fossil fuels for our transport can be reduced, and on how Australia can bring forward alternative fuels and alternative modes of transport that are less dependent – and ultimately not dependent at all – on imported oil.

We look at the various technical options available, both in terms of automotive systems and in terms of fuels – all of which are well documented and available, at least in prototype form. We do not consider anything in this report that is not already proven. The real issue is how the barriers to their commercial introduction can be overcome.

Here we offer an analysis that would see Australia not just swinging behind alternative fuels and alternative modes of transport, but building new industries to produce and service these products that would sustain our oil independence for the indefinite future.

We start our discussion by looking at the present situation and how we arrived at this near-total dependence on oil for our transport. We discuss the fundamental reasons why this situation cannot be allowed to continue.

These reasons stem from:

- Economic insecurity – the higher prices to be paid for oil, and our growing dependence on oil imports;
- Energy insecurity – the peaking of oil production worldwide and the growing hunger for the remaining oil coming from India and China; and
- Environmental insecurity – the realisation that burning fossil fuels is leading to release of greenhouse gases that are warming the planet and also producing health problems due to the toxic emissions from oil-fuelled transport.

These sources of concern have no resolution while we remain wedded to oil.

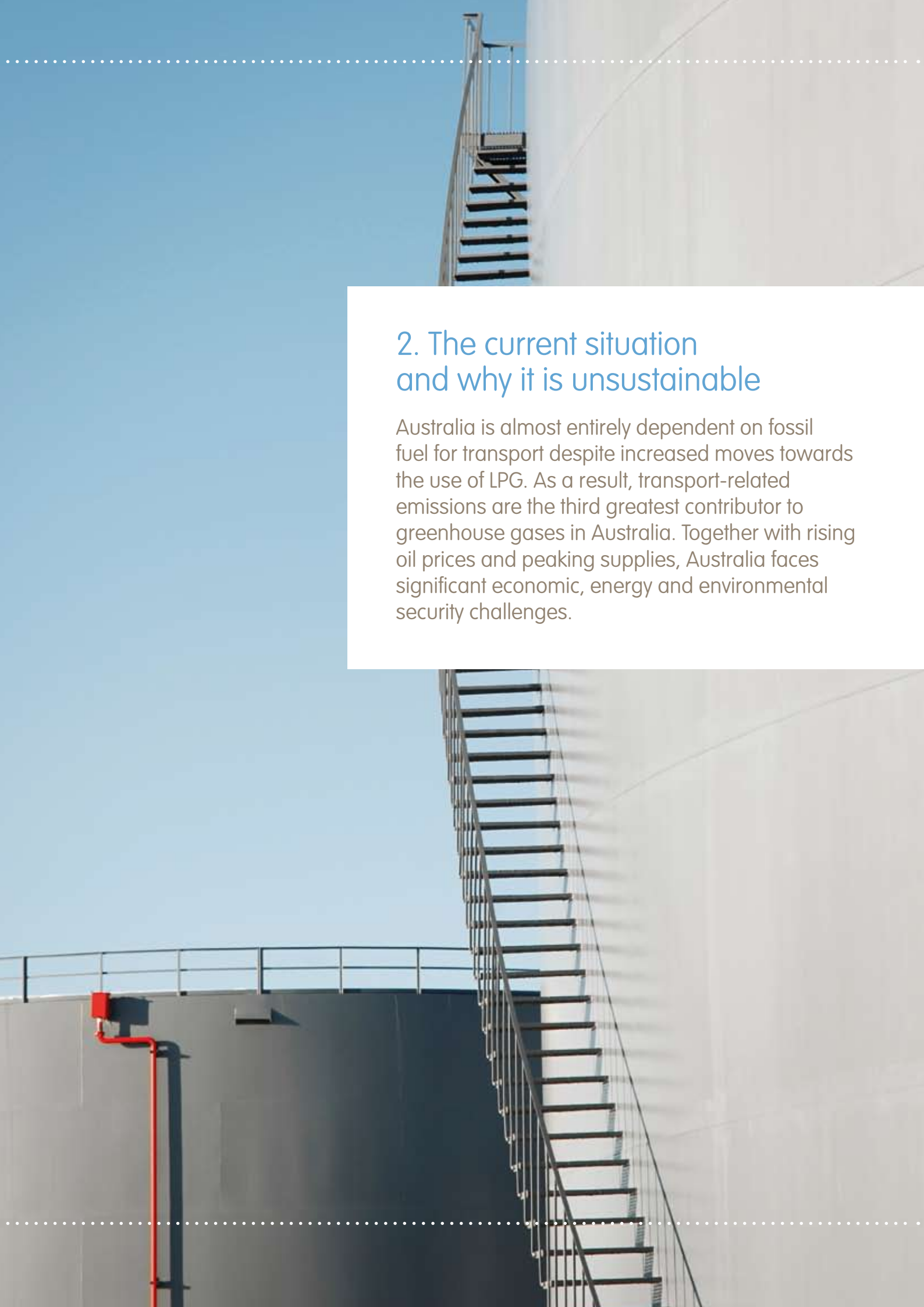
We then move to discuss the various technical options available for giving us relief – options which are already in production or in prototype around the world. We consider alternative fuel options for the present range of light and heavy vehicle engines – such as natural gas and biofuels – and we discuss the various technical options for transforming our automotive systems, from hybrid electric vehicles to plug-in electrics, all of which are advancing at a rapid pace and changing the technical landscape as we write.

We acknowledge too that while our discussion focuses on private transport, the issues of improved public transport and improved energy efficiency are an integral part of the wider picture of a sensible energy policy.

Finally we examine the barriers that have held back adoption of these alternative options and how they can be overcome with serious and dedicated policies. We recognise that no country has managed to introduce alternative fuel systems without government intervention of some kind – either to mandate more stringent fuel consumption standards or automotive emissions standards, or to mandate market shares for alternative fuels, as is being done seriously at the moment in the European Union, the United States and Japan.

The determination to see alternative fuels and transport systems introduced in Australia to reduce our oil dependence, has to start with this recognition of the necessity for government intervention to kick start the changes needed.

The NRMA asked the Jamison Group for a 'roadmap' guiding the transition to a future that is less dependent on oil – and ultimately one that is completely independent of imported oil. This is what we believe we have provided.



2. The current situation and why it is unsustainable

Australia is almost entirely dependent on fossil fuel for transport despite increased moves towards the use of LPG. As a result, transport-related emissions are the third greatest contributor to greenhouse gases in Australia. Together with rising oil prices and peaking supplies, Australia faces significant economic, energy and environmental security challenges.

Not only is Australia 99.9% dependent on fossil fuels for private transport, but this consumption is rising – despite a move towards smaller vehicles and greater awareness of the need for energy conservation and energy efficiency. Total fuel consumption is rising, from 35 gigalitres (GL) (billion litres) in 2002/03 to 38.6 GL in 2006/07, as revealed in Table 1.

Table 1 shows that the only real 'alternative' fuel that has been allowed to penetrate the Australian market is Liquefied Petroleum Gas (LPG) – which is only partially an alternative in that it is produced partly from natural gas but also from refined local and imported oil. The introduction of E10 in 2005/06 is too small to represent in the figures in Table 1.

Oil rose to prominence in the transport sector because of its cheapness, its energy concentration, and its convenience – despite its problems of flammability and toxic emissions. As a result it came to be backed by a powerful global business lobby that had no incentive to investigate alternatives. The situation has now changed with oil no longer so attractive due to increasing demands on supply, the resulting rising costs, and environmental concerns.

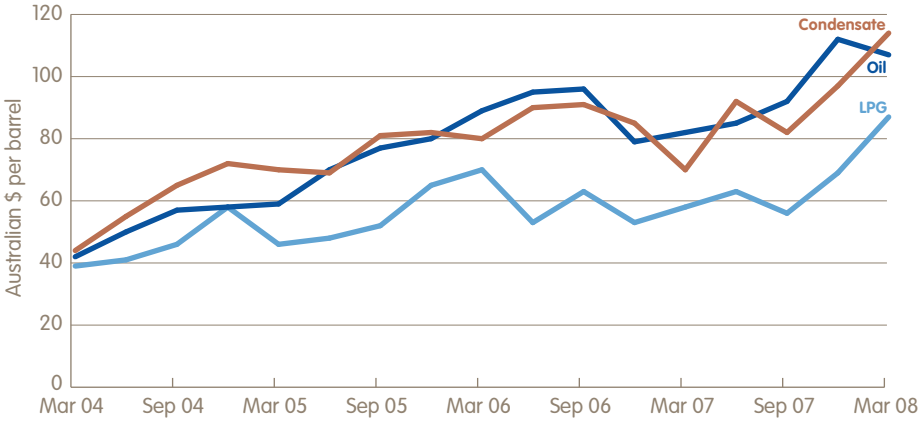
Australia's increasing level of dependence on imported oil and on a handful of oil companies will become increasingly problematic as the price of oil rapidly rises. In Figure 1 it is shown how oil has doubled in price in the past three years – and can be expected to double again.

Table 1. Private road transport fuel consumption in Australia.

	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007
Petrol	18.9	20.0	19.9	19.0	19.3
LPG	2.4	2.5	2.3	2.6	2.3
Diesel	13.9	14.5	15.2	15.8	17.0
Total	**35.2**	**37.0**	**37.4**	**37.4**	**38.6**

Source: BITRE *Yearbook Transport Statistics Australia*, 2007.

Figure 1. Oil and fuel prices in Australia 2004-2008.



Source: Prices realised by Santos, adapted from EnergyQuest's *Energy Quarterly* May 2008 report.

The situation has now changed with oil no longer so attractive due to increasing demands on supply, the resulting rising costs, and environmental concerns.

Table 2. Fuel market shares by brand, Australia 2006.

Caltex	19%
Woolworths (Caltex)	19%
Coles/Myer (Shell)	24%
BP	17%
Mobil	10%
Shell	3%
Other	8%

A key concern is that in our dependence on oil for transport we have developed a domestic market dominated by a handful of oil majors (Table 2).[2] This contributes to uncertainty around energy supply and price whilst limiting the potential expansion of alternatives fuel sources – which is a policy failure.

The relentless rise in oil and related fuel prices is the most obvious indicator that something is wrong with our present oil dependence. However, our dependence must change for the following reasons:

1) Economic security – the costs of importing fossil fuels are rising rapidly;

2) Energy security – our dependence on fossil fuels puts us at the mercy of foreign oil supplies, which are now peaking around the world; and

3) Environmental security – the burning of fossil fuels is releasing greenhouse gases that are contributing to global warming.

1. Economic security:

Oil production in Australia is falling and imports are rising

Since the early 1960s, Australia has been in the fortunate position of being an oil producer – starting with the Moonie field in 1964 and then encompassing the huge Gippsland oilfields later in the decade. Production reached a level of 400,000 to 500,000 barrels of oil per day, and held steady at around this level until recently.[3] Further, as natural gas production on the Northwest Shelf increased, so associated condensate production increased as well, to a level of around 150,000 barrels per day. Over the past decade, production of crude oil and condensate has averaged around 500,000 to 600,000 barrels per day.[4]

The rate of new discoveries has declined considerably since then, leading most observers to foresee that levels of production will also have to fall – if they have not done so already.

Australia's economic demonstrated reserves of oil have been declining each year for the past decade, from a peak of 300 GL in 1996 down to 173 GL by 2006.[5] These reserves are only enough for another 10 years of production at current extraction levels – as noted by Fels and Brenchley (page 7).

Declining reserves and rate of discovery translates directly into declining levels of production (with a lag) – as predicted by Hubbert peak oil theory (discussed on page 16). Australian primary petroleum production peaked in 2002/03 at 26.5 GL, falling to 23.2 GL in 2003/04, 20.3 GL in 2004/05 and 17.2 GL in 2005/06, before recovering to 21.2 GL in 2006/07. Condensate over the same period has been more or less steady at around 7 GL per year. This would make for production of crude oil and condensate of around 28 GL in the past year, or around 500,000 barrels per day [28.8 GL].

2 All the major fuel suppliers in Australia are foreign-owned multinationals. Caltex is the local subsidiary of Chevron-Texaco; Mobil of Exxon-Mobil; while Shell and BP are local subsidiaries of their multinational owners of the same name. Australian companies include Woodside, which is an oil exporter, and Wesfarmers, which is producing LPG. The Australian national oil company, Ampol, disappeared in 1995; it had been acquired by Pioneer, then run as a joint venture with Caltex, and then finally sold outright to Caltex. Ampol had started in 1936 as the Australian Motorists' Petrol Company, adopting the name AMPOL in 1949. In 1982 it acquired the refining and marketing assets of Total Australia Ltd. The cement conglomerate Pioneer acquired 30% of Ampol in 1979 and then the rest of the company in 1989, leading to its sale to foreign interests. Other countries such as Brazil, with Petrobras, and Norway, with Statoil, have managed their national oil companies to much better effect.

3 Oil quantities are reckoned as barrels per day or per year, while alternative fuels generally use measures couched in international SI units, such as cubic metres (for gas) or megalitres (for liquid fuels). The conversion factors are: 3.79 litres = 1 US gallon, and 159 litres = 1 barrel. Hence 500,000 barrels per day translates to 80 million litres per day (x 159), or 28.8 GL (billion litres) per year.

4 Geoscience Australia, Submission to Senate Inquiry into Australia's future oil supply and alternative transport fuels, Submission #127.

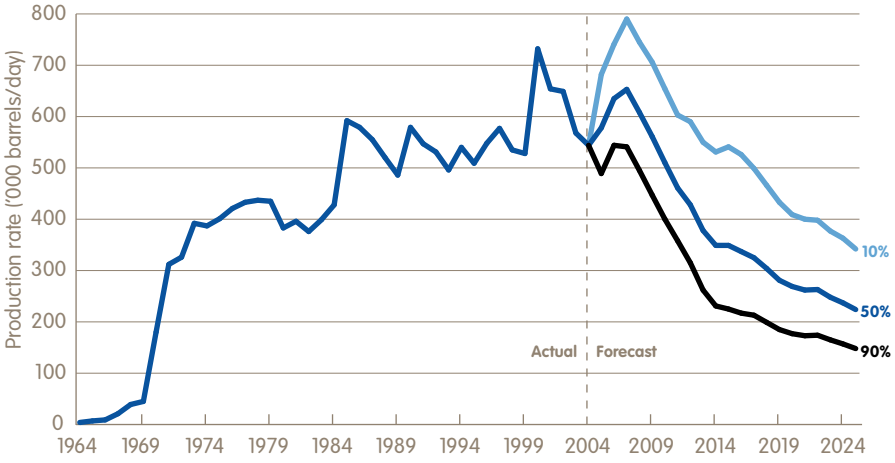
5 ABARE, *Energy in Australia 2008*, p. 5, and Table 3, p. 6.

Geoscience Australia predicts that Australian production of crude oil plus condensate will continue at around 550,000 barrels per day until 2009 and then decline steadily, reaching a mid-range estimate of 224,000 barrels per day by 2025 (i.e. a 50% reduction)6 – as depicted in Figure 2. That means that oil production has already peaked in Australia.

Meanwhile, Australia's demand for petroleum is increasing at a rate of two percent a year, from 750,000 barrels per day currently to 800,000 barrels [46.0 GL] by 2009/10 – and a lot more after that. Clearly, this extra demand for petroleum has to be met from sources other than domestically produced crude oil unless new reserves can be found. Since the production peak of 2001/02 imports of petroleum (crude and refined) have been rising steadily, as shown in Table 3.

Thus the level of imports has risen by no less than 30% in just four years – from 33.5 GL to 43.6 GL – a trend that expert commentators like Geosciences Australia see as continuing and getting worse.

Figure 2. Australian annual production of crude oil and condensate 1970-2004 and forecast annual production at 90%, 50% and 10% cumulative probability 2005-2025.



Source: Geoscience Australia, 2008.

Table 3. Imports of petroleum into Australia, 2002-2007 (GL)

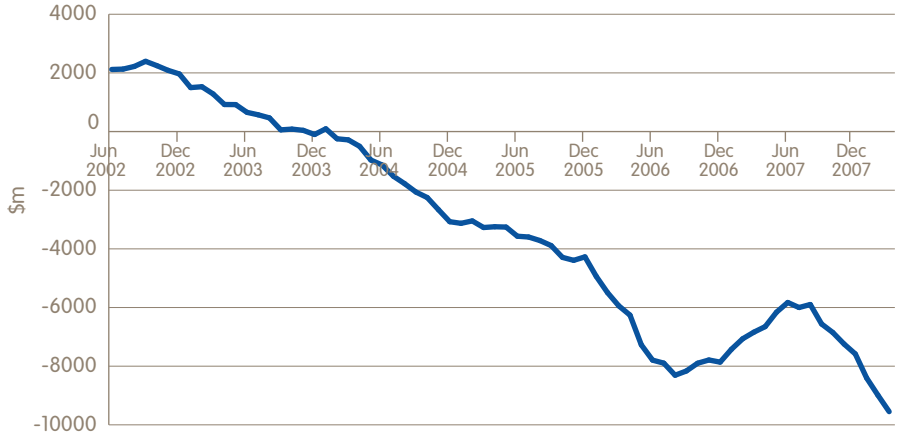
	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007
Crude oil	28.0	23.5	26.0	24.4	25.3
Refined products	5.5	11.4	11.2	15.1	18.3
Total	**33.5**	**34.9**	**37.2**	**39.5**	**43.6**

Source: ABARE, *Energy in Australia 2008*, Table 17, p. 23.

6 Geoscience Australia, submission to Senate inquiry, ibid and updated.

It is not the end of the oil era – but the end of the era of cheap oil.

Figure 3. Australia Petroleum Trade Deficit (12 month running totals), June 2002 to March 2008.



Source: ABS, adapted from EnergyQuest's *Energy Quarterly* May 2008 report.

Further, as the level of imports rises, so the balance of trade in petroleum products worsens. From a surplus in 2003 it has deteriorated rapidly, moving to a deficit in 2004 and reaching a huge deficit of nearly $10 billion in the current year. The situation with regard to Australia's worsening balance of trade in petroleum, is depicted in Figure 3.

The Australian Petroleum Production and Exploration Association (APPEA) sees this situation as only getting worse. The Association has gone on the record **predicting a trade deficit in oil and condensate of $20 billion by 2015**. The Minister for Energy and Resources, Martin Ferguson, predicts an even worse outcome, with a deficit of $25 billion in 2015.[7] This would represent an economic catastrophe for Australia, undoing all the positive results achieved by the resources boom.[8]

Not only is Australia 99.9% dependent on fossil fuels for private transport, but this dependence is reinforced and buttressed each year through further investment. The Bureau of Agricultural and Resource Economics reveals that investment of $13.9 billion is provided each year by the petroleum and coal industries to maintain this dependence.[9] There are further subsidies of close to $10 billion paid to the existing fossil fuel industries in Australia.

This fossil fuel investment and subsidisation needs to be viewed as the benchmark against which proposals for investment in alternative fuels may be compared.

The answer to this drastically worsening situation is not to place further resources into oil exploration in a futile effort to stave off the effect of peaking of oil supplies, but to start investing seriously in alternative fuel (and energy) resources. This is the key point that we are making in this report.

2. Energy security:
Peaking of oil supplies

The issue of enhancing security of energy supplies, and of oil in particular, has been sharpened by the growing realisation that globally oil supplies are peaking – or reaching the half way mark in their total exhaustion. It is not the end of the oil era – but the end of the era of cheap oil. This is the significance of the debate over Peak Oil.

The extremely influential Hirsch report to the United States Department of Energy in 2005 stated the position clearly:

> "The peaking of world oil production presents the United States and the world with an unprecedented risk management problem. As peaking is approached, liquid fuel prices and price volatility will increase dramatically, and, without timely mitigation, the economic, social, and political costs will be unprecedented. Viable mitigation options exist on both the supply and demand sides, but to have substantial impact, they must be initiated more than a decade in advance of peaking."[10]

The Australian Senate's *Standing Committee on Rural and Regional Affairs and Transport* reviewed the evidence regarding peak oil in its 2006/07 inquiry into *Australia's future oil supply and alternative transport fuels*, and again found that there is an imminent peaking of oil supplies worldwide.

7 Martin Ferguson, Minister for Energy and Resources, 'Australia's energy security and the clean energy challenge', Speech given 5 June 2008, available at: http://minister.ret.gov.au/TheHonMartinFergusonMP/Pages/Australia'sEnergySecurityandtheCleanEnergyChallenge.aspx

8 Statement of APPEA to Senate Inquiry into Australia's future oil supply and alternative transport fuels, Committee Hansard, 11 August 2006, p. 2.

9 ABARE 2008, *Energy in Australia 2008*, Table 1, Energy-related industries in Australia, 2005-06, p. 1. The Table lists gross capital expenditure in both petroleum and coal mining of $13.5 billion and $0.4 billion in petroleum processing. The Jamison Group would like to see these figures broken down into separate categories for the coal and the petroleum industries.

10 Hirsch 2005, Introduction, p. 4. Available at: http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf

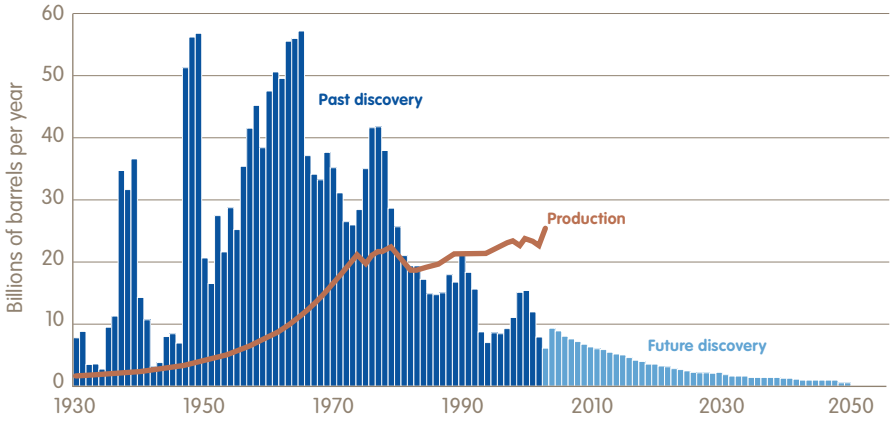
The committee's report stated:

> "The concept that oil production will peak and decline, and there will be a post-oil age, is well accepted. The argument turns on when the peak will come, and how serious its economic effects will be." [11]

While the Senate Committee did not wish to enter into the intense global debate as to when (not if) oil supplies will peak, they made some very strong points:

> "Given the huge investment needed to adapt the economy to a less oil-dependent future, and the long lead times involved, it is possible that price signals resulting from increased scarcity of oil will occur too late to spur alternative developments in a timely way in the quantities required.
>
> Government initiative is needed to promote investments which are regarded as socially desirable, but which have a longer payback period than private actors are used to.
>
> There are high barriers to entry for alternative fuels in that the refuelling network must be in place. Arguably government initiative is needed to promote change…" [12]

Figure 4. The growing gap – Discovery trends with past production and extrapolated future discovery.



Source: Colin Campbell, The heart of the matter, 2003 (ASPO-Australia).

The peak oil arguments are well rehearsed by several publications and websites, and do not need to be canvassed in any depth by us.[13] The core idea is that for any finite resource, there is a curve that describes its exhaustion, with a peak occuring halfway through the process of exploitation. The peak can be predicted by close examination of the rate of discovery of new deposits. In the case of oil worldwide, this situation can be described quite accurately.

The falling rate of discovery of new sources must be followed, with a lag, by falling production (Figure 4). This falling production, or reduced supply, stands in marked contrast with the optimistic predictions of future increases in supply to keep up with relentlessly increasing demand (particularly from India and China) that have been issued with regularity by the International Energy Agency (IEA) in their annual *World Energy Output* reports.

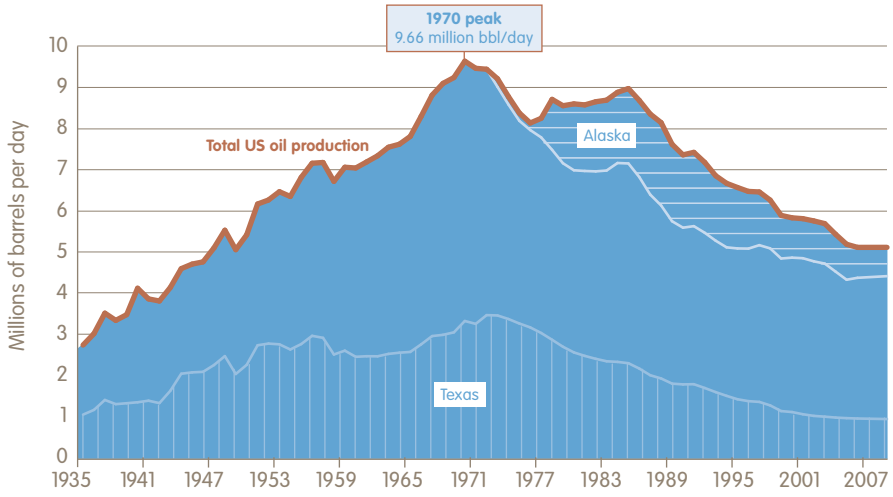
It is the gap between these unrealistic predictions of demand and the geologically based predictions of peaking supply that constitutes the gap that underlines the urgency of the energy question.

11 Senate inquiry, Australia's future oil supply and alternative transport fuels, 2007, par 3.132, p. 54. Available at: http://www.aph.gov.au/Senate/committee/rrat_ctte/completed_inquiries/2004-07/oil_supply/report/report.pdf

12 Ibid, par 3.147, p. 57.

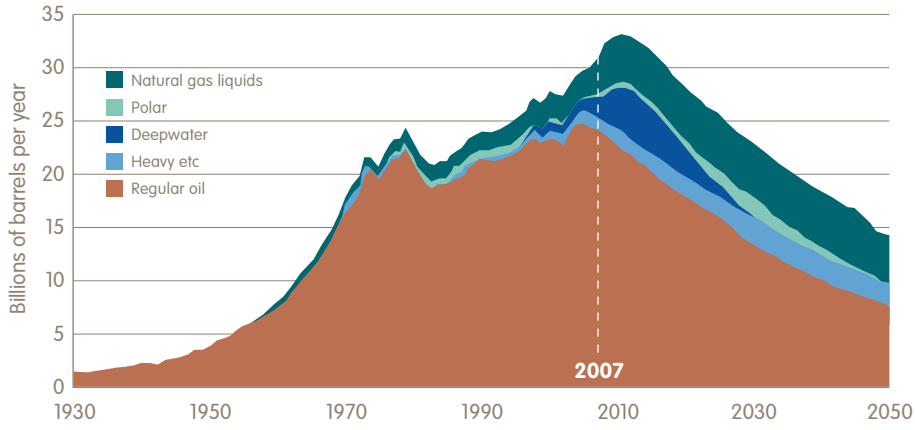
13 On peak oil, see in addition to the Hirsch report and the Australian senate report, publications such as Campbell and Laherrere (1998) – the first article on peak oil in the refereed scientific literature – and subsequent works, e.g. by the Princeton geologist Deffeyes (2006). A listing of refereed publications is maintained by the ASPO website: http://www.peakoil.net/

Figure 5. Peaking of oil in the United States



Source: United States Energy Information Administration and Railroad Commission of Texas.

Figure 6. Peaking of oil and gas liquids globally (2006).



Source: Uppsala Hydrocarbon Depletion Study Group, Updated by Colin Campbell, 2006 (ASPO-Australia).

The concept of peak oil (which is quite different from the 1970s concept of exhaustion of resources, creating 'limits to growth') was developed by the United States geologist, L. King Hubbert. In a paper published in 1956, he made a famous prediction that United States supplies of domestic oil would peak in 1970 – a prediction that turned out to be accurate to within a year.[14]

He was able to make this prediction based on close examination of individual oil fields and their rate of depletion, combined with the falling away of new oilfield discoveries. The actual experience of domestic oil supply in the United States, and the country's increasing dependence on oil imports, is by now well known, as shown in Figure 5.

Here the peaking of United States oil production is clearly shown as having occurred in 1970, with the trajectory ever downwards in the years since. When the situation is extended to the global level, as in Figure 6, the same Hubbert argument applies, the difference being that the level of uncertainty as to reserves is raised. Nevertheless the argument that if discovery is falling then production must fall after it, must hold.

Whether the peak has already happened, or is happening now, or will happen this decade, is immaterial. The point is that the peak is real and must set the context for all planning of oil-based transport systems – including the Australian transport system.

14 Hubbert's original article was delivered in 1956 to a meeting of the American Petroleum Institute (Hubbert 1956). For a discussion of the Hubbert model and approaches to its testing, see Brandt (2007).

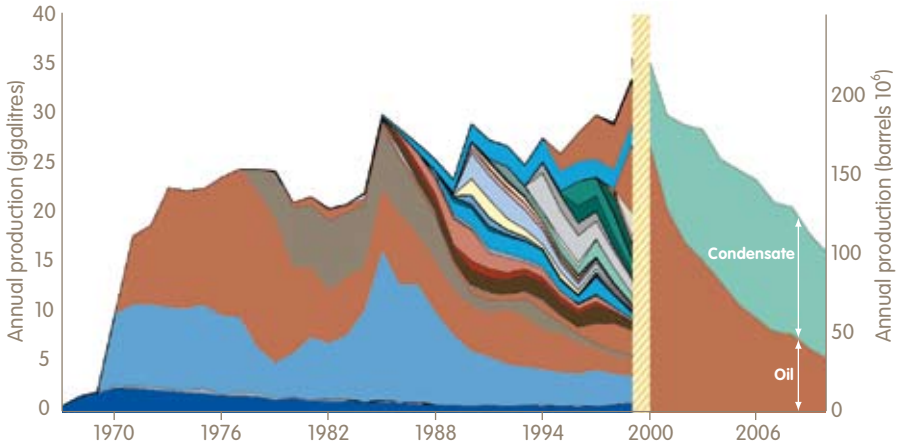
As for the Australian situation, the Association for the Study of Peak Oil in Australia (ASPO-A) published a figure that shows Australian oil supplies peaking in the early 2000s. Figure 7 shows Australia's domestic oil production as peaking in 2001. Small oil fields peaked in 1970; the Gippsland fields (GF) peaked in 1985. Domestic oil production has been falling since 2001 – as clear a case as any of the reality of 'peak oil'.[15]

Figure 7 is in broad agreement with Figure 2 and estimates quoted above (with the exception of a brief upturn in 2006/07). However, the trends are definitely an indication that Australia is well into the 'downside' of the peaking of oil supplies – just like other countries before it, including the United States (which peaked in 1970), China (which peaked in the 2000s), and many others.[16]

3. Environmental security: global warming and toxic emissions

The reason that there is so much concern over atmospheric carbon pollution – as opposed to carbon build-up in the earth or sea – is that the atmosphere is a highly sensitive layer in which life survives. Over geological time, levels of carbon in the atmosphere have fluctuated, but a pre-industrial level is reckoned by the Intergovernmental Panel on Climate Change (IPCC) as being around 600 Gigatonnes, or 285 ppm.

Figure 7. Peaking of Australia's oil supplies.



Source: TG Powell, 2001 (ASPO Australia).

Since then, the level has been rising relentlessly as a result of human activity, including the burning of fossil fuels by transport and industry.

The current carbon level in the atmosphere is about 800 Gigatonnes (Gt), or 385 ppm. Around 8 Gt are being added each year from the burning of fossil fuels and industrial processes such as energy and cement production, while around 2 Gt are being absorbed by the ocean (leading to a slow acidification) and 2 Gt by forests and eco-systems of the world, meaning there is a 'carbon flux' or net carbon addition of 4 Gt per year.[17] According to a 'business as usual' scenario, that is, where increased demand for energy is met by fossil fuel sources, the carbon 'flux' is likely to grow to 10 Gt per year by 2025 and perhaps to 15 Gt per year by 2050. By this time the carbon level in the atmosphere would be approaching 1000 Gt.

The most recent assessment of the Intergovernmental Panel on Climate Change (IPCC, 2007) indicated that it is likely that important tipping points exist, that is where irreversible change occurs to the climate system or other systems dependent on climate. Many scientists, for example James Hansen, Director of the NASA Goddard Institute for Space Studies, have argued that even the present level is dangerous and must be reduced. As Al Gore and others have been warning, the world has to do something, and quickly before such tipping points are reached. This is an extremely abbreviated account of why the global warming issue is a component of the need for a departure from oil usage.

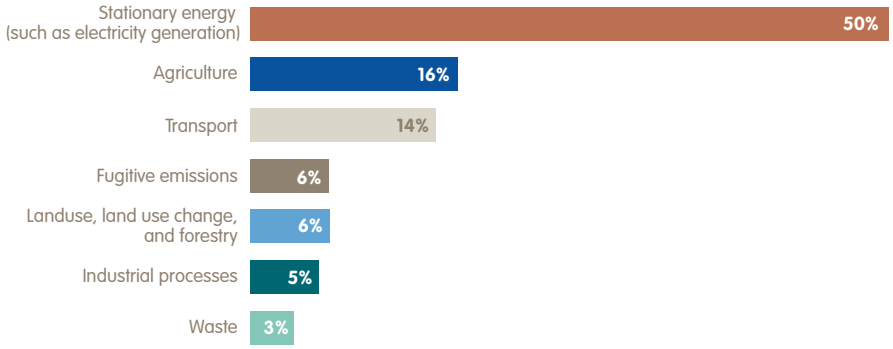
15 Powell T G (2001) Understanding Australia's petroleum resources, future production trends and the role of the frontiers. Geoscience Australia. APPEA Journal 2001, 273-287

16 For extensive discussion of the issues associated with the peaking of oil supplies, not just in Australia but globally, see the website of the Association for the Study of Peak Oil (ASPO): http://www.peakoil.net/ and its Australian organisation: http://www.aspo-australia.org.au/ The Heffernan report of the Senate into 'Australia's future oil supply and alternative transport fuels' provides a well-informed discussion of the peak oil issue and how it affects Australia. The report states in its summary that 'Australia's net self-sufficiency in oil is expected to decline significantly as future discoveries are not expected to make up for the growth in demand and the decline in reserves as oil is produced' (p. ix).

17 1 Gigatonne (Gt) is 1 billion tonnes. Emissions expressed in units of Carbon can be converted to emissions in units of CO_2 by making an adjustment in terms of molecular weights: Carbon is 12, while CO_2 is 44, and so the ratio between the two sets of units is 44/12. Thus 1 Gt Carbon is equivalent to 3.67 Gt CO_2. In volumetric terms, 1 ppm Carbon is equivalent to 2.1 Gt Carbon. For discussion of global carbon accounting and options for reducing carbon emissions, see Pacala and Socolow (2004).

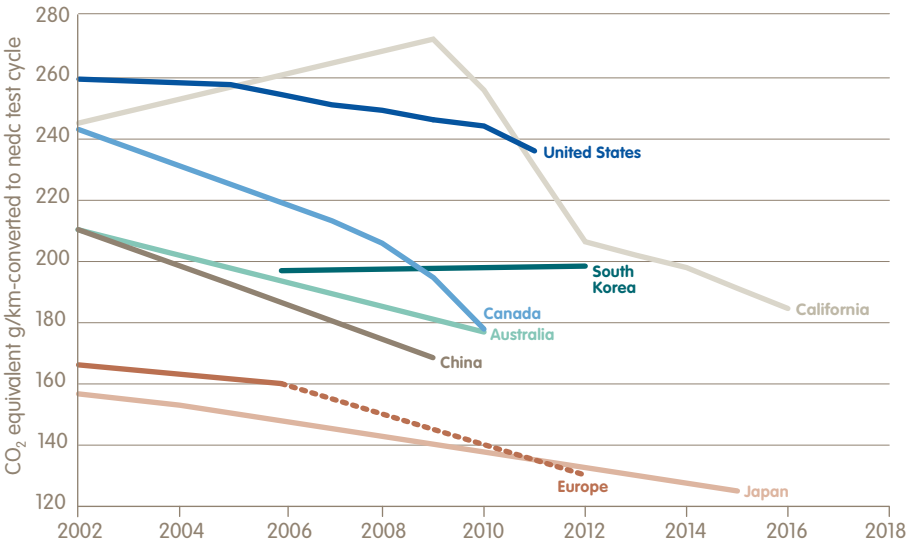
Transport, based mainly on oil, is the third most carbon emitting activity behind coal-powered electricity generation and agriculture.

Figure 8. Sources of Australian carbon emissions, from transport and other sectors.



Source: Department of Climate Change, February 2007.

Figure 9. Global comparison of carbon dioxide emission targets from private transport



Source: ICCT, Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update 2007.

The contribution of transport to Australia's greenhouse gas emissions is shown in Figure 8. Transport, based mainly on oil, is the third most carbon emitting activity behind coal-powered electricity generation and agriculture.

Australian transport releases over 80 million tonnes of carbon dioxide-equivalent into the world's atmosphere each year. This is why there is such a cause for concern and the necessity for a search for fuel and transport alternatives.

Australia's transport sector accounts for 14 percent of total greenhouse gas emissions (the rest coming from electricity generation, industry and such sources as land clearing).[18]

Cars emit carbon dioxide from the burning of petroleum-based fuels and other greenhouse gases (such as nitrogen oxides) depending on the quality of the fuel and the technological sophistication of the engine. Australian cars emit on average 200-230 grams of CO_2 for every kilometre they travel – compared with just 161 grams under new standards applying to passenger cars in Europe, where emissions regulations have been tighter.

The European Union and Japan lead the world in mandating reductions in carbon dioxide emissions from cars and trucks. By 2012 both the European Union and Japan will have lowered their CO_2 emissions limit for passenger cars to 130 grams CO_2 per km driven. This is what Australia should be demanding of the automotive industry.

18 Department of Climate Change of the Australian government Transport sector greenhouse gas emissions projections 2007, available at: www.climatechange.gov.au/inventory/2006/pubs/inventory2006.pdf

Australia's greenhouse gas emission standards are not compulsory – something that needs to be remedied as one of the first ways of reducing our environmental insecurity caused by burning of petroleum fuels in transport.

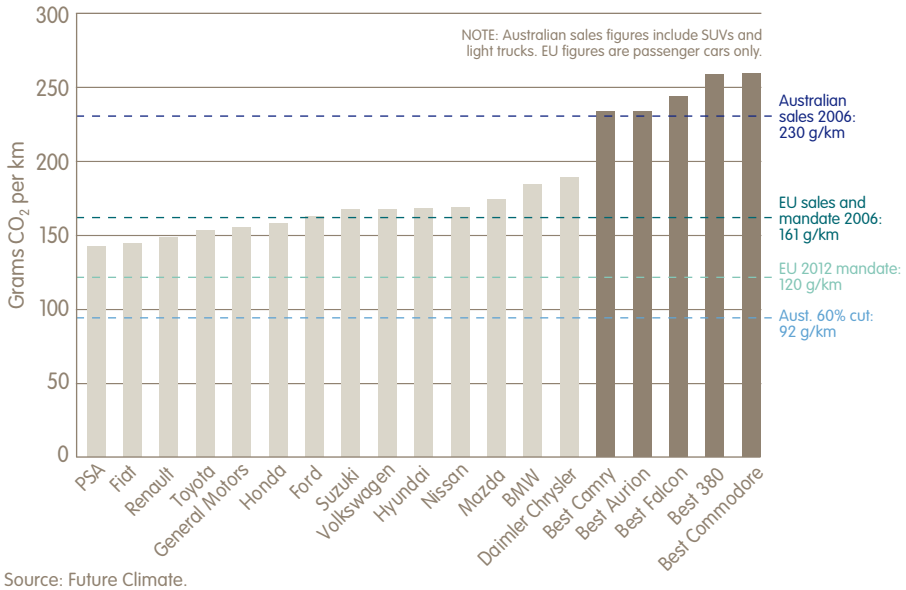
In fact, when the data focus on individual car fleets produced by manufacturers, emissions from cars manufactured in Australia may be seen to be much worse than those produced by cars manufactured in Europe – as revealed in detail in Figure 10.

Figure 10 clearly shows that all the automotive models manufactured in Australia – taking the 'best' performing vehicle from each of the Camry, Aurion, Falcon and Commodore – are emitting at or worse than 230 g CO_2 g/km compared with current vehicles sold in the European Union which emit an average of 161 g CO_2/km and the European Union target for all passenger vehicles of 130 g CO_2/km (120 g CO_2/km with complementary measures).

A clear focus for the Australian Government to bring about greenhouse gas emissions reduction from liquid fuels might be to legislate that Australian car manufacturers bring down their carbon dioxide emissions by 2012 to the level achieved by manufacturers in Europe or Japan.

As this legislation is couched in terms of what the manufacturers are already required to reach in the European Union and Japan, there can be no question of their claiming that it is not technically possible for them to achieve those standards in their Australian manufacturing operations. The demand must be that they meet these world-best standards.

Figure 10. Comparison of carbon dioxide emissions: Australian and European Union sales by vehicle model, 2006.



Source: Future Climate.

In addition to greenhouse gas emissions, the burning of fossil fuels emits other pollutants. Vehicles burning petroleum fuels emit toxic nitrous oxides, unburnt hydrocarbons, particulates, carbon monoxide and volatile organic compounds. One of the great but hidden costs of burning fossil fuels is the degradation of the air quality in cities – and one of the benefits of switching to alternative fuels is that they burn more cleanly.

The health costs associated with partly combusted fuels, for example the build up in carcinogenic polycyclic aromatic hydrocarbons, in volatile organic compounds and in particulate matter, are now coming to be recognised as serious.[19] As Australian author Terry Tamminen, former environmental adviser to Californian Governor Arnold Schwarzenegger, puts it in his text, *Lives per Gallon*:

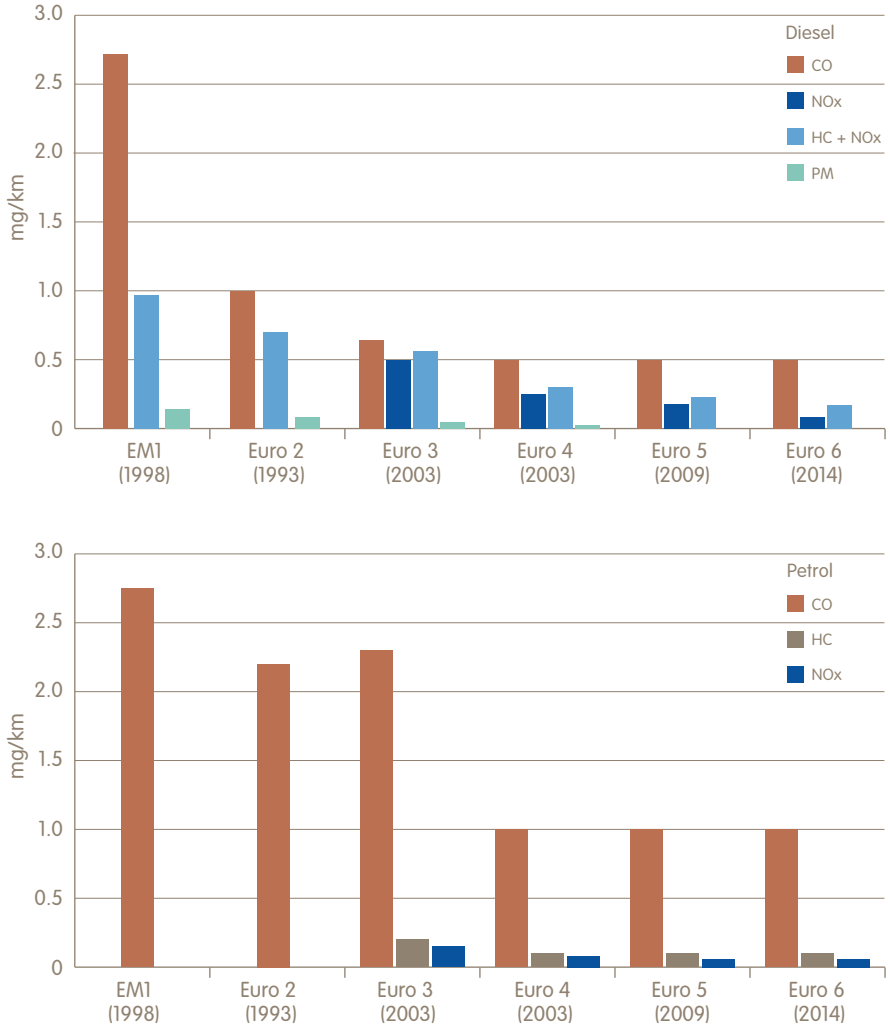
After more than a hundred years of research, many of the health effects of smog are well understood, yet they are still very much out of control, both in the United States and in a growing number of cities around the globe.[20]

So strong is the evidence on the adverse health effects of the products of combustion of fossil fuels that the Australian Medical Association (AMA) has backed the introduction of mandatory targets for biofuels. In August 2005, the head of the Association, Dr Mukesh Haikerwal, wrote to the Prime Minister's Biofuels Taskforce detailing the AMA's support for the mandatory use of ethanol in petrol in the interests of protecting and improving human health.

19 Dr Ray Kearney, Associate professor at Sydney University's Department of Infectious Diseases and Immunology. See his 'Fossil fuels – the new "asbestos"' in Opinion Online, 23 November 2005, available at: http://www.onlineopinion.com.au/view.asp?article=3861 He draws attention in particular to the dangers from micron-sized particulate matter, such as those less than 2.5 microns in diameter (PM 2.5).

20 Tamminen (2007), p. 13. This book is of interest as it traces the history between the development of the automotive and oil industries in the USA; similar discussion is developed by the NY Times journalist, Edwin Black, in his book Internal Combustion (Black 2006).

Figure 11. European fuel emissions standards: Euro 1 to Euro 6.



Source: Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information.

Australia can look to Europe for guidance as to how to deal with toxic fuel emissions and the setting of limits that must be met by vehicle manufacturers. Since 1992, European standards for toxic fuel emissions have been getting more and more stringent, moving through Euro 1 to Euro 2, 3, 4 and now Euro 5 standards applying to both petrol and diesel vehicles – as shown in Figure 11. These standards cover nitrogen oxides emissions, hydrocarbons, carbon monoxide, and particulate matter.

Again, the point has to be made: if vehicle manufacturers can meet such standards in Europe, why should we allow them to sell cars that are dirtier and emit more noxious fumes here in Australia? Whilst Australia has incorporated Euro 4 standards in the Australian Design Rules from 2008, clearly, the NRMA should be demanding of government that nothing inferior to the Euro 5 standards (and anticipating the proposed Euro 6 standards) be permitted in Australia.

The implementation of the United States corn-based ethanol program is **not** a good model for Australia.

Moves to enhance independence from fossil fuels around the world

The world's leading countries are already taking active steps, in different ways, to decrease their oil dependence and to reduce the effects of that dependence. There is much experience that Australia can learn from.

In the **United States**, for example, a long period of denial of the urgency of dealing with oil dependence (and particularly dependence on oil imports from the Middle East) has now been transformed into some rapid action, at both the federal and state levels (particularly in California). The most arresting development has been the rise in production of biofuels, particularly ethanol, whose level of production has risen from just 1.6 billion gallons in the year 2000 to 6.4 billion gallons in 2007 [from 6.0 GL to 24.3 GL] with the vast majority coming from corn.

Of course, this corn-based biofuel production is not sustainable, and requires almost as much energy to produce (with fossil fuel inputs in the agricultural methods, transport and processing) as it delivers. But the shift is striking.

In the opinion of the Jamison Group, the implementation of the United States corn-based ethanol program is not a good model for Australia. In the United States there are substantial fossil fuel inputs (e.g. in fertiliser, distillation and transportation) and fierce scientific debate reveals that any greenhouse benefit, compared with burning oil directly, is at best marginal. This experience demonstrates the importance of choosing feedstock, location and conversion processes carefully. These issues are taken up again in our discussion of biofuels.

At the end of 2007, United States President Bush signed into law the Energy Independence and Security Act (EISA) of 2007 as a consequence of his earlier challenge of "20 in 10" in the State of the Union address, and set a Renewable Fuels Mandate calling for at least 36 billion gallons of renewable fuels by 2022 (approximately 10% of current oil consumption in the United States today). The Act also sets a Vehicle Fuel Economy Mandate of 35 miles per gallon by 2020 – a 40% improvement on the current standard.[21]

Likewise in the **European Union**, a series of policy Directives have been issued by the European Commission in 2007 and 2008 that promise to make the European Union a leading centre in the shift away from the oil transport economy. The 1998 Fuel Quality Directive set European Union-wide specifications for petrol, diesel and gas-oil used in cars, trucks and for other uses in order to protect human health and the environment. In January 2007, the Commission proposed revising the standards so as to:

- Reflect developments in fuel and engine technology;
- Help combat climate change by promoting the development of lower carbon fuels, including biofuels; and
- Meet air-quality objectives set out in a 2005 Clean Air Strategy by, amongst other things, reducing emissions of sulphur and PAHs (Poly Aromatic Hydrocarbons) from diesel.

If approved, the amendments would permit higher volumes of biofuels such as ethanol to be used in petrol.

The Commission is also proposing mandatory monitoring and reporting of "lifecycle greenhouse emissions" from fuels as of 2009, and an obligation for fuel suppliers to ensure that greenhouse gases produced by their fuels throughout their life-cycle (i.e. production, transport and use) are cut by 1% per year between 2011 and 2020. These standards now set a benchmark for the rest of the world – including Australia.

Meanwhile, in 2008 the European Union issued a Biofuels Directive that calls for 20 percent of the European Union's fuel mix by 2020 to be made up of alternative fuels, with biofuels accounting for 10 percent.

Other countries are making great strides in reducing oil dependence. **Sweden** has made the most dramatic commitment, with the government declaring a goal in 2006 of **phasing out fossil fuels in the transport sector by 2020**. The report of the government-appointed fact finding mission on this topic predicts that this goal, which amounts to reducing petroleum use in Sweden by 50%, can be reached.[22] The remaining 50% is planned to be phased out progressively thereafter, as Sweden brings on renewables, biomass-based energy systems, and imports ethanol from low-cost suppliers such as Brazil.

21 For these initiatives, see the description on the White House website, available at: http://www.whitehouse.gov/infocus/energy/

22 Governmental Commission, *Making Sweden an Oil-Free Society*, June 2006, available at: http://www.sweden.gov.se/content/1/c6/06/70/96/7f04f437.pdf For commentary on the announcement of the goal, by then-Swedish PM Göran Persson, see: http://watthead.blogspot.com/2005/12/fossil-fuel-free-sweden-by-2020-prime.html

Brazil for its part has built the largest ethanol sector in the world, based mostly on sugar cane.

A closer look at Brazil

Brazil for its part has built the largest ethanol sector in the world, based mostly on sugar cane.[23] Brazil's involvement with ethanol goes back to the 1970s, when the country's military leaders reacted to the 1973 oil crisis with a drastic push towards ethanol. Brazil in the 1970s was 80% dependent on oil imports, and 40% of its foreign exchange earnings were used to import oil (**a situation that Australia will face within the next five years**). The country slid into recession and by the mid-1970s was facing bankruptcy. In these circumstances the government issued a directive requiring that the country's gasoline should be blended with 10% (E10) ethanol – a level that Brazil raised steadily over the next five years to 25% (E25).

The *Brazilian National Alcohol Program*, or *Proalcool*, was launched in November 1975, with the goal of fostering a national alcohol production and distribution industry. To facilitate the shift, the government provided sugar cane companies low-interest loans to build ethanol plants, as well as funding domestic efforts to produce a car that would run on pure alcohol – which was achieved at a Brazilian Air Force laboratory.

After the 1979 Iranian revolution, and a further rise in oil prices, the government amended the program, under which the ethanol blend targets were raised; further subsidies and low-interest loans were made to sugar companies to raise ethanol production; tax breaks were offered to car companies to build ethanol-powered vehicles; and the national oil company, Petrobras, was ordered to make ethanol available at filling stations. By the end of 1979, Fiat was offering an ethanol-only vehicle for sale in Brazil.

All told, Brazil spent a total of $16 billion from 1979 until the mid-1990s on the Proalcool program – with savings in oil imports amounting to at least US$120 billion.

The Brazilian program dipped in the mid-1980s, as oil prices fell to record lows, but was never entirely discontinued. Meanwhile, Brazilian sugar producers were raising their productivity. By the mid-1990s, Brazil had discontinued its subsidies for the sugar industry, forcing producers to be world competitive. As oil prices rose again in the 2000s, so the program came back into fashion, this time under a civilian administration, and this time building on the competence base established by the Proalcool program.

Brazil now mandates a fuel blend of 25% alcohol nationally. However, ethanol has become so popular that it now accounts for at least 40% of all vehicle fuel, and this is rising. Brazil is estimated to save $50 billion per annum in terms of petroleum imports – one of the most significant side-effects of moving to biofuels.

The latest biofuel initiative from Brazil, involving biodiesel, shows just what can be achieved by a country that focuses its institutional innovations on reducing oil dependence. The Brazilian biodiesel program, which began only in 2005, is an incremental program, with four central features.

First, a voluntary phase, bringing the country up to a level of 2% biodiesel when blended (following the example of the Proalcool program). By 2008 this 2% minimum becomes mandatory, and rises to 5% minimum blend by 2013 (the success of the program so far means that it is widely anticipated that the mandatory 5% blend (B5) will take effect at an earlier date, possibly as early as 2010). Thus, the country as a whole has reached a position where by 2013 at the latest (and possibly as early as 2010) it will be producing 5% of all diesel requirements from vegetable oils, bringing it abreast of world leaders such as Germany. The program is overseen by the Ministry of Mines and Energy.

Second, the capacity of the country is being ramped up in the initial, voluntary phase, by the smart expedient of staging national auctions for biodiesel by the national motor fuel standards agency. These auctions have encouraged bids from potential suppliers who are thereby induced into the market. The state-owned oil company, Petrobras, acts as the buyer of last resort, thereby ensuring that the auctions bear some relationship to market reality. The whole program is overseen by the National Petroleum Agency.

23 Further information on Brazil's ethanol energetics and environmental issues, demonstrating advantages over corn-based ethanol in the US can be found in Macedo, I. de C. (Ed.) 2005. Sugar cane's energy: Twelve studies on Brazilian sugar cane agribusiness and its sustainability. Sao Paulo: UNICA. The following Goldemberg et al paper illustrates Brazil's learning curve. Goldemberg J., Coelho S.T., Nastari P.M., Lucon, O. 2004. Ethanol learning curve: The Brazilian experience, Biomass and Bioenergy, 26 (3): 301-304.

A similar 'whole of government' approach is needed in Australia, where we start a long way behind the rest of the world in shaping alternative fuels production strategies.

Third, there is a distinct and explicit social goal to the biodiesel program – again, learning from the experience of the pro-alcohol program. The Ministry of Agrarian Development (which is pro-small farmers) has shaped the biodiesel program with its 'seal of social responsibility' whereby small farmers have to contribute over 50% to a large trader's or distributor's biodiesel. It is only with such a seal that large companies receive tax credits and are allowed to bid at the auctions.

Fourth, Brazil is backing a wide variety of oilseeds in these early stages of the program, to see which ones turn out to be best in a tropical country (and bearing in mind that European experience is confined exclusively to rapeseed and United States experience to soybean).

Output is currently dominated by soybean and palm-oil, but cottonseed and castor oil are also picking up, under the influence of the Ministry of Agrarian Development's social inclusion or rural smallholder development strategies. New candidates are coming on to the scene, such as the oilseed *Jatropha curcas*, widely utilised for biodiesel in India (it grows under harsh conditions and it is a perennial that can be harvested regularly).

The broader Brazil's scope of oilseed culture, the more it is able to take advantage of changes in world prices for these vegetable oil commodities, switching between one and the other. This aspect of the program is overseen by the Ministry of Agriculture.

These four central features of the program are thus driven by four Ministries, all in the pursuit of highly creative strategies: the Ministry of Mines and Energy, backing renewable energies generally; the National Petroleum Agency, to safeguard standards and conduct the auctions; the Ministry of Agrarian Development, which is essentially launching a new land reform program with the biodiesel projects in its direct appeal to 'social inclusion' as a national goal of the program; and the Ministry of Agriculture, which is promoting a wide variety of oilseed crops and not just soybean. The success of the program to date indicates successful collaboration between these four ministries.

We devote space to the details of these Brazilian programs because they demonstrate a 'whole of government' approach to fostering alternative fuels and the building of new biofuels industries as national development projects. We are not concerned at this stage with the pros and cons of biofuels (discussed in section 3) but with the strategies employed in Brazil to build the new industries.

A similar 'whole of government' approach is needed in Australia, where we start a long way behind the rest of the world in shaping alternative fuels production strategies. However, as a result we have the advantage of learning from what others have done, particularly in the European Union, the United States and in Brazil.

Given that alternatives to fossil fuel dependence have to be found, and found quickly, we now turn to consider the options that are available.

3. Alternative technical options

We need to reconsider our automotive and fuel options. Alternative automotive technologies include cars with lower fuel consumption and hybrid and electric vehicles. Alternative fuel options are LPG, natural gas and biofuel technologies. To date, Australia has lagged behind the rest of the world – including China – in both alternatives.

In considering options available for alternative fuels and for alternative modes of transport (such as electric vehicles) we are not looking for blue-sky innovation, but proven technologies that can be introduced in Australia almost immediately – given the political will and the investment incentives needed.

We consider options in two categories – options for alternative vehicles (automotive options) and options for alternative fuels. Obviously the two are closely connected.

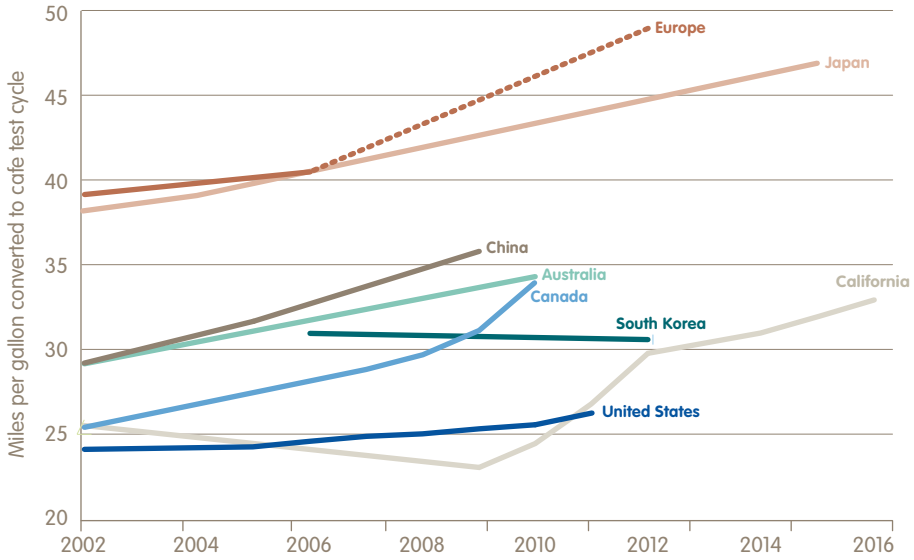
We start with the simplest and most straightforward option, which is to make existing engines more efficient and cleaner – in terms of distances travelled per litre of fuel consumed. Part of the problem is that Australia still has no fuel consumption mandate.

1. Alternative automotive technologies

a. New low fuel consumption engines

Australian fuel consumption standards have been allowed to lag behind world leaders. They are entirely voluntary– meaning that the car companies can choose to meet the standards, or can choose to ignore them. Our current fuel consumption standards were introduced in 1972 and have been tightened since, but are still well behind the leading fuel consumption standards required in the European Union.

Figure 12. International fuel consumption standards.



Source: ICCT, *Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update 2007.*

The automotive and petroleum industries in Australia have had abundant time to meet the challenge of improving fuel consumption while continuing to meet emissions standards – and have failed to do so.

Even though Australian vehicles have had to provide a fuel consumption label since 2001, a different approach is needed. That approach is obvious: it requires government mandating of more stringent fuel consumption standards, to catch up with the best in the world. International comparisons for fuel consumption standards are shown in Figure 12.[24]

In terms of fuel consumption, according to the Federal Chamber of Automotive Industries, new Australian vehicles in the year 2007 achieved 226.1 grams of carbon dioxide per km (meaning that they needed around 8.0 litres of fuel to travel 100 kms).[25] Back in the 1960s, the popular Volkswagen Beetle could achieve the same distance on only 7.2 litres – meaning that a car that was in production half a century ago could achieve better fuel consumption than today's models.

24 Fuel consumption standards can be expressed as fuel consumption itself (litres per 100 km) or in terms of GHG emission standards (g CO_2 /km). These are interchangeable, with one widely used point of reference being that at a fuel consumption level of 10 L/100 km a vehicle emits carbon dioxide at a rate of 282 g CO_2/km. The GHG emissions standards have the advantage that they draw attention to the greenhouse effects, whilst also offering a direct comparison between different fuels, such as petrol, diesel and LPG, without needing to adjust them for energy content. The GHG standards also highlight the point that Australia's National Average Carbon Emissions (NACE) were measured for vehicles sold in 2007 as 226 g CO_2/km, with a target of 222 g CO_2/km, which is well above the target set in the European Union of 130 g CO_2/km (although the Australian standard does include a larger range of vehicles). This only goes to demonstrate why agreed international standards for vehicle emissions that give comparability across countries are desperately needed – standards for which the NRMA could lobby.

25 According to the Background Paper issued by the Bracks review of Australia's automotive industry, all Australian vehicles achieved a fuel consumption level of 13.8 litres needed for 100 kms. This figure includes trucks and commercial vehicles as well as passenger vehicles. See Bracks Review of Australia's Automotive Industry 2008, Background Paper, p. 31, available at: http://www.innovation.gov.au/automotivereview/Documents/AutomotiveReview2008BackgroundPaper.pdf

Table 4. Japanese fuel consumption standards to be met by 2015.

Japanese 2015 Fuel Economy targets for Light Duty Passenger Vehicles				
Class	**Vehicle weight (kg)**	**Target**		
		km/L	**L/100km**	**mpg US**
1	<600	22.5	4.4	52.9
2	601-740	21.8	4.6	51.3
3	741-855	21.0	4.8	49.4
4	856-970	20.8	4.8	48.9
5	971-1080	20.5	4.9	48.2
6	1081-1195	18.7	5.3	44.0
7	1196-1310	17.2	5.8	40.5
8	1311-1420	15.8	6.3	37.2
9	1421-1530	14.4	6.9	33.9
10	1531-1650	13.2	7..6	31.1
11	1651-1760	12.2	8.2	28.7
12	1761-1870	11.1	9.0	26.1
13	1871-1990	10.2	9.8	24.0
14	1991-2100	9.4	10.6	22.1
15	2101-2270	8.7	11.5	20.5
16	>2271	7.4	13.5	17.4

Source: ICCT/Green Car Congress.

The rest of the world is now realising how important these fuel consumption standards are in the battle against global warming – and to reduce household expenditure on fuel.

The Chinese government has devised an oil strategy to try to mitigate and delay problems related to liquid fuels. Part of it is strict fuel consumption regulations, the first phase of which came into force in July 2005: a fuel consumption standard of 38 miles per gallon (mpg) for lighter cars [6.2 L/100km] and 19 mpg for heavier trucks. In 2008, these standards rise to 43 mpg [5.6 L/100km] and 21 mpg respectively.

In the Chinese regulations, the fuel consumption standards apply to each vehicle model and not to fleet averages, which makes it harder for automakers to create a few poor-selling low fuel consumption cars while continuing to sell energy-intensive vehicles.

Japan leads the world in terms of fuel consumption standards, and in how compliance with the standards is measured, and now insists on more stringent procedures. In December 2006, Japan revised its existing fuel consumption standards and increased the weight categories from nine to sixteen. An update of the test cycle used in Japan is due to be introduced in 2010 and will apply to meeting the 2015 standards. The test is longer, has higher average and maximum speeds, and requires more aggressive acceleration than the older 10-15 cycle. The latest Japanese standards, applicable up to the year 2015 and graduated over vehicles of increasing weight, are shown in Table 4.

Australia should acknowledge world leading fuel consumption standards and take steps to keep abreast of them.

In Australia, the automotive industry has promulgated its own voluntary (weak) standards.

In March 2003, the Federal Chamber of Automotive Industries (FCAI) introduced a voluntary standard aimed at improving fuel consumption in new passenger vehicles in Australia to an average of 6.8 litres per 100 kilometres (L/100km) by 2010. Note that this voluntary standard is inferior to the Chinese mandatory standard and very much inferior to the new Japanese standards. As such, it is clear what the NRMA should be lobbying to achieve.

This is not to ask that Australia be a world leader – but simply that Australia acknowledge world leading fuel consumption standards and take steps to keep abreast of them. The NRMA should demand nothing less for its members.

In Australia, all vehicles sold must have a fuel consumption label. The Australian Design Rules were recently amended so that from October 2008 the label must report fuel consumption and carbon dioxide emissions for urban and extra urban (highway) driving (Figure 13).[26]

In New Zealand, the fuel consumption label also provides a star rating (similar to the Australian energy and water rating labelling schemes for new products including appliances)[27] and estimation of the cost per year. At the same time, submissions have now closed on a new statutory regulation mandating fuel consumption standard.

The technologies for improving fuel consumption and general efficiency are already well known. They include various kinds of turbo-charging, and moves towards new kinds of diesel engines and new low-sulphur diesel fuel.

New diesel engines

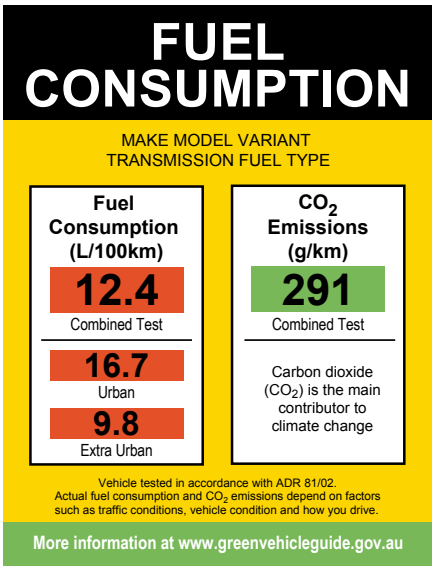
The Australian vehicle fleet is still overwhelmingly based on spark ignition internal combustion engines. Low-emission diesel (or clean diesel) engines now employ a wide variety of technological fixes to vastly improve their fuel efficiency and the cleanliness of their burn. Diesel engines, as a compression engine system as opposed to spark ignition (the burn is accomplished by putting the gas under pressure, rather than introducing a spark), have lower fuel consumption than petrol-driven internal combustion engines (ICEs). New technologies make them cleaner than before (if fitted with particulate filters) and more fuel economical.

b. Hybrid and electric vehicles

By far the most productive shift in automotive technology is that towards electric propulsion, achieved initially by hybrid-electric vehicles (HEVs) that capture energy when a vehicle is slowing or braking and re-use that energy when the vehicle is accelerating. Advanced versions of HEVs have more electrical storage capacity so that the vehicle can rely less on the engine and more on electric propulsion. Toyota and Honda have had ten years of experience making, selling and servicing HEVs and total world-wide sales of HEVs will soon reach two million vehicles.

Car batteries have a history of being unreliable, so carmakers offer warranties of five years or more on HEV battery packs because battery cost is a significant proportion of the vehicle cost. New battery technologies are making rapid progress.

Figure 13. Australian vehicle fuel consumption label.



When scaled-up to the size needed to power a vehicle, the advanced technologies used in mobile telephones and cameras (lithium-ion technology) are yet to be proved sufficiently reliable for global carmakers such as Toyota or Honda, who are still using nickel-metal-hydride battery technology. However, this may change within a couple of years. The uncertainties have not prevented specialised carmakers from using lithium-ion technology in small-volume manufacture and there are several examples in Europe and the United States, particularly in California.

26 Vehicle Standard (Australian Design Rule 81/02 – Fuel Consumption Labelling for Light Vehicles) 2008 Amendment 1

27 Energy efficiency rating scheme () and water efficiency labelling scheme (www.waterrating.gov.au)

The shift towards electric vehicles is likely to happen far faster and earlier than could have been imagined.

In order to protect the battery from early failure, carmakers use electronic controls that prevent the battery from excessive charge and discharge. Enthusiasts have been removing the electronic protection in order to get better performance from the vehicle even though this voids the vehicle warranty. By adding additional battery capacity and an inverter, enthusiasts have converted HEVs to be able to be charged from the electricity grid, claiming that it dramatically reduces the cost of motoring (depending of course on the price of electricity). This level of technology has become known as 'Plug-in Hybrid' technology or PHEV.

Toyota, the world's largest carmaker has announced that it will produce one million HEVs in 2010 alone and in the same year will release a PHEV onto the market. One form of PHEVs, termed the 'series hybrid', uses the engine only to generate electricity to charge the batteries and can therefore be operated at its 'sweet spot'. This means reducing fuel consumption and emissions to the lowest possible level. An engine operated in this way can achieve amazingly low fuel consumption levels and very low pollutant emissions.

United States studies are showing that large numbers of PHEVs could be recharged from the grid without increasing overall greenhouse gas emissions even if the grid is supplied from coal burning generators. Of course, as the grid moves towards sustainability, PHEVs open the door to reducing vehicle emissions commensurately. Furthermore, PHEVs create the opportunity for motorists to fuel their vehicles from home-based solar electricity or from small wind turbines, achieving the dream of zero emission vehicles.

Australia has a unique battery technology that could play a useful role in the world of PHEVs. CSIRO designed the 'Ultrabattery' for HEVs and it is already being made in Japan for supply to Japanese carmakers because Japan has a significant HEV manufacturing industry.

The battery combines the benefits of supercapacitor technology that absorbs electrical energy rapidly, with the low cost of lead-acid battery technology resulting in a battery around 70% cheaper than the nickel-metal-hydride batteries used in today's HEVs. The 'Ultrabattery' is heavier than the high-tech batteries, but the low cost offers the opportunity to reduce substantially the price premium normally associated with HEVs.

As HEVs are introduced to Australia there is an opportunity to use at least one Australian technology in the HEV industry. The 'Ultrabattery' is also being tested in wind power applications and is already known to be suitable for automotive applications that need greater energy storage reliability.

Electric vehicles – vehicles that rely totally on stored electrical energy – are very suitable for city use, where most car journeys are short (VicRoads reports that in Melbourne 40% of journeys are 2 km or less and 60% are 5 km or less).

In January 2008, Nissan-Renault announced that it will be offering all-electric vehicles in the United States and Japan in 2010 and in other countries by 2012. It is the first automotive major to make such a commitment.

General Motors expects its Chevy Volt to be available in the United States in 2010 and in Australia in 2012. Tesla in the United States offers an electric sports car with breathtaking acceleration and boasts a full order book, but at a price of around $100,000 per vehicle.

Electric cars are inherently much simpler than cars that use an internal combustion engine and are therefore potentially cheaper and require less servicing than other cars. This lower cost of motoring with potentially lower carbon impact will be attractive to some, but the benefit of having an on-board range extender in the form of a small engine will probably mean that most will prefer the flexibility of a PHEV.

PHEVs and all-electric vehicles will bring about a different approach to energy management. With greater energy cost awareness and the instrumentation to manage energy better, consumers will be able to choose when to draw energy from the grid and when to sell energy to the grid. When more homes and businesses are fitted with solar collectors overall transport emissions will benefit and dependence on liquid fuels will be reduced.

The shift towards electric vehicles is likely to happen far faster and earlier than could have been imagined. By putting electric vehicles at the top of its priority list, the government in Australia could play a major role in creating a fundamental shift away from fossil fuel dependence – provided the electric power being generated is coming increasingly from renewable and low-carbon sources.

Consumers have everything to gain from the shift towards electric vehicles in that they are clean, efficient and almost maintenance-free. Bob Lutz, the man at GM who "killed the electric car" is now a strong proponent of the new Chevy Volt. He is on record as saying that "electrification of the automobile is inevitable".[28]

28 Bob Lutz, GM vice-chairman for global product development, quoted in 'Bob Lutz: The man who revived the electric car', Newsweek, Dec 31 2007-6 Jan 2008, available at: http://www.newsweek.com/id/81580

If Australia's 14 million cars were able to generate just 3 kW of excess power from their charged batteries, and feed this into the grid, they would provide power equivalent to Australia's current generating capacity from all its power stations combined.

The major issue to do with electric vehicles, apart from the technology itself and innovations that are already underway, is infrastructure. Drivers of all-electric cars need to be guaranteed that there will be recharging points either at special plug-in roadside points such as in shopping centres, car parks and workplaces or at existing service stations. (electric vehicles may be designed to allow separate batteries to be charged independently, thus saving time.)

Businesses offering such services need to be encouraged, as well as those that offer alternatives such as battery leasing and exchange systems. Governments can encourage (or mandate) such infrastructure development, with appropriate incentives. Such mandated infrastructure is being installed in Denmark and in Israel – so why not in Australia?

The provision of small onboard petrol or diesel engines to charge batteries while driving provides a sensible and low-cost alternative to building bigger and heavier batteries in electric vehicles, making them even more cost-effective when compared with conventional internal combustion engine vehicles. Such engines can be connected direct to a generator and do not need all the engineering components associated with a conventional drivetrain.

Recharging batteries overnight in domestic garages can also be optimised, with smart metering systems to allow drivers to take advantage of fluctuations in charging for electric power, or to take advantage of feed-in tariff systems mentioned above.

Indeed electric vehicles' batteries could be used (when parked at home) to power domestic appliances such as air conditioners, and ultimately to provide power to the grid from excess charge built up.

Just think: if Australia's 14 million cars were able to generate just 3 kW of excess power from their charged batteries, and feed this into the grid, they would provide power equivalent to Australia's current generating capacity from all its power stations combined.[29]

The latter process would call for a major reform of the electricity industry in Australia, to require it to adopt feed-in tariffs for power fed into the grid from small-scale electricity generators (e.g. from renewable energy sources).[30] Here again is an area where the federal government in Australia could give a lead to state governments in reforming their power tariff systems.

29 Australia's current generating capacity is around 42 GW, which could be produced by 14 million point sources each rated at 3 kW. A standard turbogenerator in a large NSW power station generates about 660 MW, which would be equivalent to 220,000 electric vehicles delivering excess charge at night. It is this aspect of electric vehicles , as 'mobile generating systems' that has Google interested in electric vehicles; it has invested in the US electric vehicles producer Tesla.

30 With such a system of grid connections and feed-in tariffs, households could decide for themselves whether to use the electric power they generate to charge batteries of their electric vehicles (offsetting oil) or sell to the grid to offset coal.

It seems that time and opportunity is slipping away from the fuel cell option as electric vehicles become more feasible.

c. Other non-internal combustion engine vehicles

Meanwhile, there are other non-internal combustion engines that are being promoted as suitable for city cars, such as the compressed air powered engine being promoted by the French company, MDI, through a series of prototypes that it calls Compressed Air Transport.

The tireless inventor of the technology, the former Formula One engineer Guy Negre, announced a joint venture with a New Zealand firm in early 2008 to produce cars and power systems at a plant in Melbourne, with an estimated start date of 2010.[31] Most experts are sceptical of the claims because of energy density issues and the source of the energy to compress the air, but it remains an option to watch.

A final consideration is fuel cells – once considered the ultimate replacement for the internal combustion engine.

Fuel cells can be described as electro-chemical energy conversion devices, producing energy that can drive a car from a flow of reactants. The great advantage of fuel cells is that they are efficient, clean and quiet – but everything depends on the 'fuel' source, which is generally reckoned to be hydrogen.

The energy required to produce the hydrogen, and the infrastructure needed to distribute it are, at this stage, the principal barriers in the way of widespread adoption of fuel cell vehicles. They may in the end prove to be a dead-end if plug-in electric vehicles take over as the technical option of choice. There are as yet no commercially produced fuel cell vehicles, although several manufacturers have prototypes that are slated for production in 2012.

It seems that time and opportunity is slipping away from the fuel cell option as electric vehicles become more feasible. It is likely that by the time an affordable fuel cell is available and the infrastructure to distribute and store hydrogen gas is established, electricity will already be the dominant fuel for vehicles. Hydrogen, if sustainably produced, could be used to supply the electricity grid rather than fuelling individual vehicles.

One of the most interesting fuel cell options is the two-staged system, where a first fuel cell uses ethanol (or methanol) to produce hydrogen, and then the second fuel cell uses the hydrogen to produce electric current that drives the vehicle. This dual fuel cell (still in the concept stage) eliminates all the difficulties involved in moving to a hydrogen economy.

Now we turn to consider the technical options for fuels needed by these alternative vehicular systems.

2. Alternative fuel technologies

Options that we consider to be viable alternative fuels that could be introduced into the Australian transport scene, include:

- Natural gas - Compressed natural gas (CNG) and liquefied natural gas (LNG);
- LPG – liquefied petroleum gas;
- Biofuels – Ethanol, biodiesel, bio-oils, biogas, and second generation biofuels; and
- Synthetic fuels - gas to liquids (GTL), coal to liquids (CTL), DiMethyl Ether (DME) and methanol.

We consider options, in terms of their technical characteristics and applicability in the Australian context, and the prospects for their substituting for fossil fuel imports. We also consider the prospects for improving fuel consumption and reducing toxic effects of existing fossil fuels.

a. Natural gas: compressed natural gas (CNG) and liquefied natural gas (LNG)

Compressed natural gas (CNG) is the simplest and most feasible of the alternative fuels in Australia. It is a substitute for both petrol and diesel, burning more cleanly than both. It is produced by compressing natural gas, most of which is methane (CH4).

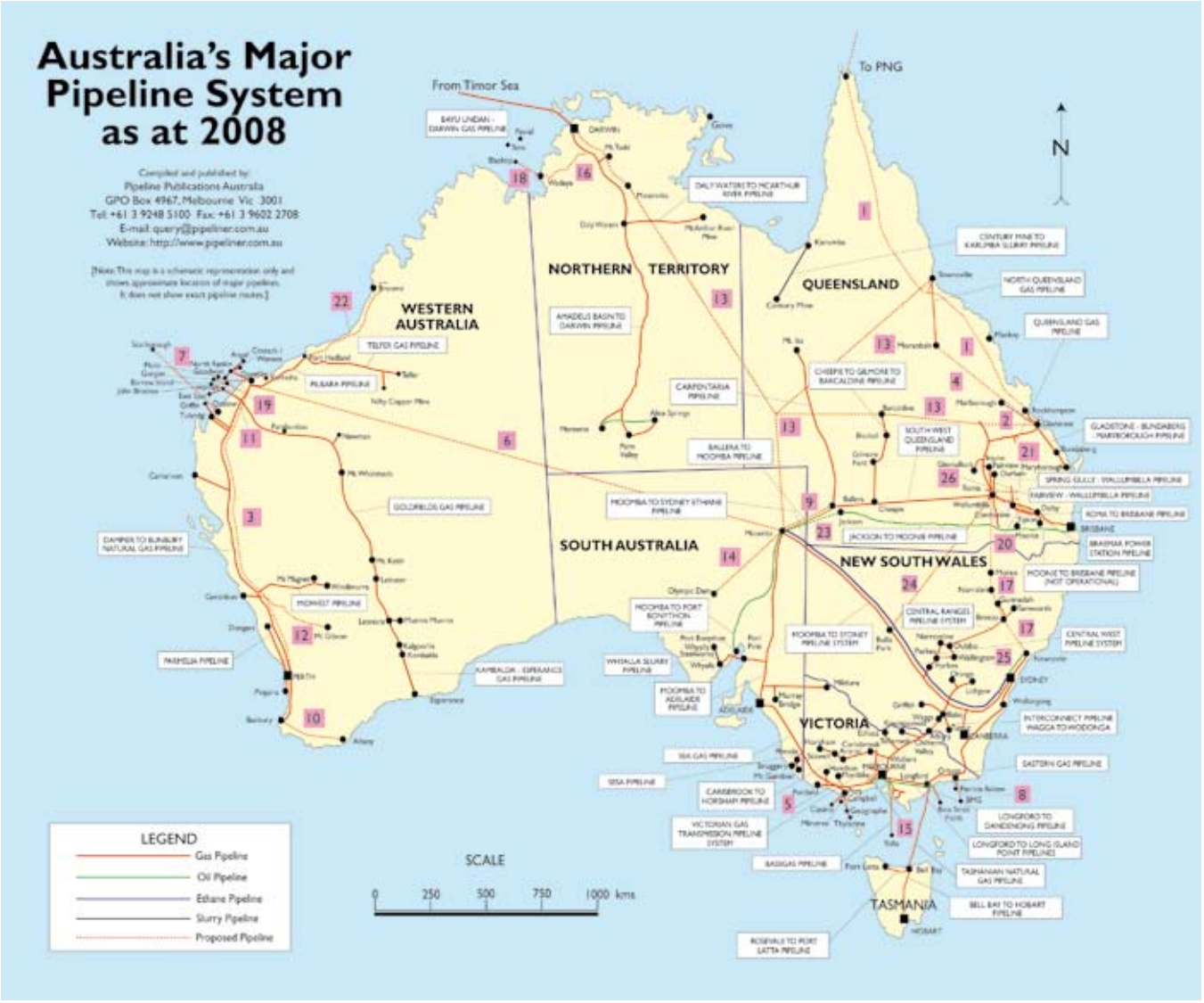
Natural gas exists in very large reserves in various locations in Australia – chiefly on the Northwest Shelf off Western Australia but also in fields in NSW, Victoria, Central Australia and Queensland, where production has begun from coal seams.

Natural gas is used as a fuel in gaseous form, under pressure, carried usually in metal cylinders. It requires special fuel dispensers that are costly to add to existing fuel infrastructure – but could be added with appropriate incentives, thereby creating a new infrastructure industry for Australian firms to enter.

Liquefied natural gas (LNG) is the liquefied form of natural gas, liquefied under pressure at a very low temperature (cooled to -163 degrees C and stored in cryogenic tanks). LNG is viewed as a fuel for commercial fleet operators, mainly commercial vehicles and buses, rather than for private motorists. LNG and CNG vehicles have shorter ranges than their diesel and petrol counterparts so must be refuelled more frequently.

31 'MDI's air car to be built in Melbourne', Alternative Fuels Australia, Dec 3 2007, available at: http://altfuelsaustralia.wordpress.com/2007/12/03/mdis-air-car-to-be-built-in-melbourne/

Figure 14. Australian oil and gas pipelines



Source: Pipeline Publications, www.pipeliner.com.au

Australia has vast deposits of natural gas on the North-West Shelf. Apart from the relatively small quantity that is transmitted annually by pipeline to Perth and surrounding industrial areas, all the production from the North-West Shelf is currently exported by tanker-ships as LNG. This is sold on the world market at prices that are escalating.

As oil prices increase, so do gas prices, since gas can substitute for most uses of oil. If eastern Australia purchased some of this LNG in the future, it could be very expensive. In addition, building a pipeline to connect North-West Shelf gas to Moomba in central Australia and hence to the pipeline network of eastern Australia, would cost at least several billion dollars (the existing pipeline network is shown in Figure 14.).

Interest in and readiness to build an Australian CNG and LNG industry is there. It simply awaits serious government attention and the creation of long-term incentives.

As more export contracts are signed, the size of the North-West Shelf reserves potentially available to eastern Australia shrinks. We recommend that the Australian government quarantine part of the North-West Shelf gas reserves for potential future use in Australia.

The exact magnitude of Australia's gas reserves in central and eastern Australia is uncertain, but they are definitely very much smaller than those of the North-West Shelf, even taking into account coal seam methane and LPG.

The prices of these eastern gas reserves are currently much lower than world prices for gas. However, there are proposals to export some of the coal seam methane from eastern Australia. Furthermore, when the carbon emissions trading scheme becomes operational in 2010, it is likely the combined-cycle gas-fired power stations will become competitive with coal for base-load operation.

Therefore, it is unlikely that gas could become a major fuel for the private motor car. However, it could potentially make a significant transitional contribution to fuelling trucks and buses. For some years, it will still be less expensive than North-West Shelf gas but, in an oil-constrained world, it will not be cheap for long.

CNG and LNG are options most easily exploited initially by vehicle fleet operators, since they can bypass many of the initial infrastructure issues that would act as a barrier for private motorists.

Already Sydney buses are enthusiastic users of natural gas, and other commercial fleet operators such as Boral Transport (cement delivery trucks) and Murray-Goulburn Cooperative have taken advantage of the incentive programs offered by the Howard government – the Alternative Fuels Grants Scheme (AFGS) and the Alternative Fuels Conversion Program (AFCP), now operated by the Federal Department of Environment, Water, Heritage and the Arts.[32]

These cash grant programs have proven to be 'too little, too late' to have had much effect in building an Australian CNG industry.

Prominent firms promoting the use of CNG and LNG as an alternative fuel include Advanced Fuels Technology, which offers CNG and LNG conversion equipment, installation, training and CNG and LNG cylinders. The company targets fleet managers who wish to convert to gaseous alternative fuels. The firm has long-standing commercial partners in most Asian markets, including Singapore, Indonesia, Thailand, China and India.

There are industry associations promoting a shift to natural gas powered vehicles, again with an emphasis on heavy vehicles such as buses and fleets. These include the Asia-Pacific Natural Gas Vehicles Association (ANGVA) and the International Association for Natural Gas Vehicles (IANGV).

All this indicates that the interest in and readiness to build an Australian CNG and LNG industry is there. It simply awaits serious government attention and the creation of long-term incentives.

There was a brief moment when it looked as though an Australian CNG industry would take-off, in the early 2000s, but government assistance and facilitation was too haphazard (e.g. the support scheme AFCP offering cash grants for CNG infrastructure that only had to be in place for three years – the result being that some recipients of the grants uprooted their installations after three years and a day). Tampering with the fuel excise to be paid by CNG operators was the last straw.

Serious action to create a natural gas alternative fuel industry in Australia requires a serious statement of government intent, backed by sensible policies to expand the market and to support early investments in providing the fuel and its distribution infrastructure.

Advanced Fuels Technology put forward a seven-point plan to the Senate inquiry into alternative fuels, covering:

1. Setting a minimum target for conversion of diesel fleets to natural gas (10 to 15% of all new commercial vehicles by 2010);
2. Sponsoring a strategic corridor of filling stations along the eastern seaboard;
3. Funding introduction of new gas engine technology into the Australian market;
4. Continuing to support end-users with grants to cover conversion costs;
5. Setting a long-term fuel excise level that allows commercial fleet operators to make commercial decisions (for fleets lasting five years);
6. Sponsoring the setting up of small CNG and LNG depot-based refuelling stations; and
7. Implementing an Import Duty Regime ensuring that products imported be rated with zero duty.[33]

32 For a description of these, and other programs of the Howard government, see the Parliamentary Library Research Note, 'Government assistance to alternative transport fuels', by Richard Webb (Research Note #9 2006-07), available at: http://www.aph.gov.au/library/Pubs/RN/2006-07/07rn09.htm

33 Senate inquiry, ibid, par 6.60.

We see these as sensible suggestions and we incorporate them in our Roadmap and Recommendations below. They have been generalised as measures needed to mandate a market for alternative fuels, and measures needed to promote uptake through tax-based assistance for those who take up the alternative fuel and for those who invest in the alternative fuel technology.

On the other hand we have to note that the introduction of an Emissions Trading System is likely to put a price on coal that will make it less attractive as a fuel for use in electricity power stations, and at the same time make natural gas more attractive (and cleaner). We therefore foresee serious competition between transport and power generation for remaining natural gas reserves – not to mention the desirability of maintaining some reserves for the future and for alternative use as feedstock in the chemical industry, for example.

These conflicting demands all place caveats on the rapid deployment of natural gas as a transport fuel in Australia.

We do not advocate that Australia move from one monopoly fuel to another, and so we would wish to see natural gas as one option amongst many. This would be inconsistent with the limited capacity for any one option to meet all demands and the level of uncertainty that exists for all options. That risk is best managed through diversity of options for the future. In the case of natural gas supply itself, we would want to see a variety of sources.

The explosion on 3 June 2008 at the off-shore gas drilling installation of Apache Energy, the Australian operating subsidiary of the giant United States Apache oil and gas corporation, reveals just how dependent downstream industries can become if their sources of energy are not diversified.

b. Liquefied petroleum gas

Liquefied Petroleum Gas (LPG) was, as the name implies, a petroleum derived fuel. It can be produced in conventional refineries, turning what was once a waste product into a mainstream product. However, with the increased use of natural gas in Australia, another source of LPG has become available, namely condensates, which are the components of natural gas that are more easily condensed.

LPG is now sourced more from condensates in Australia than from petroleum – by firms such as Wesfarmers at their Kwinana refinery in WA.

The advantages of LPG over conventional petrol and diesel are that it burns much more cleanly, it produces far fewer particulates, and burns with up to 20% lower carbon dioxide emissions per unit of energy produced. The obstacles are that LPG has a lower energy density than conventional petrol and so larger volumes need to be carried on board for the same distance travelled, with the result that passenger vehicles lose up to a third of their boot space. The same has to be said for CNG vehicles, since CNG has an energy density even lower than LPGs.

LPG is the one 'alternative fuel' that has made some headway into the Australian transport fuels market, reaching a penetration by 2007 of nearly 6% by volume (Table 1), but equivalent to 3% by energy due to the low energy density, from virtually nothing in 2000.

LPG can be used with a modified internal combustion engine or diesel engine and most vehicles can switch between LPG and conventional fuel, making it very convenient as an alternative fuel. However, we would want to confine the categorisation of LPG as an 'alternative fuel' to that which is produced from natural gas, and view petroleum-derived LPG as simply another fossil fuel.

In Australia, the Howard government took up the challenge of encouraging a switch to LPG in a voluntary fashion, offering an incentive to consumers who would make the switch to LPG. This was not complemented by any efforts to build up a local LPG kit industry in Australia and so all the components had to be imported, with predictable delays and costs.

If the Rudd government is to opt for this technical option, then it should do so with determination – making the shifts mandatory (as part of a comprehensive alternative fuels market mandate) and providing incentives to local firms to enter the LPG conversion kits business.

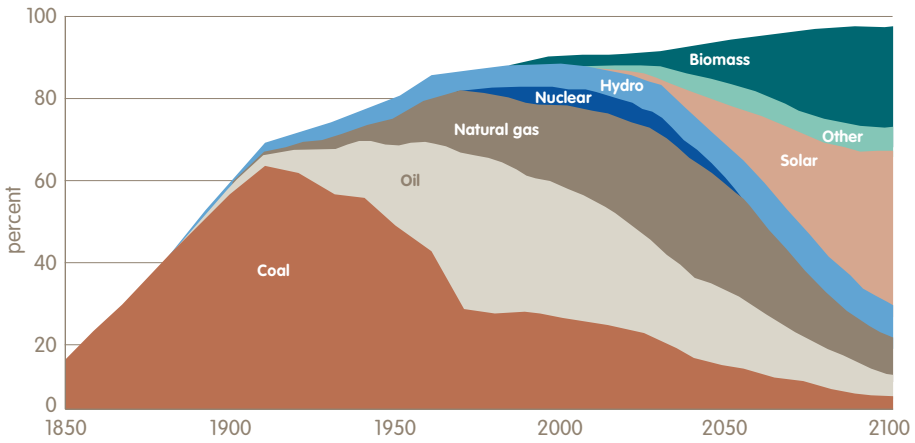
Another mechanism open to the government of Australia would be to mandate the use of a certain percentage of locally-produced gas within Australia (rather than allowing it all to be exported), thus making more plentiful the supply of natural gas-sourced LPG as well as CNG and LNG.

It is worth noting that in Latin America, particularly Argentina and Brazil, strong government promotion of natural gas as an alternative to gasoline and diesel has resulted in very high take-up of this option compared with other countries. The policies are justified in terms of reducing air pollution in cities and increasing energy independence.

In Argentina, promotion of natural gas began in the mid-1990s, and by 2003 the penetration of natural gas vehicles into the domestic fleet had surpassed 15 percent. Direct government involvement lies behind this transformation, both on the demand side and on the supply side (such as through government investment in refuelling infrastructure).[34]

34 For a description of the Argentine experience, and especially for an analysis of the policies that led to the success of the natural gas initiatives, see Yeh (2007).

Figure 15. Changes in global primary energy sources, 1850 to 2100.



Source: Nakicenovic et al (1998) Fig 5.7 Scenario C1

c. Biofuels – ethanol, biodiesel, second generation biofuels (bio-gas, bio-oils)

The biofuels industry in Australia could be a valuable complement to the country's strength as a sugar producer and could possibly see oil plants developed in regulated enclosures in northern Australia.

To achieve this in a manner that is acceptable to the Australian public, it will be essential to use crops, locations and conversion processes that are environmentally sustainable.

Unfortunately, the experiences with the production of bioethanol from corn in the United States and biodiesel from palm plantations in South-East Asia, have reflected poorly on the whole biofuels industry. Australia is fortunate in that its present small bioethanol industry, from wheat and sugar wastes, can be justified on environmental grounds.

To expand this, tapping the much larger biofuels potential of Australia, it is essential that we learn from overseas experience and continue to integrate environmental sustainability into the development.

We adopt a cautious tone in our biofuel recommendations precisely because we are aware of the potential pitfalls and of the need to take a comprehensive view when evaluating matters as complex as claimed improvements of greenhouse-gas emissions, land use changes and expansion of agricultural activities.[35]

We see biofuels as a transitional contributor to the world's energy security, paving the way to a future energy industrial system that is grounded in renewables from a variety of sources.

From the perspective of the year 2100, when the oil era will be well behind us, things will no doubt look clearer – as depicted by one scenario shown in Figure 15.

To date, Australian production of biofuels has been confined to some production of ethanol from grains (wheat and sorghum) and sugar wastes (molasses) on a small scale, and some biodiesel production from vegetable oils extracted from soy and canola, and from animal fats and abattoir wastes, again on a very small scale.

If there is to be serious production of biofuels in a way that contributes to fossil fuel independence in transport, at least up to a level of a 5 percent blend (E5 for ethanol or B5 for biodiesel) and possibly going beyond that to E10 and B10 and eventually to a maximum of E20 or B20, then there has to be very serious consideration of the land options, crop options, and water options available in Australia's setting.

35 Prior studies of biofuels potential in Australia include the CSIRO/ABARE/BTRE study of a biofuels target for Australia (2003); the Biofuels Taskforce with its report to the Prime Minister (2005); and the RIR&DC/CSIRO/NFF 2007 study on Biofuels in Australia: Issues and Prospects.

We see biofuels as a transitional contributor to the world's energy security, paving the way to a future energy industrial system that is grounded in renewables from a variety of sources.

Land options: We do not advocate any expansion of Australia's temperate crops, such as wheat or soy or sorghum, as feedstocks for biofuel production. There is already sufficient pressure on natural ecosystems and agricultural land, from drought and land degradation effects, without contributing to a food versus fuel debate in Australia. This might be further exacerbated in a warming and drying Australian climate (CSIRO/Bureau of Meteorology 2007).

Hence we see biofuel production to be focused on expansion of tropical crops, and in particular on sugar cane for first generation ethanol production. Potential expansion of sugar cane production could occur in Queensland, using only land that has already been cleared and is probably degraded. So that cultivation of a perennial like sugar cane would have beneficial soil impact as well as climate effects, via the net removal of carbon from the atmosphere and minimisation of net nitrogen loss as nitrous oxide.

We would wish to see any such expansion of sugar cane cultivation conducted only after full public inquiry, and under conditions that are certified to be best practice from the perspective of minimising chemical inputs and other fossil fuel inputs.

Crop options: The last thing Australia wants to do is replicate the disastrous policies followed in the United States and the European Union, where domestic production of corn-based ethanol and soy-based biodiesel in the United States, and sugar beet-based ethanol and rapeseed (canola)-based biodiesel in the European Union, is leading to pressure on existing crops, on food and feed prices, and to minimal environmental benefits.

We advocate a quite different model for Australia, where our tropical crops and native species may provide a natural basis for bioenergy production.

For first generation bioethanol, sugar cane (the fastest growing plant on the planet) is the obvious choice, with an estimated potential yield of 4,000 litres per hectare. Other tropical candidates to be explored would include cassava.

For first generation biodiesel, there are native oil-bearing trees such as Pongamia, as well as Brassica mustard, and the crop that is making enormous headway in India, China and South East Asia – *Jatropha curcas* – that cannot be introduced in Australia because of quarantine restrictions.

Second generation biocrops would include eucalyptus plantations based on mallee root, for example, which would not only provide fast-growing biomass but also contribute to reduction of soil salinity. There are many other second generation candidates, including pulp waste from paper mills.

Water options: In a dry continent such as Australia, where river systems like the Murray-Darling are under great pressure, the last thing we advocate is introducing another water-intensive crop. That is why we do not favour ethanol production from grains or biodiesel production from soy or canola. Instead, we see any expansion of biofuels production taking advantage of northern rains and, in particular, monsoon rains. Expanded sugar cane production should be able to demonstrate that it can be rain-fed without the need for irrigation or with minimal irrigation from river valleys in northern Queensland where there is degraded land.

With these provisos, we advocate as guidelines the following scaling up of biomass production in Australia.

Scale of activity

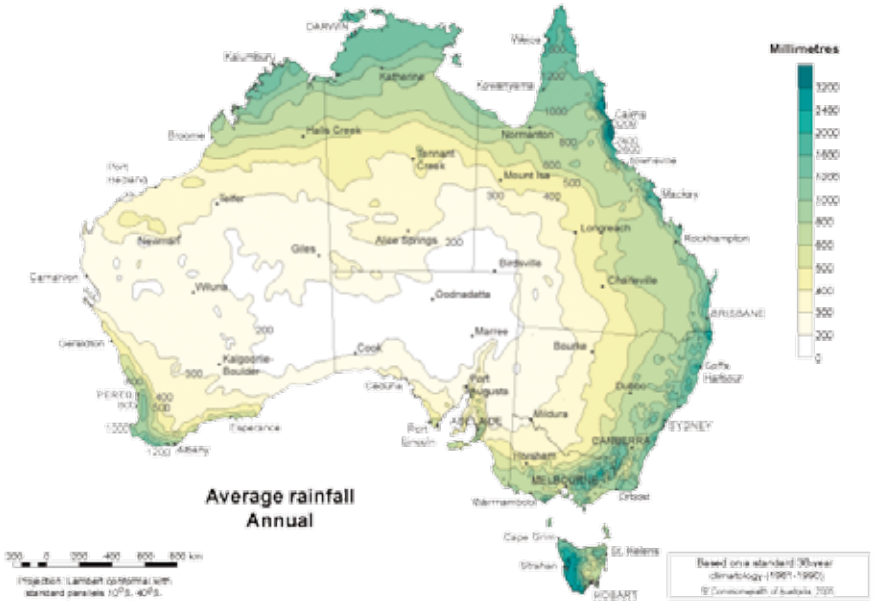
Let us take first generation sugar cane based ethanol as an illustration of what might be possible. The current standard for ethanol biorefineries is a plant producing 200 million litres (ML) per year, at a capital cost of around $200 million. This is a capital cost, needed to set up a biorefining operation with equipment, operating staff and permits and licenses – to which must be added the cost of the raw material. Even so, it is clear that ethanol production would be highly competitive with fossil fuels in Australia at the moment.

Let us say that five biorefineries producing ethanol are built in Australia over the next five years – making for a total of 1 GL per year by the end of five years. This is a very modest proposal by international standards given that Brazil is already producing nearly 20 GL per year, largely from sugar cane, and the United States is producing the same amount, largely from corn as feedstock. Of course, this assessment does not fully account for issues such as competition for food production (fertile land areas, appropriately skilled human workers), impacts on biodiversity, the inclusive costs of the alternatives, etc.

Investment called for would be $1 billion over five years – compared with the $13.5 billion per year currently invested in producing new oil wells, coal mines and petroleum refineries.

How much land under sugar cane would be needed in such a modest proposal? At a yield of 4,000 litres per hectare (slightly below the yields currently achieved in Brazil) a 200 ML biorefinery would draw on 50,000 hectares of sugar cane fields. This is a square with side 22 km in length. Five such biorefineries would call on 250,000 hectares of cane, after a five year period of expansion. This is the area occupied by a square with sides approximately 50 km in length – hardly more than the area of Brisbane City Council.

Figure 16. Tropical rainfall patterns in Australia



Source: Australian Bureau of Meteorology, 2007.

The current sugar industry in Queensland, which is concentrated in the Pioneer Valley and the Burdekin Valley, occupies 400,000 hectares, and is contracting due to government policies over the past decade where farmers were being paid to leave the industry. Instead of contracting the sugar industry, a proposal for modest investment in first generation sugar cane based ethanol could double the land area under cane cultivation – and double the jobs provided by the industry (from 10,000 people employed to 20,000). Expansion would be possible in the areas, presently at least, fed by regular monsoon rains, eliminating the need for irrigation.

The extent of the tropical/monsoonal rainfall belt across the north of Australia is revealed by the map in Figure 15 provided by Australia's Bureau of Meteorology. This shows the pattern of rainfall received over a 30 year period. It needs to be said that this rainfall pattern does not necessarily translate into water availability on the ground, given that climate change is already occurring and enhancing evaporative loss (CSIRO/BoM 2007). It also needs to be said that higher rainfall levels do not necessarily equate with suitable soils, and that transport and other costs might be prohibitive in some parts.

Again, caution needs to be exercised by public authorities in allowing an expansion of sugar cultivation in low latitudes in Australia, with all likely factors being evaluated.

There is scope to increase the land under cultivation in regions such as the Herbert River Valley in northern Queensland, which receives regular monsoon rain each year. We are aware of possibilities of expanding cane production in the Northern Territory, where there are vast river valleys that presently receive monsoon rains each year and sweep all the rainwater back out into Australia's northern seas. There is no reason in principle why at least some of this rainfall could not be captured by new sugar cane plantations in areas such as the Daly River catchment area, subject to comprehensive environmental oversight.[36]

We simply recommend that these are options which should be investigated and where further scientific research should clarify the risks and possibilities available through a holistic examination of climate change, soils, infrastructure requirements, skills availability, societal change, etc.

Existing bioethanol proposals in Australia, such as they are, all involve grains (wheat or sorghum). In this case, five 200 ML biorefineries would call on 1.3 million hectares under grain – or more than five times the land required by sugar cane based processes.

This is why grain-based ethanol is not the way forward for ethanol in Australia – quite apart from the issue of competition with food or feed supplies.

We suggest that bioethanol could be produced from sugar cane grown in the far north of Australia, opening up new rural development possibilities. A doubling of the current sugar crop to expand into ethanol production could revitalise the industry and the regions associated with it, helping to reverse the serious decline in the quality of life in rural and regional Australia. Queensland-grown ethanol could be a means of saving on oil imports.

36 Studies of the Daly River catchment area have already established some of the criteria that would need to be met by any biofuels expansion; see Blanch, Rea and Scott (2005) or Scott (2006) for an overview.

We emphasise that any such expansion be undertaken after due deliberation, with open public inquiries being conducted, to ensure that land use issues are thoroughly explored. If there are native title issues involved then these will have to be addressed – and perhaps Aboriginal communities themselves would want to become involved in growing and processing biofuels from cane (or other tropical crops such as cassava).

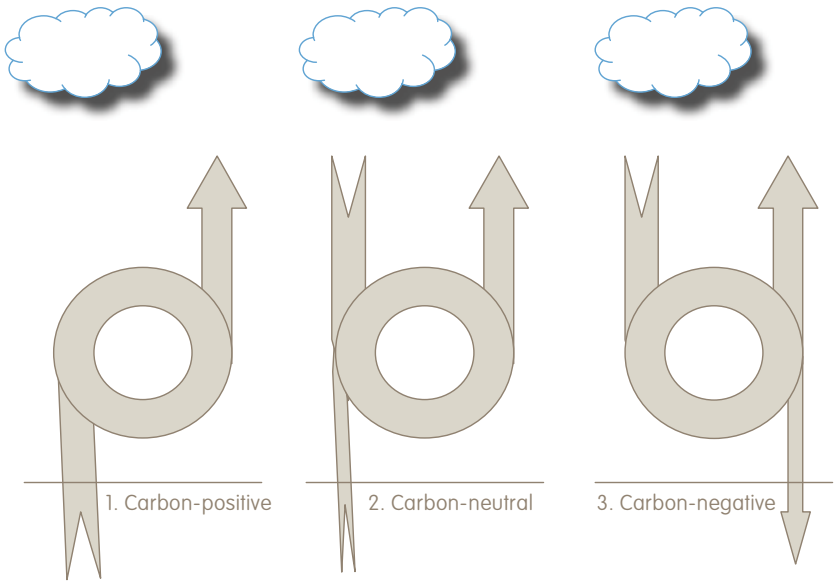
Any expansion of biofuels production in Australia would have to be conducted under the most stringent environmental protection and certifiable sustainable practices, to satisfy the Australian public as well as international markets.[37] One element in ensuring acceptability would be for Australian biofuels to be carbon negative (including the effect of the nitrogen cycling).

Carbon negative biofuels

Any biofuel that draws carbon from the atmosphere during the growing of the biomass (by photosynthesis) can be rendered carbon negative by returning a portion of the biomass to the soil in more or less permanent form.

One means of doing so is through production of biochar – setting aside a portion of the biomass and converting it to a mixture of bio-oils and biochar through pyrolysis. It is a strategic choice how much of the biomass to convert into biofuel like ethanol or biodiesel and how much into biochar via pyrolysis – a choice that can be made by farmers and fuel producers, depending on prevailing prices.

Figure 17. Carbon-positive, -neutral and –negative biofuels



Source: Mathews (2008).

There are many other options for carbon sequestration – as demonstrated by the work currently underway in 'clean coal' technology. Here the approaches associated with 'carbon capture and storage' (CCS) can be applied not to fossil fuels but to biofuels – thereby again making them carbon negative.[38] When applied to biofuels, these approaches to carbon sequestration – both biosequestration and geosequestration – have the potential to draw more carbon from the atmosphere than is emitted through their use as fuel.

The technical means of making biofuels carbon negative are already available. The differences are clear:

1. Carbon-positive fuels are drawn from fossil fuel deposits and are burned releasing carbon dioxide into the atmosphere;
2. Carbon-neutral fuels absorb carbon dioxide as they grow and release the same carbon back into the atmosphere when burnt. In practice, they will always be at least somewhat carbon positive depending on the fossil fuels used in their production and transport;
3. Carbon-negative fuels absorb carbon dioxide as they grow and release less than this amount into the atmosphere when used as fuel, either through directing part of the biomass as biochar back into the soil, or through carbon capture and storage (Figure 17).

37 The Dutch Cramer Commission (2007) has formulated sustainability criteria for biofuels now adopted by the Dutch government. These would serve as a model for the Australian case.

38 On this, see the IPCC special report on Carbon Dioxide Capture and Storage, available at: http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm; and the draft special report prepared under the auspices of the UNFCCC by Chris Hendriks, available at: http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/hendriks.pdf

Soils that are being impoverished by conventional fertiliser-driven agriculture have the chance to be regenerated through production of biofuels combined with biochar amendment to the soils.

i. Biochar

The most straightforward and attractive idea for biosequestration is recycling of part of the biomass produced in the form of charcoal, or 'biochar'. Biochar is produced by a process of slow burning of biomass in limited oxygen (slow pyrolysis). There is an alternative of 'fast pyrolysis' where the biomass is exposed to a high temperature (in excess of 500 degrees C) for a few seconds. However, this has largely been focused on production of gases or liquids as fuels, rather than on biochar.[39]

Either way, it is the addition of biochar to soil that provides the means of permanently sequestering the carbon. This process turns out to have an array of beneficial effects that are now being discussed in a growing and lively literature[40] and will need to overcome the challenges of verification of soil carbon sequestration. Biochar increases the fertility of the soil, not in the form of organic carbon, but in the way that a coral reef increases the nutrients available to biota in the sea. Microorganisms that fix nitrogen, for example, are encouraged by the addition of biochar, and it has a quite spectacular impact on reducing release of other greenhouse gases such as nitrous oxide.

Thus, soils that are being impoverished by conventional fertiliser-driven agriculture have the chance to be regenerated through production of biofuels combined with biochar amendment to the soils.[41]

In terms of atmospheric carbon sequestration, Lehmann and others believe that Gigatonnes of carbon can be removed – up to 4 Gt per year, or as much as the carbon flux currently created through burning of all fossil fuels. There is already a legislative initiative in the United States Congress to channel federal support towards biochar initiatives.[42]

We would like to see strong endorsement of biochar initiatives in Australia, and active encouragement for farmers such as cane farmers switching to ethanol production to utilise some of their cane crop for conversion to biochar and its use to enrich the soil. In the context of carbon trading in Australia, such changes in soil use should be able to attract carbon credits.[43]

Another option is to apply the range of carbon capture and storage (CCS) techniques developed in relation to 'clean coal' technology and apply them to the case of biofuels used to produce electric power. This has been explored under the rubric of 'Bio-Energy with Carbon capture and Storage' (BECS) by scholars associated with the Abrupt Climate Change group, amongst others.[44] It is not expected, however, that such options will become available in the near future.

39 See for example the review by Bridgwater, Meier and Radlein (1999). The Argentinian-Canadian company Dynamotive is currently building fast pyrolysis plants, produced for it by the engineering services company Tecna.

40 The Cornell group led by Johannes Lehmann is prominent in this regard; see for example Lehmann (2007a and -b). For a popular and accurate introduction to the topic, see Renner (2007).

41 Pioneering studies have been undertaken on biochar at the Agricultural Research Station operated by the NSW Department of Primary Industries, at Wollongbar, NSW. For a description of the work, see the DPI website: http://www.dpi.nsw.gov.au/research/staff/lukas-van-zwieten

42 The Bill introduced by Rep. Salazar is the Salazar Harvesting Energy Act 2007. The content of the Bill can be found here: http://www.biochar-international.org/images/S.1884_Salazar_Harvesting_Energy_Act_of_2007.pdf
For commentary on its biochar provisions, see: http://www.biochar-international.org/policyintheus.html

43 The study by Crutzer et al (2008) on nitrous oxide release from agro-biofuel production provides a further cautionary note before claiming greenhouse gas benefits from biofuels. But we note that Crutzer et al see sugar cane-based ethanol as having a net negative impact on global warming (as compared with rapeseed and corn), and thus acts as a global coolant. Lehamnn (2007b) further notes that biochar is a powerful reducer of emissions of both nitrous oxide and methane from soil, both powerful greenhouse gases.

44 See for example Read and Lermit (2005) for an overview.

ii. Algae and other photosynthetic approaches

Another avenue involves the use of photosynthesis to grow algae on a large-scale (for example, feeding off the smokestack emissions of power plants), where a portion of the biomass yield is pyrolized to bio-oils and which can capture carbon credits.

This is a future-oriented approach, not to our knowledge practised anywhere on a large scale.[45] However, the theoretical existence of such an option points to another option nearer to home, namely current advanced production methods for sugarcane, where traditional practices such as burning off are dispensed with, and instead the green 'tops' of the cane are returned to the soil as the cane is harvested.

This practice in itself creates an option on carbon negativity, since only a part of the cane's biomass is being harvested and fermented to ethanol. The balance is allowed to stay in the field as organic carbon.

If these new practices are combined with organic approaches to cultivation, including dispensing with agricultural chemicals in favour of biological control, and with power for the biorefinery being provided through cogeneration, then the carbon negativity of the resulting ethanol would be assured.[46] This is current best practice in Brazil. Even without the addition of biochar these practices could be as carbon negative when the carbon absorbed by the total biomass grown (per hectare) is contrasted with the carbon released as the fuel produced (per hectare) is burnt.

The bioconversion of carbon dioxide to algae is thus one of the more promising of second generation technologies with the prospect of being carbon negative.

The GreenFuels E2B technology licensed by Biomax in Victoria (formerly Energetix, and an affiliate of the Smorgon Group) produces photosynthetic organisms from carbon dioxide and water. According to Biomax[47] the algae are produced in a proprietary Bioreactor that is a containment vessel filled with water, inoculated with a selected strain of algae, connected to a carbon source (such as flue gases from a power station) and exposed to sunlight. The flue gas provides the algae with nutrient carbon and nitrogen (and possibly other materials depending on the composition of the gases) and through photosynthesis these are converted to biomass – with impressive efficiency.

Biomax claims to be able to produce annually more than 200,000 litres of biomass per hectare from this process – as compared with 1000 litres per hectare for canola, or 5,000 litres per hectare for palm oil. This suggests that algae production can be 100 times as efficient. The algae consist of 33 percent lipids (oil), 33 percent carbohydrates (sugars), and 33 percent protein, and as such they can be used as feedstock for both ethanol and for biodiesel.

Of course, if the algae provide biomass for conversion to a fuel such as ethanol or biodiesel (or gasified to biogas), then when the fuel is burnt the carbon extracted from the power station emissions is returned to the atmosphere – and so the overall greenhouse savings are reduced.

Further advantages of the algae option include the point that land is not required on a large scale– reducing some of the biggest barriers to widespread adoption of conventional biofuels.

This is a promising technology and one that could spawn a variety of further developments. We encourage further research in an Australian setting to explore the potential of algae as carbon bio-sequestration systems and sources of bioenergy and biomass.

45 Under the rubric of 'algaculture' these ideas have been pursued, for example under the Aquatic Species Program (ASP) of the US National Renewable Energies Laboratory. For a comprehensive report on the achievements of the ASP, see *Biodiesel from Algae: A Look Back at the Aquatic Species Program* (NREL 1998), available at: http://www1.eere.energy.gov/biomass/pdfs/biodiesel_from_algae.pdf

46 These practices can be found in advanced sugarcane sugar/ethanol businesses in Sao Paulo, Brazil – such as the organic sugar/ethanol business run by the Balbo family, at Usinas Sant'Antonio. See the description at: http://www.commondreams.org/headlines06/0409-07.htm

47 Energetix 2006, Submission to the Inquiry into production and/or use of Biofuels in Victoria, by the Victorian Parliamentary Environment and Natural Resources Committee, Submission #43, October 2006, available at: http://www.parliament.vic.gov.au/enrc/inquiries/biofuels/submissions/Sub_43_Energetix.pdf

Biodiesel

Biodiesel has a future as the fuel of choice not only for on-road vehicles (where its superior efficiency and fuel economy over internal combustion engines is prized), but also for off-road vehicles. Think of the huge coal cutters and dredges and loaders in open-cut mines; these are just some of the candidates for biodiesel in Australia.

Biodiesel is essentially a derivative of oilseed that is akin to making soap from fat. What is added is an alcohol (usually methanol, but we would want to add ethanol in Australia) as well as an alkali like lye. The reaction is called trans-esterification and was first patented by a Brazilian engineer in the early 1980s. When we think biodiesel, we think oilseeds and the kinds of plant that produce them.

So far Australia's biodiesel industry is in its infancy. It has tried to establish itself using as feedstocks oilseeds such as canola and soy, and some animal fats from abattoirs. However, this has proven to be a difficult and expensive path to take.

Some Australian firms such as Axiom Energy in Victoria have built business models not around locating biorefineries close to crops but at ports (e.g. Geelong) with a view to importing their feedstocks, such as palm oil from Malaysia. This seems to be more promising at the moment, but leaves open the question of the sustainability of such supplies.

Australia urgently needs a national research and development program to evaluate alternative oilseed sources as *Jatropha curcas* and Indian mustard (*Brassica juncea*) and the native tree *Pongamia pinnata* for a national biodiesel program, based in the more arid inland regions where traditional agriculture is retreating.[48] Jatropha can potentially be used to hold and fortify the soil in such regions, and in effect roll back the desert, while producing copious quantities of oil that can be converted easily in biorefineries to biodiesel. The only major difficulty is that the Australian Quarantine Service classifies Jatropha as a noxious weed and this is a seriously limiting factor and would require research and control to ensure it could be safely grown in Australia.

The Rural Industries Research and Development Corporation has commissioned interesting proposals for the building of a biodiesel industry in Australia, viewing energy production as a prime means of revitalising some of Australia's seriously declining rural and regional areas. A Discussion paper prepared by Australian Agricultural Crop Technologies, commissioned by the Rural Industries Research and Development Corporation, proposed a business model that considered the following issues:

- Biodiesel is an efficient, biodegradable and renewable fuel, with potentially outstanding benefits for regional Australia – provided it is produced in a fully sustainable and certifiable fashion;
- Worldwide supply of feedstock, by means of environmentally sound processes, is the biggest constraint on the biodiesel industry's development;
- Brassica mustard is potentially a candidate for producing biodiesel in Australia, in that it can quickly adapt to areas of low rainfall, and can be inter-rotated with wheat to improve soil fertility and reduce disease;
- In the longer term, crops such as Pongamia may represent sound options for Australia, given their very low operating costs.[49]

We view these as options to further analyse to see efforts expended to develop a biodiesel industry in rural Australia. We would add the cautionary note that there is growing scientific concern that current South-East Asian sources of palm oil for biodiesel process are actually greenhouse positive, as the result of clearing tropical rainforest and draining peatlands, as well as causing substantial biodiversity losses. Therefore, importing feedstock from this region is unlikely to be a credible option for Australia.

We wish to reiterate our caution in advocating expansion of biofuel activities in Australia – from an admittedly very small base. We have no wish to see Australia repeat the mistakes made in the United States and European Union.[50]

48 In January 2008 it was announced that a research program into Pongamia at the University of Queensland. See 'Pongamia research starts in Queensland', *Envirofuel*, 14 January 2008, available at: http://envirofuel.com.au/2008/01/14/pongamia-biodiesel-research-starts-in-queensland/

49 'Biodiesel production for rural Australia: An initial concept and model', Paper prepared for Biodiesel in Agriculture workshop, Canberra, Sep 2007, available at: http://www.rirdc.gov.au/reports/BBE/07-140.pdf

50 See for example the OECD report *Biofuels: Is the Cure Worse than the Disease?* (OECD 2007) Again, it has to be pointed out that the OECD is here attacking the model of biofuel development found in the US and EU. We wish to see a different model pursued in Australia.

Coal to liquids (CTL) can only be considered as a viable option if combined with carbon capture and storage (CCS) – not yet demonstrated commercially.

By contrast we see Brazil, where alternative fuels led by sugar cane based ethanol have been pursued for decades and have secured energy independence for the country, as a model – again subject to appropriate caveats and caution around other issues such as climate change, nitrogen cycling, biodiversity, etc. Brazilian sugar cane-based ethanol has superior energetics, superior water usage and chemicals usage compared with its United States and European Union counterparts.

Sugar cane is a perennial rather than an annual, and so it has the potential to enhance soil – particularly if used with biochar amendment to the soil, as we advocate. In Brazil, there are organic sugar cane farms where not a single chemical is used – which can act as the model for best practice that we would like to see in Australia.

We therefore advocate a significant and holistic examination with the objective of a possible expansion of the sugar industry to produce 1 GL of ethanol per year, allowing for a national ethanol-petrol blend of 5 percent: E5. If there are no problems, this could be followed by expansion to produce 2 GL per year, allowing for an E10 national blend. This would be a small – but significant – contribution to energy independence and alternative fuel production in Australia.

c. Synthetic fuels (gas to liquids; coal to liquids); DiMethyl Ether and methanol

Unexplored in the Australian context is the range of synthetic fuels derived either from coal, from natural gas, or from biomass. These technologies are mature, and are ready to be applied – provided there is a clear will in Australia to establish industries producing such synthetic fuels, and provided any carbon dioxide produced is sequestered.

In Australia, a consortium called Monash Energy, a subsidiary of Anglo Coal, is proposing a coal to liquids (CTL) plant producing 60,000 barrels per day of liquid fuel (mainly synthetic diesel) to be located in the Latrobe Valley in Victoria.[51] This plant would use the abundant seams of brown coal found in the Latrobe Valley. Monash Energy projects that the pilot plant would not be operational until 2016, and that its cost would be of the order of $5 billion. The site is next to the Gippsland oil field that is becoming exhausted, creating the opportunity for eventual carbon capture and storage (CCS) for the carbon dioxide generated in the CTL process. The cost of this component is yet to be determined and there remain uncertainties around the limits of storage capacity.

There have been other announcements of CTL projects, by companies such as Chevron and Shell, but so far commercial viability seems to be a long way off.

The Jamison Group is of the view that CTL in Australia is an outgrowth of the coal industry lobbying efforts and could, if publicly supported, waste valuable funds that would be better spent developing a natural gas industry and a biofuels industry.

CTL can only be considered as a viable option if combined with carbon capture and storage (CCS) – not yet demonstrated commercially.

By contrast, natural gas and biofuels industries could be viewed as bridging (and relatively cheap) options that will allow Australia to reduce dependence on imported oil, and reduce greenhouse gas emissions, until the arrival of the electric car and the upgrading of electric public transport systems. The gain would be even greater with 'green' production of electricity to power them.

Much more promising as a synthetic fuel is methanol and its derivative, DiMethyl Ether (DME), a gaseous fuel that is a complete substitute for diesel. The huge advantages of methanol and DME are that they can be produced from biomass, through chemical and thermal conversion processes (rather than through biological processes such as fermentation).[52]

Natural gas provides another option for the production of methanol, DME and synfuels from an indigenous fuel source. Unlike the case of CTL, synfuels derived from natural gas are less carbon-intensive than synfuels derived from coal. Further research on this option is desirable, particularly in an Australian setting with Australian sources of biomass.

51 60k barrels per day is 21.6 million barrels per year, which is (x160) 3.46 billion litres per year. At a projected capital cost of $5 billion, this is around $1.40 per litre, including public subsidies. Compare this with the capital cost estimates for biofuels, which are $200 million for a plant producing 200 million litres per year – or $1 per litre – without any subsidies at all.

52 See the review by Semelsberger et al (2006).

The Jamison Group defines 'alternative fuels' as those that are not directly derived from, or connected with, oil or coal.

3. What then do we mean by 'alternative fuels'?

The Jamison Group defines 'alternative fuels' as those that are not directly derived from, or connected with, oil or coal. As such, alternative fuels are derived from three sources, namely natural gas, biological sources, or electricity generated from renewable sources.[53]

Natural gas derivatives, including CNG, LNG and LPG if it is produced from natural gas (and not from petroleum refining) as well as downstream synfuel derivatives such as methanol and DME, all count as 'alternative' fuels because they come from natural gas deposits found in Australia, enhancing our energy and economic security, and because they burn more cleanly than petroleum.

Biologically derived fuels, including first generation biofuels ethanol and biodiesel, as well as synfuels derived biologically such as biogas and bio-oils, are all clearly 'alternative' fuels in that they come from a completely different source than fossil fuels and promise strong independence from imported oil. They burn more cleanly than petroleum, are environmentally more friendly, and if produced appropriately and in certified fashion, promise substantial greenhouse gas benefits as well.

Electricity generated from renewable sources is likely to become the dominant 'alternative fuel' for private and public transport, certainly by the 2020s, where the issue will turn on the extent to which the electric power is generated from renewable sources. We expect the proposed Emissions Trading System to put a price on cheap fossil fuels like coal that will help to drive the electricity generating system towards renewable sources.

We consider that these three kinds of alternative fuels – deriving from natural gas, from biological sources and from renewably generated electric power – need to be based on new, domestic industries that promise domestic consumers, farmers and businesses a growing level of independence from imported oil as well as providing export possibilities.

We exclude from our definition any fuel associated with petroleum (such as LPG derived from petroleum refining) or petroleum derivatives (e.g. DME derived from petroleum) or fuel associated with coal such as Coal to Liquids processes.

This definition is framed to offer a clear distinction between conventional fuels and alternative fuels, and to give a clear indication of what we believe to be candidates for public support in framing an energy independence roadmap for Australia.

53 Our discussion is framed to be consistent with the expanding international literature on alternative fuels, such as McLean and Lave (2003), Holden and Høyer (2005), Gielen and Unander (2005), Romm (2006), or Moriarty and Honnery (2007).

4. How to reach the mandated targets?

The key goal of our discussion is to demonstrate the feasibility of reaching mandated market shares for alternative fuels of, say, 5% alternatives by 2010, 10% alternatives by 2015, and 20% alternatives by 2020.

We have stated already above that we believe there would never be a need for a target exceeding 20%, because by the year 2020 the dominant form of transport is likely to be electric (even air freight is moving to fast electric trains in Europe), and the issue will be the extent of renewable and other low-carbon generating sources for the electricity being used.

Assuming that fuel economy measures are implemented, we do not expect fuel consumption in Australia to rise much above 40 GL per year, from its level of 35 GL five years ago and 38 GL today.

A mandate of 5% alternatives by 2010 would call for alternatives amounting to 2 GL per year, which could be satisfied by natural gas supplies or biofuels alone, both domestically produced and imported.

A mandate of 10% by 2015 would call for 4 GL of alternatives, which might be made up of 1 GL of CNG and natural gas-derived LPG; 1 GL of domestic -produced ethanol; 1 GL of domestic-produced biodiesel; and 1 GL of certifiably sustainable biofuel imports.

Similarly, a mandate of 20% by 2020 would be met by 8 GL of alternative fuels, coming perhaps from 2 GL of CNG and natural gas-derived LPG; 2 GL of domestic-produced ethanol; 2 GL of domestic produced biodiesel; and 2 GL of certifiably sustainable biofuel imports.

These are possible scenarios, to illustrate the feasibility of the targets. We are not insisting on the precise mix of future alternatives, but on the feasibility of setting market mandates to build alternative fuels industries.

In fact, we expect these targets to be achieved earlier than the dates set, given a supportive environment for investment in the nascent alternative fuels industries. We would expect them to become export industries as well as suppliers of fuels for domestic consumption, thereby displacing imports.

The investment involved in such a roll-out – by businesses setting up alternative fuels production or distribution systems – would be in the order of $5 billion per year, needed for investment in plant and equipment.

This compares extremely favourably with the $13.9 billion that is currently invested in maintaining our fossil fuels industries (plus the extra $9 or $10 billion that goes in subsidies to fossil fuels). If anything, investment of $5 billion per year is too modest.

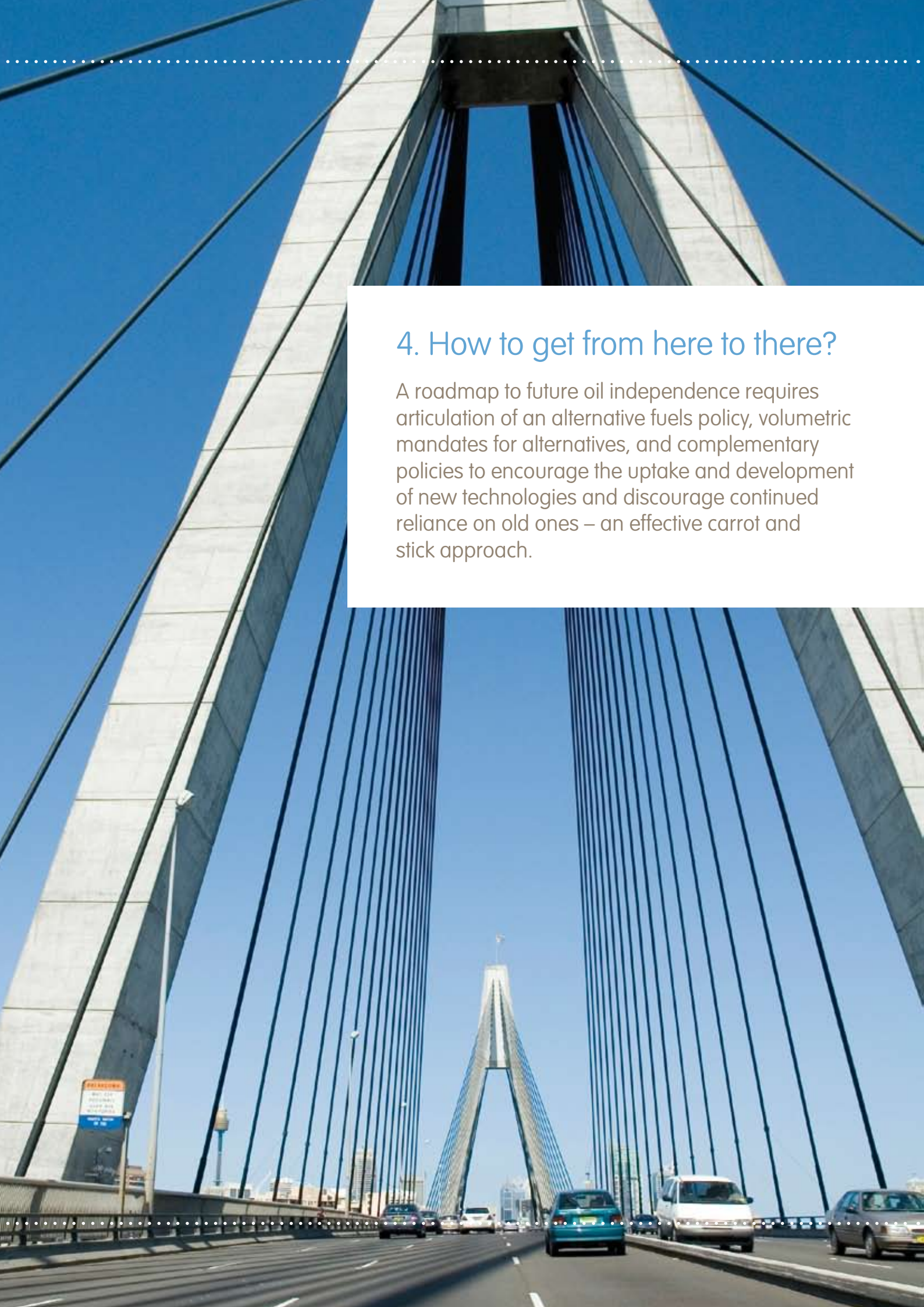
Contrast these figures with the figure of $5 billion quoted by Monash Energy for a single CTL plant , producing 60,000 barrels of fuel per day – or 3.5 billion litres per year – with a projected date for a pilot plant of 2016 – i.e. eight years away.

Biofuels are not only much more immediate and cost-effective, but they promise greenhouse gas emissions savings (compared with the need for carbon capture and storage for the CTL plant proposed) and a cleaner fuel.

When we factor in the point that an expansion of biofuels would revive rural industries like sugar cane and would create new rural industry development possibilities in the tropical north, we feel that there is no contest – biofuels trump coal to liquids as a source of alternative fuels in Australia.

Building a natural gas industry in Australia with links to fuel distribution in the cities as well as creating an export platform is also a national infrastructure building project of enormous significance.

Both kinds of projects are needed to build energy independence for the private transport sector in Australia.



4. How to get from here to there?

A roadmap to future oil independence requires articulation of an alternative fuels policy, volumetric mandates for alternatives, and complementary policies to encourage the uptake and development of new technologies and discourage continued reliance on old ones – an effective carrot and stick approach.

The time for a fresh start has arrived – a start that is driven by the three principal imperatives of economic, energy and environmental security.

Changing the Australian way of transporting ourselves will be a test case for the wider challenge of changing the present fossil-fuelled economy to a low-carbon, low emissions economy.

The time for a fresh start has arrived – a start that is driven by the three principal imperatives of economic, energy and environmental security.

Economic security means taking seriously the impending costs of remaining wedded to oil as our prime transport fuel at a time when our imports of oil and the price of oil are both relentlessly rising – a double whammy that makes the present cries of pain over fuel costs a mere whimper to what we can expect.

To enhance our economic security we must make a fundamental commitment to reduce our reliance on fossil fuels, to rebuild our industrial base both to produce clean and renewable energy, and to use such energy sources preferentially – principally as a means of transport.

Energy security means taking seriously the prospect of world oil supplies peaking (they may already be doing so) and thus underlining the necessity to move to an economy that is less and less dependent on oil as its driving force.

Transport is in the front line here because it starts with such near-total oil dependence. Moving away from oil dependence to relying increasingly on renewable and other low-carbon energy sources should be the guiding light in fashioning public policy.

For transport options, that means swinging support behind a new generation of electric powered vehicles and new electric public transport systems for our cities, backed up with new industries for growing our own fuels (biomass, bio-oils, bio-gas, and first generation biofuels) and for making use of Australian-produced cleaner fuels such as natural gas.

In the first instance, it means supporting new fuel-efficient kinds of cars and trucks that make use of the latest in low-fuel consumption technologies.

Environmental security means taking the threats to our environment from the burning of fossil fuels seriously – from the planetary effects that are captured by the phrase 'global warming', to the local effects that are measured in terms of smog and air pollution in our cities, causing high levels of avoidable respiratory disease, cancer and other serious public health impacts.

Creating energy independence

The immediate and short-term way to reduce such impacts is to insist that fuels sold in Australia meet the highest standards of fuel economy and health standards; while the longer term means of meeting the environmental threat involve finding ways to rebuild our economy on a low-carbon footing.

The real barriers to creating energy independence from imported oil lie not in the technology or in the scale of the activities required, but in the policy settings that will trigger – or block – investment in the alternative fuels industries required. A clear roadmap is needed to guide the process of delivering energy emancipation.

The first step in a roadmap to a future of sustainable mobility for all Australians is to articulate the need for an alternative fuels policy. Australians have become addicted to cheap oil and, like all addicts, the first step in curing addiction is to acknowledge that there is a problem.

The formulation of a sustainable mobility perspective will provide a checklist for all policy initiatives.[54]

If there are proposals to expand housing for 'working families' and this involves a knee-jerk expansion of housing in outer suburbs that are bereft of any transport facilities, then it must be queried on sustainable mobility grounds.

If there is a proposal to expand the plug-in hybrid and electric vehicles fleet, but no effort is made to improve the proportion of renewable energy sources in the electricity generation industry, then these vehicles will not substantially improve the country's greenhouse gas emissions profile.

So a sustainable mobility vision cuts across the whole of government, as well as providing a context in which it becomes politically feasible to discuss lifestyle changes that actually reduce energy consumption.

The second aspect of a roadmap would be to carve out some space for alternative and renewable fuels to grow, in a market dominated by fossil fuels and by companies making and selling fossil fuels.

54 See the report from the World Business Council on Sustainable Development, Mobility 2030 (WBCSD 2004).

Every country that has successfully reduced its dependence on fossil fuels has done so through the judicious use of market mandates.

Every country that has successfully reduced its dependence on fossil fuels has done so through the judicious use of market mandates. The latest exponent of such mandates is the United States. At both state level (California) and now at the federal level, policies have been enacted mandating certain levels of renewable and alternative fuels, increasing over time. These are volumetric mandates, i.e. applying to the whole of the market, and thus allowing for variations around the norm.

The European Union is also mandating certain levels of alternative fuels, notably biofuels, with an initial requirement of 10% of biofuels to be available as part of the fuel mix by 2015. Japan is following suit.

The most famous and successful of all such market mandate policies is that of Brazil, where a mandate enacted in the 1970s has evolved to a point where no such mandate is needed today. The country has already switched to a position where ethanol accounts for over 40% of the passenger vehicle fuel market, and since the 2000s biodiesel has started to make inroads (based on graded market mandates) as well.

In this world setting, it is astonishing that Australia has no such market mandates – other than a paltry requirement that biofuels be produced at a level exceeding 350 ML by 2010 (supplemented with a NSW state mandate that ethanol account for 2% of petrol sales).

Thus, this second step for a sensible set of policies would involve setting realistic market mandates – such as 10% by 2015 and 20% by 2020. This sends a clear signal to all companies investing in fuel delivery systems in Australia, and provides an opening to smaller local companies wishing to break into a market long dominated by a handful of international oil companies.

We note that in Australia we have allowed the domestic fuel market to be dominated by foreign oil majors – thus underlining the greater need for an alternative fuels market mandated scheme.

The market mandates do not need to specify the particular 'alternative fuels' but would have to be based on clear advantages over current fossil fuels. They would include CNG and synthetic fuels based on biomass to liquids, as well as biofuels generally and of course all forms of electric propulsion (if the electric power comes from renewable sources). Such market mandates would in particular give a domestic biofuels industry a chance to establish itself – without any costs to the taxpayer.

Market mandates are not a subsidy; they are simply a government-mandated requirement that supply to the market must adjust in line with social expectations. A long history of the failure of 'voluntary' means of seeking to shape market outcomes for fuel supply in Australia underlines the necessity for market mandates. In effect, mandates produce a level playing field enabling feasible development of alternatives.

Market mandates would provide some security and certainty for entrepreneurs looking to create new businesses in supply or production of alternative fuels – such as producers of biofuels, or operators of retail fuel outlets with alternative fuel facilities.

The market mandate makes it easier for them to raise finance, since banks and other lenders are more comfortable with the level of risk involved. This has been the factor that has held back major investments in Australian alternative fuels industries. The proposed ethanol biorefinery at Dalby in Queensland, for example, has been several years on the drawing board while financing was sought.

These steps need to be complemented by measures that address the supply side and the demand side for fuels. Taking the demand side first, there are a number of ways in which smart interventions can be made to promote and encourage the uptake of alternative fuels, given that this is seen as a desirable direction to move in as a matter of public policy.

The simplest way is to provide tax rebates for buyers of new vehicles that offer the option of utilising alternative fuels (such as flex-fuel vehicles) or use electric power (such as hybrids); or to consumers who switch to gas-powered vehicles and retrofit gas tanks on their cars. All of these consumer choices are moves away from fossil fuel dependence, and all are to be encouraged.

State governments could also play a role: a simple fiscal incentive could be offered through registration payments that vary according to the size of the car – making drivers of large SUVs pay much higher registration charges than drivers of lower fuel consumption vehicles.

Tax penalties could be imposed by the federal government on imported vehicles that are high consumers of fossil fuels, and relaxed for imports that represent a move away from fossil fuels. This would be more important than imposing a wealth test on such purchases.

Both state and federal governments could take active steps to improve public transport and non-polluting forms of mobility such as cycling.

On the supply side, there are numerous ways of encouraging firms to move into the supply of alternative fuels, the supply of vehicles utilising alternative fuels, or the provision of infrastructure needed to move towards an alternative fuel economy (such as dispensers for CNG fuelled vehicles and plug-in chargers for electric vehicles). The worst way would be to give cash grants from taxpayers' money – since this sets up continuous expectations of market-distorting handouts. The best way is to use the tax system, offering tax rebates on investments that are judged to be making a real contribution towards the shift to an alternative fuel economy.

Tax credits could be offered for investments in:

- Growing biofuel feedstock crops;
- Building biofuels processing plants;
- Creating alternative fuels distribution systems;
- Converting existing fuel outlets to dispense alternative fuels and plug-in electric charging;
- Manufacturing alternative fuels components e.g. lithium-ion batteries; or
- Producing lower fuel consumption vehicle engines.

The Jamison Group considers that these tax-based systems would be much more effective than the grants schemes that were launched during the years of previous governments, such as the Alternative Fuels Grants Scheme (AFGS) and the Alternative Fuels Conversion Program (AFCP), operated by the Australian Greenhouse Office.[55]

At the same time the tax system could be used to impose fiscal penalties on suppliers of fossil fuels, particularly through the operation of a fuels excise system that attaches the heaviest burdens on gasoline, a less heavy burden on diesel and gas, and the lightest burden of all on biofuels.

We recognise that reform of the tax system would be a pre-condition of such an approach, given that some firms regard tax incentives as an invitation to 'rort' the system, as happened with previous tax-based systems such as the 125% tax allowance for R&D. However, tax-based measures are inherently efficient and reduce transaction costs, while eliminating the pursuit of rents by claimants looking to take advantage of funds established for handing out grants.

On balance, we prefer tax credits as tools to influence public behaviour.

To ensure that electric vehicles reach their full potential they should be allowed to sell power to the electric grids as well as purchase power – and this calls for a fundamental change towards the use of 'gross' (rather than 'net') feed-in tariffs. Such an arrangement would allow other decentralised producers of electric power from renewable sources – such as farmers producing wind power on their land – to sell power to the grid, in addition to users of electric vehicles.

It is an example of a small change in regulatory arrangements – requiring electric generation companies to buy power from a range of small producers – that could have large-scale ramifications.

The measures discussed so far are aimed at encouraging oil independence and the building of alternatives to fossil fuels. The fossil fuel industries already enjoy many subsidies which need to be wound back in order to level the playing field.

55 For a description of these, and other programs of the Howard Government, see the Parliamentary Library Research Note, 'Government assistance to alternative transport fuels', by Richard Webb (Research Note #9 2006-07), available at: http://www.aph.gov.au/library/Pubs/RN/2006-07/07rn09.htm

In a study published in 2003, Riedy and Diesendorf found that total subsidies enjoyed by fossil fuel industries in Australia amounted to $6.5 billion per year. In an update, Riedy (2007) finds that these subsidies have grown to close to $10 billion per year – setting a considerable agenda for government to reverse as a high priority.

Tax credits offered for oil exploration in Australia, amounting to approximately $260 million in 2005-06, could be phased out over a three-year period. Companies would still to be free to invest in such exploration, but they would do so at their own risk, and not with public subsidy.

Initiatives can be taken by the government itself, such as in making land grants in northern Australia under strictly controlled terms for the growing of biofuels crops. Areas of land in the vast river valleys of northern Australia, such as the Daly River valley, could be set aside in parcels and made available for agricultural development of biofuels crops – as land grants are made available in areas such as the Ord River scheme for crops cultivation.

All these initiatives must be seen as complementing the steps taken by the government to kick-start a low-carbon economy.

The proposed Emissions Trading Scheme (ETS) to curb release of greenhouse gas emissions could be utilised, by ensuring that the production and refining of fossil fuels be included in any such scheme. While including petroleum refining within the ETS, would add a few cents to the price of each litre of petrol, it would make production of alternative fuels economically more attractive.

This is a price increase that the government could defend as the price of long-term economic and energy security – ignoring populist and fruitless debate over how to 'reduce' the impact of petrol prices.

Beyond the ETS, the government could move ahead of the Kyoto Protocol in creating carbon credits for a variety of rural activities that could be linked to production of alternative fuels. Carbon credits could be generated, for example from growing plantations such as mallee plantations whose biomass could provide feedstock for biooil or biogas, in a way that is consistent with the Clean Development Mechanism of the Kyoto Protocol.

Carbon credits recognised from such Australian initiatives would make them economically viable and encourage farmers to diversify away from simply growing food crops to thinking strategically about energy.

A final step would involve a complete redirection of government R&D expenditure, away from support for the fossil fuel industries and towards support for nascent alternative fuels industries.

Research organisations could be encouraged to establish or expand R&D programs in alternative engine technologies e.g. investigating external combustion engines and improved combustion systems; researching potential biofuel crops for Australia, such as *Jatropha curcas*; developing high-energy perennial crops such as mallee eucalyptus; investigating the properties of biochar as a means of replenishing the fertility of soil; and fostering second generation biofuels production and suitable strains of algae.

Ultimately, accomplishing the shift means building the new industries to create and sustain our energy independence.

It means building a new domestic industry based on compressed natural gas, to use this resource for Australian private transport. It means building new biofuels industries, based initially on first generation ethanol and biodiesel, but in such a way that they can make the transition to second generation biofuels based on a vast range of biomass inputs which Australia will have in abundance if public policy moves in an appropriate direction to support their growth and supply. It also means building and sustaining new industries producing renewable and other low-carbon energies principally solar, wind and geothermal based – in which Australia should be a world leader. Further, both the energy and energy technology could become our principal export industries, eventually eclipsing coal.[56]

We know how to build new industries. We only have to look to our north, to see how Singapore, Taiwan, Korea and originally Japan all built new industries in the post-war period, with enormous success.

Building a new industry requires :

- A strong and public statement of intent;
- A preparedness to intervene and create the market, if necessary by mandating a market share to tip the balance against incumbents;
- A preparedness to use all the tools of public policy to create the industry, on both the demand side and the supply side;
- Government support for a shift in R&D that underpins the new industry and its supply of new products and services; and
- Government support in purchasing the output of the new industry, such as in swinging government car fleets in favour of the alternative fuels.

56 For a recent survey of prospects for renewable energies in Australia, see Diesendorf (2007).

Both the energy and energy technology could become our principal export industries, eventually eclipsing coal.

If grant-based funds are to be used (such as the Green Car Fund) they should be used in a transparent fashion to encourage a clear swing away from the status quo towards doing things differently. For example, in the case of the automotive industry, doing things such as producing vehicles with new low fuel consumption engines and new 'green' electric powered vehicles.

However, the reality is that almost all the tools of new industry creation are available through the tax system and through public competitive processes, without the need for cash-based grant programs or old-style tariff protection programs. In this sense, our roadmap towards an alternative fuels future does not 'cost' anything.

Our proposals are couched in terms of alternative investment strategies – utilising investments that would otherwise have been sunk in reinforcing our fossil fuel dependence into building renewable energy industries and expanding alternative fuels industries. Examples include expanding our sugar industry to become a monsoon-fed ethanol industry and expanding our domestic natural gas industry.

All Australians will benefit from investments made in these industries of the future.

We advocate market mandates, tax incentives and government procurement as tried and tested means of shifting investment away from fossil fuels towards alternative fuels, rather than creating large funds from taxpayers' contributions.

The NRMA can play an important role in setting the stage for the new alternative fuels and renewable energy era. The NRMA could:

- Start by making itself a green organisation and switch its own car fleet to a renewable fuel standard, e.g. by opting for CNG or biofuels;
- Offer prizes, in conjunction with other public bodies in Australia, for new low fuel consumption technologies and engine designs – such as for new plug-in electric vehicles and their components, or compressed air engines;
- Ensure that member discounts are spent on new and renewable fuel options and secure discounts from firms offering such green and renewable energy options;
- Use its membership base to create a powerful market force for change – negotiating with automotive companies that NRMA members will receive a discount if they purchase green vehicles, or with fuel companies that NRMA members will receive a discount for purchasing renewable and other low-carbon fuel options.

These are all ways through which the government and businesses such as the NRMA can demonstrate seriousness about shifting the economy onto a new transport footing, one that is less reliant on fossil fuels.

These are ways that do not involve cash transfers to private interests – long regarded as the standard method of encouraging desired activities in Australia. Instead, they involve governments making smart moves to adapt and shape the tax system to reward both consumers and producers who make moves towards alternative fuels, and to penalise those who do not.

Industry associations

An important means through which new and alternative industries establish themselves is through the building of industry associations. The biofuels industry in Australia, such as it is, has already consolidated its representation through the merger of the Biodiesel Association of Australia with the body representing ethanol producers, the Renewable Fuels Association, to create a single body, unified Biofuels Association of Australia (BAA).

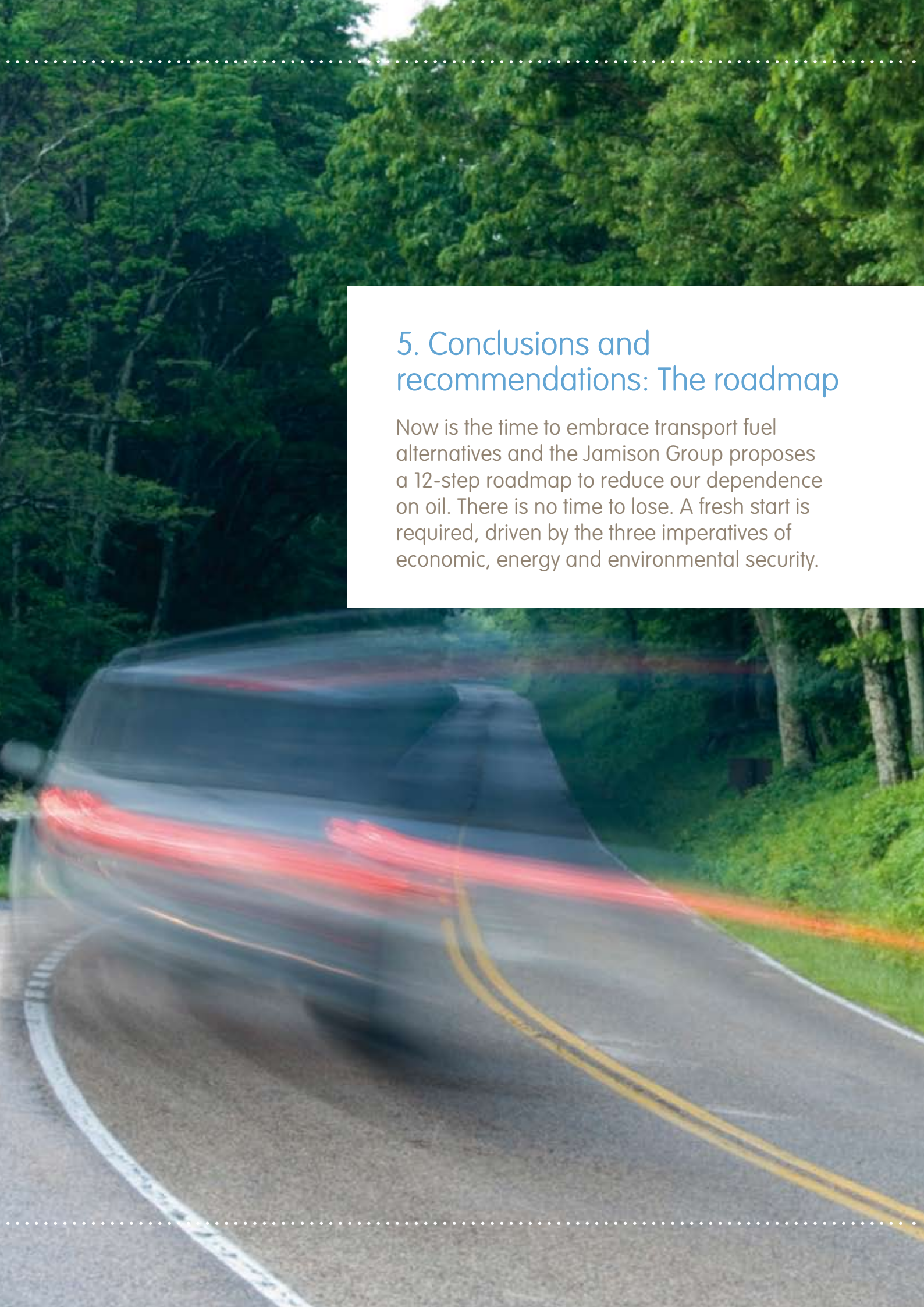
The BAA now provides a single point of reference for the biofuels industry. Outside this body there exists the Asia-Pacific Natural Gas Vehicles Association (ANGVA). A logical next step would be for an Australian chapter of ANGVA to join with BAA to create a single federated Australian Alternative Fuels Industry Association (AAFIA), which would stand in support of all alternative fuels and provide an alternative viewpoint to the Association for Petroleum and Petroleum Exploration of Australia (APPEA) which already provides a single point of representation for the fossil fuel industry.

A new and dynamic AAFIA would represent a clear break with the policies supported by the APPEA and a coming of age of alternative fuels as an industry in Australia.

The NRMA itself could play a positive role as a sponsor and broker of such a new industry association. An AAFIA would counter the lobbying efforts of the APPEA; it would insist on national standards favouring the development of alternative fuels; and it would stand its ground in support of alternative fuels against the huge incumbent advantages of the fossil fuels industry.

We are convinced that there will be no alternative fuels industry in Australia without a single industry association to represent its interests.

Finally then, we turn to our roadmap, or sequenced series of steps that we believe would get Australia off its fossil fuel treadmill.



5. Conclusions and recommendations: The roadmap

Now is the time to embrace transport fuel alternatives and the Jamison Group proposes a 12-step roadmap to reduce our dependence on oil. There is no time to lose. A fresh start is required, driven by the three imperatives of economic, energy and environmental security.

Australia is almost entirely dependent on oil – increasingly on imported oil – for its transport fuel.

Recent soaring oil prices have dramatically highlighted the challenges to Australia's future economic, energy and environmental security. There is no mechanism available for making up the current shortfall and questions arise as to the capacity of the world's current energy mix to supply global energy needs in the medium to long term.

Now is the time to embrace transport fuel alternatives and the Jamison Group proposes a 12-step roadmap which aims to address the identified security challenges.

We recognise that we are in a place we want to leave behind – with near total dependence on oil, particularly oil imports, and on continued high prices for oil as it becomes harder and harder to find and import.

Our roadmap is designed to relieve us of this burden of uncertainty, and to build new industries that can sustainably take the load. These will be the renewable energy and low-carbon industries of the future. Significantly, many of the technologies for reducing our dependence on oil are already available.

We start with the immediate steps that a government interested in combating oil prices and investing in an alternative fuels future must consider and move through the 12 steps to more comprehensive measures. These steps seek to recognise the complexity of the challenges involved and avoid fixating on a single solution.

Ultimately, the swing away from fossil fuels will succeed only if it is driven by changes to the incentives provided by government, the investment patterns of businesses and finally, through changes in public opinion and behaviour.

The Jamison Group's proposed 12-step roadmap, outlined below, is a starting point towards such a desirable outcome.

1. Reduce oil dependence in Australia by 20 percent by 2020; 30 percent by 2030; and by 50 percent by 2050

A roadmap to reducing oil dependence should start with a goal – with a sense of where we are headed as a nation. A good standard to guide all future policy, and to set benchmarks against which other steps can be measured, would be to set a goal of, say, reducing oil dependence overall by 50% by the year 2050, rising to reach this from a 20 percent reduction in oil dependence by 2020 and 30 percent by 2030.

These are realistic goals that would seize the public imagination in Australia and provide a benchmark against which all government policies could be measured. These goals would be subject to scrutiny by a panel of experts appointed by the government and required to report by 2009 on the feasibility of the goals and steps that could and should be taken to achieve them.

Such goals could provide a national unifying force and eliminate much of the party political wrangling over fuel prices and fuel policy. It would mesh with concurrent initiatives to establish a national carbon emissions trading scheme, which will put a price on carbon. The goals would directly address the looming threat of an enormously increased trade deficit Australia faces if oil imports are allowed to grow at their current rate.

A key part of expanding the use of alternative fuel will be comprehensive research to consider in an integrated and robust way the social, economic, engineering and environmental aspects of each option.

2. Promote and develop alternative fuels

Australia has to reduce its oil dependence and take the steps needed to do so on three grounds:

- To satisfy economic security – reducing dependence on oil imports and address balance of payments difficulties;
- To satisfy energy security – reducing dependence on oil supplies that are becoming more difficult to extract and will command ever rising prices; and
- To satisfy environmental security – reducing greenhouse gas emissions from vehicles burning oil-derived fossil fuels.

The goal to reduce oil dependence should translate into a commitment to develop alternative fuels in Australia as well as to reduce consumption and improve energy efficiency generally.

The Jamison Group would encourage the development of three major alternatives to oil-based fossil fuels:

- Natural gas – CNG, LNG and LPG derived from natural gas;
- Biofuels – first generation ethanol and biodiesel; second generation lignocellulosic biofuels; bio-oils and biogas; and
- Electric vehicles – hybrids, plug-in hybrids and eventually all-electric vehicles.

These alternatives all provide opportunities to develop new industries in Australia, subject to the most stringent environmental precautions, certification and development of national standards that are on a par with best international standards.

Natural gas can be sourced from Australian reserves (some of which should be reserved for domestic use) and thus meet concerns over economic and energy security. Although natural gas burns more cleanly than petroleum, it is still a fossil fuel and contributes greenhouse gas emissions. As the national emissions trading scheme starts to bite, we see natural gas becoming the fuel of choice in power stations, thus competing as an end use with natural gas used in transport.

Biofuels are a natural candidate for expansion in Australia, but only in such a way that they are seen to be sustainable and deliver real greenhouse gas emissions improvements. This means expanding biofuels activities in such a way that they do not compete with food production and minimise fossil fuel inputs into the production process. Biofuels production should meet stringent environmental standards and be certified as such.

Electric vehicles are a promising automotive alternative, with zero tailpipe emissions. However, they will deliver only minor greenhouse gas gains while generation of electricity in Australia remains tied to the burning of coal. To the extent that power production responds to fresh policy initiatives (such as the national ETS) and renewable sources of electric power become available, so the electric car option will become more attractive.

A key part of expanding the use of alternative fuel will be comprehensive research to consider in an integrated and robust way the social, economic, engineering and environmental aspects of each option.

3. Compulsory fuel consumption and carbon dioxide standards

The best way to reduce oil dependence is to reduce the consumption of oil-based fuels in transport, through improvements in consumption standards and/or their equivalent in greenhouse gas emissions standards.

The current voluntary fuel consumption standard operating in Australia has brought us to the point where passenger vehicles made in Australia, and imported vehicles sold in Australia, are giving drivers no better than a level of 8 litres per 100 km travelled.

A declaration is required by the federal government that the current European, Japanese and Chinese standards for new passenger vehicles must be met in Australia in staged increments, from 2010 to 2012 to 2015, and that no passenger vehicle be sold in Australia by 2015 unless they achieve a standard of less than 5 L/100km, comparable to European and Japanese standards.

This will be the single biggest saving on fuel costs that the government can offer to working families in Australia. It will also be a powerful lever to reduce carbon dioxide emissions from the private transport fleet.

The claim from the government that Australian greenhouse gas emissions will be reduced by 60% by 2050 can actually start with the automotive industry, where tailpipe emissions will need to be significantly reduced. This is a realistic target, and sets the right example for the rest of the economy to move to low-carbon technologies.

A 'back of the envelope' calculation reveals that Australia's 14 million vehicles, each travelling an average of 19,000 kms per year, generate a total of 265 billion passenger km per year (BITRE 2007). A saving in fuel consumption of 2 litres per 100 km (bringing Australian levels down to current Chinese levels) would generate total savings for all Australian drivers of 5.3 billion litres per year, or just under $10 billion at current petrol prices.

These savings from fuel consumption need to be contrasted with a hypothetical saving of 5 cents per litre from a reduction in fuel excise, which for a total petrol consumption of 20 billion litres would translate into savings of just $1 billion ($2 billion was allowed for in the Federal Budget).

Treasury could be asked to model the impact of such a compulsory fuel consumption standard with greater precision, to estimate the degree to which it will reduce consumers' private transport costs. This modelling should also link with fuel excise exemption arrangements, to show how a shift in consumption towards alternative fuels will also result in lower fuel budgets for working families and for citizens generally.

The requirements to meet compulsory fuel consumption and vehicle greenhouse gas emissions standards should be imposed on the automotive industry, where the companies producing cars in Australia, and those selling cars in Australia, will be required to submit test data showing how they are complying with the standards. Those meeting the standards ahead of time will be offered a tax incentive, while those failing to meet the standard will be penalised.

4. Further compulsory emissions standards

The current Australian Design Rules that regulate toxic fuel emissions for vehicles sold in Australia have fallen well behind the best in the world. A government interested in leading the country to a low-carbon and healthy future would start with a requirement that the tailpipe emissions of nitrogen oxides, carbon monoxide and particulate emissions meet the standards that are already being met in Europe and Japan, such as the Euro 5 and proposed Euro 6 standards.

These emissions standards would be staged in terms of increasing stringency, from 2010 to 2012 to 2015, by which time the automotive industry would be required to be on par with current European and Japanese standards. Such a requirement will force-march innovation and catch-up by the automotive industry in Australia, making it more receptive to alternative fuels.

5. Alternative fuel market mandates

The best way to promote fuel alternatives is to set mandates for increasing market shares of alternatives. Alternative fuel industries will be built in Australia only to the extent that market mandates that break the grip of the petroleum industry on our fuels market are promulgated.

Voluntary targets do not work, and urgent action is needed now to avoid the looming threat of an enormously increased trade deficit caused by the costs of oil imports.

We propose an alternative fuels mandate of 5 percent by 2010, 10 percent by 2015 and 20 percent by 2020. These mandates will complement the overall national goal of achieving oil independence, and complement the overall national goal of achieving a 20 percent reduction in oil dependence by 2020.

Fuel mandates are requirements imposed on the fuel industry. Individual companies refining or selling fuel in Australia (above a certain minimum) will be required to provide data that demonstrates compliance with the mandate across the total pool of fuel sold. Fuel suppliers that can meet the mandated standard ahead of time should be able to claim a tax credit, while those that fail to do so would be penalised. Repeated failure would result in loss of a license to refine and distribute fuel in Australia.

Such mandates will encompass alternative fuels that meet the reasonable requirement that they do not emanate from oil or from coal. These mandates will encompass fuels derived from Australian natural gas (CNG, LNG and LPG from gas) which provides some short-term relief from oil imports and burns more cleanly (but is not a solution to greenhouse gas concerns); and fuels derived from biological sources and which can demonstrate that their production has been certifiably sustainable. This includes both ethanol grown largely from sugarcane and biodiesel grown largely from oilseed plants that do not compete with production of food – such as the Queensland native tree Pongamia.

Such fuel market mandates can be found throughout the world where governments are serious about switching the fuel mix away from dependence on oil – in the European Union, United States, Japan, and of course in Brazil where the feasibility of a non-oil transport fuel mix was first demonstrated. They should now be found in Australia as well.

The federal government would need to promulgate these market mandates as national development goals and take steps to meet them in a 'whole of government' approach. There would be a role for several government departments to play in meeting the goals.

- The Department of Resources, Energy and Tourism would administer the alternative fuels program and set the quality standards for fuels produced by national alternative fuels industries, based on the best advice from other leading countries that are taking active steps to develop alternative fuels.
- The Department of Innovation, Industry, Science and Research would set the goals for new industry creation and expansion of existing industries – starting with a tripling of the size of the present sugar industry to create a foundation for ethanol production, and a doubling of the size of the present natural gas fuels industry.
- The Department of Agriculture, Fisheries and Forestry would facilitate the switch in agricultural output from food and fibre to food, fibre and fuel, focusing on new plant varieties for biodiesel that could be grown in Australia without subtracting from current efforts to produce food. This would also prepare for major land reform to switch the emphasis from farming in the dry south to farming in the tropical north.
- The Department of the Environment would ensure that new alternative fuels industries meet stringent international certification standards to ensure sustainability and public acceptance.
- The Treasury and Department of Finance would track the subsidies currently paid to fossil fuels and monitor their gradual winding down through successive budgets, as well as administering a tax system that favours innovation in introducing alternative fuels infrastructure and disadvantages those staying with the oil-based status quo.
- The Department of Climate Change would ensure that the ETS include transport, complementing the market mandates for alternative fuels, and that carbon credits could be generated by alternative fuel producers.
- The Australian Bureau of Statistics (ABS) would track the balance of payments deficit in oil and the production of alternative fuels as offset against this, as well as bringing a focus in its reporting processes on renewable energies and low-carbon activities.

The prime purpose of such market mandates is to generate certainty in the size of the industry market for firms willing to make the investments needed to bring the alternative fuels to fruition, and thus to assist them in securing finance for these investments. As soon as market forces are operating, the mandates can be relaxed.

Every purchase of a low fuel consumption vehicle should carry a clear tax incentive.

6. Tax incentives for vehicles running on alternative fuels or propulsion systems

The entire tax system, which is at present focused on raising revenue, should be refocused to accomplish a swing in the vehicle fleet towards flex-fuel vehicles running on both petroleum-based and alternative fuels; and towards vehicles that depart radically from oil dependence, particularly electric vehicles and hybrids.

In a context of tax reform, where the tax system is simplified to combat evasion, such a shift in emphasis makes eminent sense and will complement the alternative fuel market mandates as well as the new compulsory fuel consumption standards and emissions standards.

Vehicles and fuels that perform better would attract tax benefits, and vehicles that perform at current standards or worse would be penalised.

On the demand side, we see government encouraging the shift to lower fuel consumption engines and cars and trucks. Every purchase of a low fuel consumption vehicle should carry a clear tax incentive, and every purchase of a vehicle that utilises standard fossil fuel technology should be penalised.

This could be implemented by the federal government in its next budget, creating tax rebates for purchases of hybrid electric vehicles (thereby complementing the $35 million boost for hybrid production in Australia committed to Toyota through the Green Car Fund), while eliminating the import duty concessions given perversely to purchasers of SUVs.

Government is itself a major vehicle fleet operator and can utilise its procurement powers to ensure that its own vehicle fleets operate on alternative fuels. This in itself would send a powerful market signal to both automotive producers and fuels companies.

As part of its announced tax reform, the government should revisit fuel excise to ensure that exemptions granted reflect the desired shift away from fossil fuels and oil dependence. An immediate and popular measure for the federal government to take would be to remove excise levied on alternative fuels, or continue current excise exemption arrangements indefinitely into the future.

This would respond to the current intense debate over excise levied on petrol – and it would send a clear signal that the government is prepared to change excise arrangements only in line with a shift towards alternative fuels consumption.

In addition, tax or other incentives are needed to encourage owners of older motor vehicles to trade them in for cleaner alternatives.

The entire transport system in Australia has been weighted towards private mobility at the expense of public transport and sustainable mobility options.

7. Tax incentives for alternative fuels and infrastructure

On the supply side, government can play a significant role in providing tax incentives to firms that are making investments in green energy, or are building new green energy businesses that will pool to become the new green energy industries of tomorrow.

In transport terms, this means offering incentives to:

- Automotive firms to shift to fuel efficient vehicles utilising new fuel efficient technologies (such as clean diesel);
- Fuel distributors to offer a range of fuel dispensing systems including diesel, biofuels such as E10 and B5, and CNG;
- New biofuel producers building biorefineries to produce a range of first and second generation bio-gas, bio-oils and biofuels; and
- Farmers to invest in new crops for producing energy without sacrificing our food production and export of food crops.

One of the simplest steps that the federal government could take would be to remove all excise levied on alternative fuels (such as natural gas, ethanol and biodiesel) and reindex the excise payable on fossil fuels – petrol, diesel and LPG. At the same time, the government could remove the perverse exemptions enjoyed by some SUVs (they pay only 5% import duties) and switch them instead to energy-efficient vehicles which currently have to pay 10% duty.

8. Wind back subsidies that reinforce oil dependence

There exists a raft of explicit (as well as hidden) subsidies provided to fossil fuel industries in Australia, as identified by Riedy and Diesendorf. One of the easiest ways for government to level the playing field is to dismantle these subsidies, explaining at the same time why it is doing so.

The subsidies and incentives include tax benefits for cars provided by employers (but perversely excluding non-polluting forms of transport such as bicycles and public transport); import duty inequities for some SUVs; non-recovery of public agency costs (such as the heavy industry support provided for the oil exploration industry by Geoscience Australia); explicit fossil fuel tax concessions; fossil fuel energy R&D (such as massive expenditure in Australia on so-called 'clean coal' while winding back support for renewable energy R&D); the diesel fuel rebate scheme; and subsidies for road use and car parking.

We noted above that these subsidies probably amount to close on $10 billion per year – a huge 'free kick' offered to fossil fuels over their renewable counterparts.

We recommend that Treasury and the ABS be tasked with monitoring this subsidy problem and that Treasury find ways to unwind the subsidies.

9. Use of Green Car Fund

The federal government made a pre-election commitment to create a Green Car Fund to rebuild the Australian automotive industry and make it fit for the new carbon-conscious 21st century.

No details have been issued as yet as to how the Fund is to operate, although $35 million has been committed to Toyota to assist it in building the hybrid Camry in Australia. We understand that the Bracks Review of the automotive industry will make recommendations as to the use of the Green Car Fund.

We offer the recommendation that these funds would be wasted if paid simply to the large automotive builders – GM-Holden, Toyota or Ford. We would like to see the largest part of the fund distributed to small and medium-sized components producers who have products that can reduce greenhouse gas emissions or reduce our oil imports.

The Green Car Fund could then complement efforts at innovation and the building of export-based industries, while contributing to the fulfilment of the goals of the alternative fuels program.

10. State governments to play their role

The federal government could play a coordinating role in bringing the states to reform their own tax and tariff arrangements, introducing changes such as:

- Graduated vehicle registration charges – this would ensure that drivers of smaller and lower fuel consumption vehicles pay lower registration charges, while drivers of large SUVs and larger vehicles are charged at a higher rate; and
- Full feed-in tariffs – as a payment for all electricity supplied to the grid from renewable sources, feed-in tariffs would play the same role in Australia as they have already played in Europe and elsewhere, in driving the development and expansion of renewable energy industries.

11. Allow carbon credits to grow alternative fuel industries

The proposed national emissions trading system is going to have to cover as many greenhouse gas emitting industries as possible if it is to function effectively.

The fossil fuels industry, with its mining and refining activities both intense emitters of greenhouse gases, cannot be allowed to be an exception. Already there is skirmishing underway, with claims that the transport sector should not be covered unless some other sector is also covered, e.g. agriculture. These claims must not be allowed to progress.

We see the ETS applying in the first instance to large upstream emitters of carbon, and eventually covering agriculture, forestry and livestock as well as downstream users such as private transport.

The counterpart to a compulsory emissions permit system is a system for allocating carbon credits to activities not covered by the ETS that reduce carbon emissions, or preferably sequester carbon already present in the atmosphere, as is done by carbon negative biofuels.

As a complement to the proposed national ETS, the government could create a national mechanism for recognising and certifying carbon credits (probably under the AGO) that would act in concert with, but across a broader range of activities, than the UN Clean Development Mechanism.

Such certifiable credits could then be traded on carbon markets in Australia, giving a further financial incentive to farmers and producers of biofuels and other alternative fuels businesses (such as conversion kits suppliers) that could make a case to the AGO that they are creating carbon credits.

12. Foster urban public transport and sustainable mobility options

The entire transport system in Australia has been weighted towards private mobility at the expense of public transport and sustainable mobility options such as cycling.

A shift towards alternative fuels as a way of enhancing economic security, energy security and environmental security should be accompanied and complemented by a revitalisation of public transport systems (inter-city rail; urban fast metros; light rail systems; mixed mode transport) and a new seriousness in promoting sustainable mobility alternatives such as cycling (cycle lanes and pathways; cycle rental and exchange depots).

These new emphases will signal a determination to deal with rising energy prices and a recognition that the era of cheap oil is well and truly over, meaning that alternatives can and must be developed.

All government transport planning and approaches to framing energy policy need to start from this new awareness and sustainable mobility perspective.

A smart government will be able to emphasise the opportunities so generated for Australian business.

End note

The Australian public has been bombarded with commentary about oil prices, oil excise, plans for reducing the price of petrol, biofuels, alternative fuels, peak oil, and climate change. The Jamison Group has attempted to collate the facts and draw measured and realistic conclusions and recommendations. The language is often forthright, reflecting the Group's intense concern that Australia does not have a plan to deal with the enormous impact of the potential oil shortage and the need to act on greenhouse gas emissions. The Jamison Group is keen to convey the message that there is no time to lose. A fresh start is required – and quickly – driven by the three imperatives of economic, energy and environmental security.

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Acronyms

AAA Australian Automobile Association

AAFBR Automotive Alternative Fuels Registration Board (Vic)

ABARE Australian Bureau of Agricultural and Resource Economics

ADRs Australian Design Rules (for fuel emissions targets)

AFVs Alternative Fuel Vehicles

AGO Australian Greenhouse Office

APPEA Australian Petroleum and Petroleum Exploration Association

ANGVA Asia-Pacific Natural Gas Vehicles Association

BAA Biofuels Association of Australia

B5–B20 Biodiesel blend (5% to 20%)

BTRE Bureau of Transport and Regional Economics

BTL Biomass to Liquid

CAFE Corporate Average Fuel Emissions (US)

CDM Clean Development Mechanism (UN Kyoto process)

CNG Compressed Natural Gas

CTL Coal to Liquid

DME DiMethyl Ether

E5–E20 Ethanol blend (5% to 20%)

EU European Union

FCAI Federal Chamber of Automotive Industries

FFVs Flex-Fuel Vehicles (running on petrol and ethanol)

FIT Feed-In Tariff

GHG Greenhouse Gas

GL Gigalitres (billion litres)

GTL Gas to Liquid

HEVs Hybrid-Electric Vehicles

LCA Life Cycle Analysis

LNG Liquefied Natural Gas

LPG Liquefied Petroleum Gas

LSD Low Sulphur Diesel

MRET Mandatory Renewable Energy Target

NACE National Average Carbon Emissions (Aus)

NG Natural Gas

NGV Natural Gas Vehicle

PHEVs Plug-in Hybrid Electric Vehicles

RIRDC Rural Industries Research and Development Corporation

RPS Renewable Portfolio Standard (variant of MRET)

SUV Sports Utility Vehicle

ULSD Ultra Low Sulphur Diesel

US United States of America

VOCs Volatile Organic Compounds

VRI Vehicle-to-Refuelling Ratio

Conversion units

3.79 litres = 1 US gallon;
159 litres = 1 barrel petroleum

1 mile per gallon (US) = 0.42 km/l
= 235 L/100 km

10 miles per gallon = 4.2 km/L
= 23.5 L/100km

1 hectare = 10,000 square metres
= 2.47 acres; 100 ha = 1,000,000 square metres = 1 square kilometre

Passenger vehicle (petrol) with fuel consumption 10 L/100 km emits 282 g CO_2/km

Text printed on 100% recycled fibre comprising 60% post consumer and 40% pre consumer waste and cover printed on 35% recycled paper comprising 15% post consumer waste and 20% pre consumer waste, helping to divert waste from Australian landfill sites. It is processed chlorine-free at an Australianmill certified to ISO14001 standards.