Australian Government

Biofuels Taskforce

Dear Prime Minister

I have pleasure in presenting the Report of the Biofuels Taskforce on behalf of the other Taskforce members, Dr David Brockway, Dr John Keniry and Mr Max Gillard.

In preparing the report we consulted widely, including taking 64 submissions and meeting with 40 interested parties. I would like to thank those participants as well as other private sector and government bodies and individuals for their excellent cooperation in assisting the Taskforce.

I would also like to take this opportunity on behalf of the Taskforce to thank our Secretariat for outstanding work. The Taskforce Secretariat consisted of Peter Burnett, Marie Taylor, Helen Wilson, Graham Love, Bill Physick, Louise Tamaschke, Theresa Graham and Su Muir.

Yours sincerely

Conall O'Connell

Dr Conall O'Connell
Biofuels Taskforce

2 August 2005

Australian Government

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REPORT OF THE BIOFUELS TASKFORCE to the Prime Minister

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ISBN 0646-45241-X

Web address of this report: www.pmc.gov.au/biofuels

Produced by the Biofuels Taskforce
Printed by Pirion (02) 6280 5410
Edited by WordsWorth Writing (02) 6232 7511

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Contents

Tables

Figures

Boxes

Overview of key issues

Can a target of 350 ML by 2010 for biofuels be met?

If there were an operating mainstream market for biofuels (ethanol and biodiesel), which there is not, current government policy settings should be sufficient to meet a target of 350 megalitres (350 ML) by 2010.

- The Taskforce asked ABARE to assess the effect of ethanol and biodiesel production costs, the price of oil, exchange rates and the government's excise assistance on the viability of the biofuels industry.
- ABARE estimates that, on its assumptions, fuel ethanol and biodiesel producers should be commercially viable at least until biofuels' effective excise advantage is reduced towards 2015. This does not include any judgement by ABARE regarding domestic fuel ethanol's competitiveness from 2011 when import protection ends.
- Between 2010 and 2015 biodiesel is likely to become commercially unviable. Fuel ethanol would remain commercially viable beyond 2015, but at lower levels of return, again subject to being able to compete with imports.
- ABARE's modelling uses long-term assumptions of an oil price (West Texas Intermediate) at US$32/bbl and a US$/A$ exchange rate of 0.65. Should the long-term oil price be higher, all other things being equal, the commercial viability prospects of biofuels would improve.

What is stopping progress?

There are interrelated commercial risks that are impeding the 350 ML target by preventing an operating mainstream market for fuel ethanol blends.

- Oil companies in a highly competitive market, with no forcing regulation or long-term economic incentive, have no commercial reason to surrender market share to others – whether to other oil or biofuels suppliers.
- There is almost no consumer demand for ethanol blends, other than in minor market segments supplied by independents and small market trials by the oil majors.
- Consumer confidence remains poor following the events of 2002–03. Automobile associations and vehicle manufacturers generally have been cautious about giving unequivocal messages of confidence in a 10% ethanol blend (E10).
- The Taskforce considers that this low level of consumer confidence is not justified by the facts. Almost all post-1986 vehicles on Australian roads can use E10 quite satisfactorily.
- Under current market conditions, and with no consumer demand, oil majors have little commercial incentive to promote ethanol blends as a bulk fuel. But without contracts for sales to oil majors, new ethanol producers cannot invest in bulk fuel ethanol production.

- The first mover into bulk mainstream ethanol blend retailing faces considerably higher commercial risks than later entrants:
  - it would incur infrastructure and marketing start up costs
  - it may need to discount prices
  - it may not attract new customers – and so may only move current customers away from a fuel type with higher commercial returns
  - it may be unable to secure reliable and sufficient ethanol at competitive market prices
  - unless E10 is included in the shopper docket programmes, it would face a discounting price gap that will be difficult to bridge.
- Should the first mover fail to develop a retail market, it may face significant commercial losses – including wider loss of brand reputation. The oil majors cannot collude to avoid these first mover risks, even if they want to assist in meeting the 350 ML target.
- In addition, the policy settings for biofuels are complex and have undergone significant changes over recent years. Given the intense public debate around ethanol, there is sovereign risk in being the first mover to make investments.
- Until 1 July 2011, domestic ethanol producers will be protected from international competition. Current fuel ethanol costs of production in Brazil are around A$0.20/litre. Australian producers have much higher costs of production.
  - In 2011, Australian oil companies will have access to fuel ethanol at world parity prices – and so may have an incentive to wait until closer to that time if they do make strategic decisions to move into ethanol blends.
  - Raising capital for ethanol plants in Australia will become more difficult as we approach 2011 and competition looms.

What can be done to help?

The Taskforce suggests some actions could readily be taken to help address this impasse without affecting key policy settings or distorting markets, should the government wish to commit to the 350 ML by 2010 target (noting that it has not formally been adopted). As examples:

- The government mandated ethanol-blend labelling standard can be modified.
  - The Taskforce sees no need to label up to 5% ethanol blends. Suppliers would then be able to use ethanol in the mix up to 5% according to commercial requirements, including where it cost-effectively contributes to octane levels.
  - For 5–10% ethanol blends the label does not have to appear like a warning label. It could simply inform. For example: ‘E10’ or ‘Contains up to 10% ethanol’.
- Information on vehicle/fuel compatibility could be provided to consumers in a more accurate and user-friendly way than the Federal Chamber of Automotive Industries’ current listing. For example, labels on fuel-filler caps and forecourt pamphlets with simple tick boxes could be used.

- Consistency with world's best practice can be demonstrated. For example, the industry and government could highlight that European fuel standards include up to 5% ethanol in petrol without labelling.
- Submissions have raised programme options that the government could consider, to demonstrate confidence in E10. For example, opening procurement guidelines for its vehicle fleet and fuel supply to E10, or providing a limited number of competitive infrastructure grants for small-business service station owners to lessen the risk of entering an embryonic E10 market.
- Consumer confidence, and health outcomes, could be improved by increasing the level of compliance inspections for fuel quality standards. This could be complemented by supporting information provided to industry participants on ethanol blend housekeeping.

However, the Taskforce considers that, on current settings and consumer demand, it is unlikely that the 350 ML biofuels target will be met by 2010. The major commercial risk issues facing fuel ethanol are likely to predominate.

What would it cost to reach the target?

The estimated long-term costs of meeting a 350 ML biofuels target by 2010 have not significantly changed since the 2003 350 ML Biofuels Target report.

- Costs to the economy of the current policy settings, driven by the biofuels excise advantage, have been estimated by ABARE modelling for the Taskforce at around $90 million in 2009–10 reducing to $72 million a year (2004–05 dollars) in the long term (post 2015).
  - The Taskforce notes that most overseas production of biofuels is subsidised by governments, with the driver generally being agricultural support.

What benefits would we get for that cost?

The benefits of meeting a 350 ML biofuels target by 2010 have been reassessed since the 2003 350 ML Biofuels Target report.

- Meeting a 350 ML target by 2010 under current policy settings could involve investment in new ethanol plant capacity (grain and C molasses based), probably in rural/regional Queensland and NSW, and biodiesel capacity, probably in South Australia and Victoria. Modelling suggests this could provide some 648 direct and indirect jobs regionally, although these would not be net gains to employment nationally.
- There would be some greenhouse gas emission benefits, of the order of $7 million a year, which could vary greatly depending on plant design and feedstock. On their own, these are not sufficient to warrant significant policy intervention, given that cheaper carbon reduction options are readily available.
- Unlike the 2003 350 ML Biofuels Target report, the Taskforce considers that there may be potential for significant air-quality benefits from fuel ethanol use, emphasising that considerable uncertainty remains. Benefits cannot reasonably be costed at this time due to uncertainty, but the potential for these to be substantial

in the context of ethanol's long-term fuel-excise concession underscores the need for urgent scientific and technical research. There is prima facie evidence that there may be potential for significant reductions in fine-particle emissions from the use of E10 in place of neat petrol.

- Fine particles are increasingly being identified as a key urban environmental air-quality health risk. With improvements in diesel fuel standards over time, petrol motor vehicles will emit an increasing proportion of urban fine-particle pollution.
- To assess, confirm and quantify the potential fine-particle benefits of using fuel ethanol blends, comprehensive scientific and technical research is needed in Australian conditions. This could include assessing E5 and E10.

Are there emerging opportunities?

Should ethanol–petrol blends unequivocally prove to be capable of significantly and cost-effectively reducing fine-particle pollution and so public health impacts, the government may have a significant public health opportunity.

- Depending on cost-effectiveness, governments could consider tightening the framework of air quality–fuel quality–vehicle particulate emission standards, with the objective of gaining public health benefits. The Taskforce emphasises that this should take place within the general policy framework of harmonising with world automotive and fuel markets.
- In turn, tighter particulate standards may create significant market demand for fuel ethanol without requiring additional subsidies or interventions.

Globally, there is major investment in an emerging technology that can produce ethanol from lignocellulosic feedstock, such as wood fibre and grasses. This should become commercially viable in the next five to ten years. The impact of this technology on production costs, including its capacity to use widely available feedstock sources, has not been assessed.

- Emerging technology may provide opportunities for Australia, and the government's current renewable energy programmes should continue to assess the potential.
- However, to the degree that known emerging technology may have a significant effect on the global fuel-ethanol market, new policy interventions to assist investment in production from current technology should be considered carefully to ensure real investment risks are not disguised.

Chapter 1 Summary and conclusions

Context

The Taskforce has focused its attention on biofuels that are liquid transport fuels and which can be readily produced from existing technology. In this context, biofuels means ethanol and biodiesel, in both pure form and as blends with fossil fuels.

The Taskforce has made its assessment within the context of current Australian Government policy. In that regard, the Taskforce notes that while the government has adopted policies and programmes to assist biofuel production, it has not formally adopted as government policy the target, contained in its 2001 election policy *Biofuels for Cleaner Transport*, of producing 350 ML of biofuels by 2010. Having regard to this and the terms of reference, the Taskforce has focused on, but not confined its examination to, a scenario of achieving 350 ML by 2010. The Taskforce considers that clarification of the government's policy position in relation to the target is desirable.

Costs

Globally, and in the absence of subsidies, biofuels cost more to produce than petroleum fuels. Production costs are coming down, and there are new technologies on the horizon. However, barring unexpected scenarios such as ongoing oil prices over US$47 a barrel at a 65c exchange rate, ABARE analysis suggests that Australian biofuels will generally remain uncompetitive with conventional fuels without continuing assistance in the longer term.[1] Depending on market conditions, exceptions could be biofuels that are produced by existing plants with sunk costs, or biofuels made from wastes.

The government provides assistance to biofuels producers in the form of capital grants and tax concessions. This assistance involves both budgetary and economic costs. On current policy settings, ABARE estimates government assistance to the biofuels industry could cost the budget in foregone excise $118 million p.a. at 2009–10, dropping in steps to $44 million p.a. by 2015–16, assuming the 350 ML target is reached. Costs to the economy of the current policy settings, driven by the biofuels excise advantage, have been estimated by ABARE modelling for the Taskforce at around $90 million p.a. in 2009–10 reducing in steps to $72 million p.a. (2004–05 dollars) in the long term (post 2015). Economic costs arise because government assistance changes the relativities between the activity that is assisted and other activities that add value to the economy.

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[1] In assessing the 350 ML scenario, ABARE assumed that all recipients of Biofuels Capital Grants would commence production by 2010, giving 148 ML of ethanol production and 202 ML of biodiesel as ABARE's assumed split of the 350 ML. For reasons given in Chapter 6, the Taskforce concludes that some biodiesel projects are unlikely to be viable in the longer run under current policy settings. The Taskforce considers that, should the 350 ML target be achieved, ethanol will be the principal biofuel produced and so has adopted the split of 290 ML ethanol and 60 ML biodiesel as used in the 2003 350 ML Target Report. The health assessment and costing undertaken for the Taskforce reflect this, as described in Chapter 5.

Benefits

Submissions to the Taskforce identified a number of possible benefits from biofuels:

- improved urban air quality, giving improved public health
- reduced emissions of greenhouse gases
- assisting the Australian economy generally, either through import substitution or kick-starting a new industry
- improved energy security
- regional development.

These are discussed below, but the Taskforce has concluded that, of these, regional development is likely to be the principal driver of policy. In this regard, the Taskforce notes the emphasis on regional development in the government's 2001 election policy on biofuels. Although an assessment of benefits would ultimately focus on the principal driver, other benefits, such as improved urban air quality and greenhouse gas reductions, should still be taken into account.

Urban air quality and health

Air quality in Australian cities is good for four of the six most damaging pollutants—ozone and particle levels exceed standards in some cities on at least one day each year. As a result of decisions already taken to tighten both emissions and fuel standards, urban air quality is getting better. Current projections for motor vehicles, the principal source of urban air pollution, show emissions of major pollutants continuing to fall until close to 2020, when increased vehicle usage would begin to offset air quality gains.

The Taskforce has reviewed the available science, both Australian and international, on the impacts of biofuels on urban air quality and therefore on health. The main finding is a potentially significant change in relation to particulate matter (PM) emissions from E10.

Results from recent UK and US studies indicate that the assumption of negligible impact of E10 on PM tailpipe emissions in the 2003 350 ML Target Report needs to be revisited. In light of these studies, an indicative value of a 40% reduction in particulate emissions over petrol has been adopted for life-cycle and health calculations in this report. However, the Taskforce does not assert that 40% is a scientifically accepted value. Extensive experimental and monitoring work is needed to evaluate the impact of E10 on particulate emissions from petrol vehicles under Australian conditions, and on secondary particle formation.

Should research confirm that there are significant reductions in PM from the use of ethanol blends, this may present an opportunity to review particle standards. This should be done in the context of the framework for setting air quality standards and achieving them through mechanisms such as fuel quality and motor vehicle emission standards. Any confirmed air quality benefits from biofuels need to be evaluated side by side with the costs and benefits of other approaches to reducing emissions.

Possible benefits from reductions in emissions from the tailpipe with ethanol-blends of petrol would need to be weighed against the increased evaporative emissions of smog-forming organic compounds that come with adding ethanol to fuel. The potential for photochemical smog is location-specific and, unlike most fuel parameters, evaporative emissions (measured by Reid vapour pressure) are set by the states. The government could consider initiating studies of evaporative emissions, for which there are few data for Australian conditions.

Given the uncertainties surrounding the level of particulate reduction from E10, it is not possible now to quantify the health costs and benefits of E10 use. However, it is useful to give a preliminary indication of the potential health benefits should E10 significantly reduce tailpipe emissions. Under the scenario of 290 ML of ethanol and 60 ML of biodiesel by 2010, the annual health costs avoided could lie somewhere between the $3.3 million or 1.4 cents per litre (c/L) (2003 dollars) found by the 2003 350 ML Target Report, and $90.4 million, or 30.4c/L (2004–05 dollars) using the indicative 40% reduction adopted for the Taskforce's analysis.

Reducing emissions of greenhouse gases

Biofuels can reduce greenhouse gas emissions, compared with petroleum, depending on how they are produced. For E10, these reductions have typically been assessed in the 2–5% range on a life-cycle 'well to wheel' basis. A recent CSIRO study of a particular proposed ethanol facility forecast reductions in the 8–12.5% range[2], but the Taskforce notes that these results depend very much on the specifics of the facility (which remain confidential) and its ability to produce co-products. CSIRO has noted that the outcomes of this study are consistent with its earlier general advice of 2–5% reductions and cannot be extrapolated to all facilities.

The life cycle reductions for biodiesel are much more substantial on a per litre basis, ranging from 23% to 90% compared with straight diesel, depending critically on feedstock. Greenhouse emission benefits are also more substantial for E85 or E100 at around 25–30%, but these fuels require additional capital investment, such as modified engines and dedicated fuel storage and pumps.

In assessing possible greenhouse emission benefits of 350 ML of biofuels, a split of 148 ML ethanol and 202 ML biodiesel has been used. This favours the greenhouse benefits for the purposes of illustration. At 350 ML biofuel market penetration, greenhouse gas emissions would be reduced by 442,000 tonnes of carbon dioxide equivalent (CO_2-e). If greenhouse reductions alone were the rationale for biofuel assistance, given ABARE's finding that GDP would be $90 million lower in 2010 than it would be otherwise, and government expenditure at $118 million p.a. in 2010, the emission reductions would be costed at $204 per tonne in terms of reduced GDP or $267 per tonne as a cost to government. While there is no national emissions market to provide a benchmark, trading schemes provide some guidance for a benchmark value. The $15 per tonne capped value of CO_2-e under the NSW Greenhouse Gas Abatement Scheme suggests a costing of $6.6 million or 1.9c/L. This is comparable with Australian Government greenhouse gas abatement programmes.

Greenhouse gas benefits alone would not warrant further assisting biofuels, given the availability of much cheaper carbon reduction options.

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[2] The Taskforce believes these numbers should be 7–11.5% — see Chapter 5.

Other environmental benefits

Biodiesel is biodegradable and non-toxic, making B100 highly suitable for use in or near waterways and other environmentally sensitive places where there is a risk of spills. It also has significantly reduced emissions, except for NO_x, potentially reducing OH&S risks in confined areas such as mines and some construction sites where diesel-powered equipment is used. Likewise, diesohol offers significant emission benefits in off-road applications. The government and industry may wish to look at options for encouraging B100 and diesohol use in special applications.

Assisting the Australian economy through import substitution or by kick-starting industry

Some key parameters have changed since the 2003 350 ML Target Report. The long-term forecast price for oil (West Texas Intermediate) adopted by ABARE has risen from US$23/bbl to US$32/bbl. The forecast US$/A$ exchange rate for the period to 2015 has changed from 0.60 to 0.65. Some feedstock costs have increased. The Taskforce commissioned ACIL Tasman to review the methodology and parameters used by ABARE in the 2003 350 ML Target Report to assess industry viability. ABARE took ACIL Tasman's advice into account in conducting a fresh analysis using updated parameters.

The 2003 350 ML Target Report estimated that assisting the biofuels industry to meet a 350 ML target would reduce GDP in 2003 dollars by between $71 million and $74 million in 2009–10. The new modelling by ABARE forecasts a reduction in GDP of $90 million in 2009–10 for 350 ML biofuels market penetration, dropping in steps each year to $72 million in 2015.

On updated ABARE assumptions, the long-term world price of oil would need to average US$42–47 per barrel in 2004–05 dollars (depending on feedstock used) for a new ethanol producer to be viable post-2015 without government assistance. With current government assistance, the required oil price is estimated to be US$25–30 per barrel for viability in 2015. With higher feedstock costs than ethanol, biodiesel producers would require an oil price of US$52–62 per barrel without assistance in 2015, or US$35–45 per barrel with assistance.

Some submissions argued that biofuels benefit the Australian economy by improving the balance of trade. Substituting locally produced biofuels for imported petroleum products could benefit the Australian economy only if they could be produced and sold competitively with imported alternatives without significant government assistance.

Energy security

The government's policy on energy security is articulated in the energy white paper, *Securing Australia's Energy Future*, released in June 2004. At that time, the government concluded that Australia has a high level of energy security and that the level of security in transport fuels was not under threat.

Were the government to consider there was a need to purchase a higher level of fuel energy security, the cost-effectiveness of developing biofuels as a strategy to increase fuel security would need to be considered against other options, such as developing other alternative fuel sources or technologies (such as coal to liquid, shale oil, or gas to liquids), oil stockpiles and measures to encourage greater fuel-efficiency.

The Taskforce could identify no valid arguments to suggest the Australian Government's policy position on energy security is not appropriate

The Taskforce supports the energy white paper conclusion that 'there is currently no case for the government to accelerate the uptake of these fuels on energy security grounds'. In terms of the need to stay abreast of changing circumstances, the Taskforce notes that the government is committed to reviewing energy security every two years and is about to commence such a review.

Regional development

Biofuel production has the potential to affect regional economies by stimulating commodity prices (where these are not set by the world market) and investment in production facilities. Even if increased biofuels production is uneconomic in the absence of government assistance, submissions have argued that increased biofuels production is desirable from a regional development perspective.

To the extent that this production is stimulated artificially by government assistance, there will be other possibly unforeseen regional impacts. For example, an assisted biofuels industry may increase grain prices at a cost to some domestic livestock industries, which are heavily dependent on these feedstocks. This may be especially so around times of shortage due to drought, given the difficulty or cost of importing grain under strict quarantine requirements.

Under current policy settings, the high rates of return that can be obtained by the subsidised fuel-ethanol industry in the short term would allow it to bid strongly against the livestock industry for grain feedstock where necessary.

A full-scale sorghum-to-ethanol plant in a particular locality would try to source around 200,000 tonnes p.a. of sorghum from its locality. The probability that the locality would not have such a surplus is high. Accordingly, the local price may increase as freight costs from further afield get built in and/or growers shift from other crops to sorghum to get a premium driven by the ethanol plant subsidies. Either way, a feedgrain user in the locality may pay more for feedgrain. In poorer than average seasonal conditions, this may be exacerbated.

The Taskforce considers that, on current policy settings, there is real potential for subsidised grain ethanol plants to have a local impact on feedgrain prices in the short to medium term. In the longer term, fuel ethanol rates of return are likely to drop as the policy settings reduce the subsidies—and as ethanol import competition is allowed in 2011. The fuel ethanol industry will then be placed on a more even footing in its ability to bid for grain against the livestock industry.

Even assuming that the distributional benefits to regions of biofuel production outweigh the effect on other industries, there is still the question of whether assistance to biofuels represents the most cost-effective and best-targeted option for assisting regional development. An evaluation of the Commonwealth Dairy Regional Assistance Programme estimated a cost per new job of around $20,000. The Department of Transport and Regional Services advised the Taskforce that this may represent a lower bound cost of employment generation in regional areas. However, no employment-related analysis of other current regional services programmes has yet been undertaken.

ABARE estimated that reaching the 350 ML target could result in 216 direct jobs. A multiplier of two was used to calculate indirect jobs. This multiplier is supported by independent advice from ACIL Tasman. The total number of jobs (direct and indirect) potentially created by current biofuels policy settings to reach the 350 ML target by 2010 is therefore 648. The cost of these jobs (in 2004–05 dollars) would be $182,000 p.a. in government expenditure in 2009–10, or $139,000 p.a. in economic costs. These costs appear high, but could be offset by other benefits such as emission reductions. In 2015–16 the costs (2004–05 dollars) would fall to $68,000 p.a. for government expenditure or a $111,000 p.a. loss to GDP.

The Taskforce recognises that a multiplier of two is conservative, but notes that this may be offset by the fact that jobs may in fact be transferred from other areas and industries in net terms, particularly in a time of near full employment.

The Taskforce notes that an ethanol industry based on sugarcane is unlikely to assist the more marginal areas of sugar production. It would centre on areas of high productivity such as the Burdekin district in north Queensland. In addition, the degree to which a developing ethanol industry would deliver higher returns to cane growers (that is, significantly higher than world parity prices) would depend wholly on income splitting arrangements between millers, ethanol producers and cane growers.

Policy drivers in other countries

Many overseas countries have adopted policies to assist the production and use of biofuels. While national circumstances vary widely, in every case biofuel production has required government assistance.

The reasons given by governments for adopting these policies are essentially the same as the possible benefits for Australia: air quality and greenhouse benefits; economic benefit through import replacement; energy security; and regional, particularly agricultural, support. The Taskforce considers that agricultural support for agriculture is, or becomes so once government assistance is established, the primary driver of biofuel assistance in all cases except for countries with limited capacity to increase agricultural production.

The Taskforce sought to identify reasons why various overseas countries have committed significantly more resources to biofuels than Australia has done to date. Some overseas countries are driven by a much stronger predisposition to subsidise agriculture than in Australia. Others, unlike Australia, are struggling to meet their Kyoto targets and are willing to adopt high-cost measures to mitigate emissions. Still others face a much greater energy security challenge than Australia. Despite declining domestic oil production, Australia will remain a net energy exporter. For some European countries, the Taskforce gained the impression that their biofuel policies are driven by EU decisions that they do not see as being in their immediate national interest. These countries tend to pursue their EU obligations more or less assiduously depending on domestic agricultural interests.

Possible barriers to a viable biofuels market in Australia

Irrespective of whether the costs of assistance to biofuels exceed the benefits, there are existing producers supported by existing government programmes. To maximise the benefits of the programmes, it is important to ensure that existing and potential industry participants are given every fair chance of success.

Consumer confidence and engine operability

Consumer confidence was damaged significantly in 2002–03 after reports of the distribution of high-concentration (20–30%) ethanol blends around Sydney, and widely publicised allegations of vehicle damage. At the time, the Australian Automobile Association (AAA) and other consumer advocates became concerned about the potential operability and additional motoring costs associated with ethanol-blended fuels. The impacts of ethanol on certain engines, real or perceived, led the government to introduce an E10 limit and an ethanol label, seen by many as a warning label.

The Taskforce considered consumer confidence in biofuels, and assessed that consumer confidence in ethanol, while having marginally improved, is still a fundamental problem for the ethanol industry. Biodiesel does not have the same consumer confidence issues. However, the Taskforce notes that confidence can be fragile and biodiesel producers will need to take care to meet fuel quality standards and ensure users are properly advised on fuel blends

In light of the available studies, the Taskforce concludes that almost all post-1986 vehicles can operate satisfactorily on E10. As was known when setting the fuel standard, E10 is not optimal for vehicles that have carburettors or mechanical fuel injection, mainly pre-1986 vehicles[3], and drivers should seek advice from the manufacturers regarding suitability of fuel types if they are not certain. The Taskforce notes advice from the NSW Department of Environment and Conservation that pre-1986 vehicles now make up about 4% of the Sydney fleet and less than 2% of the vehicle kilometres travelled.

As part of a broader effort to assist in restoring confidence, there would be merit in projects to validate the suitability of vehicles in the current fleet to operate on E10.

The Orbital E10 study of two-stroke outboard and other small engines suggests that E10 may not be suitable for two-stroke engines. The risk of phase separation in ethanol blends, and the resulting risk of these smaller engines stalling, means that use of ethanol blend fuel requires care in a marine environment.

The Taskforce sought legal advice on government labelling regulations. As retailers already have trade practices and commercial law obligations regarding consumer information, the Taskforce considers that the government's current labelling requirements can be simplified. For E10, the label need only identify the fuel as a blend of ULP or PULP (octane specified) with 10% ethanol.

Given that an even higher percentage of cars can use E5 than E10, the information standard for fuel ethanol could be further modified so that labelling is required only above 5% ethanol in petrol, rather than 1% as at present. As in Europe, this would give fuel companies flexibility to use up to 5% ethanol as a fuel extender or octane enhancer, without the costs of dispensing E5 as a separate blend.

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[3] The Taskforce has used the term 'pre-1986 vehicles' to describe those vehicles (made mainly before 1986) that have a carburettor or mechanical fuel injection. Most post-1986 vehicles have electronic fuel injection.

Australian fuel and vehicle emission standards are being harmonised with UNECE (European) standards, although the ethanol limit in petrol under the UNECE standard is 5% (unlabelled), while Australia allows 10% (labelled). This alignment with the UNECE is facilitating the use in Australia of the latest engine technology to reduce both emissions and fuel consumption.

The Federal Chamber of Automotive Industries (FCAI) argued that, because the latest high technology engines rely on exacting fuel standards and increasingly need PULP 95, the limit for ethanol in PULP in Australia should be reduced from 10% to 5%[4]. The Taskforce considers that the option of E10 blend in PULP should be retained because it would be labelled as such and because the evidence suggests almost all post-1986 vehicles can operate satisfactorily on that blend. Also, Europe is entering a debate that may see fuel standards there amended to provide for E10 blends.

The Taskforce considers that there is no reason to reduce the maximum ethanol limit in petrol from 10% to 5%, as proposed by the FCAI.

There is also a small number of post-1986 vehicles for which the manufacturer advises against the use of E10. In some cases this advice has been given out of caution in the absence of actual test data. Manufacturers are not likely to commission the expensive testing of older models that would give data to reconsider their advice. As part of an awareness campaign, the FCAI vehicle list could be revised into a simplified format and confined to clearer statements about the suitability of vehicles to use ethanol blend fuels. Fuel suitability information should be presented by automotive manufacturers to consumers in a less confusing manner.

The Taskforce considers that a greater focus on industry-based information dissemination and marketing/promotional activity may improve consumer confidence in ethanol blend fuels.

As B5 meets the diesel fuel standard, no label is needed. Labelling higher biodiesel blends is a necessary piece of consumer information but could be relatively straight-forward in line with a simplified ethanol label.

As with E10, there appears to be limited testing of the suitability of biodiesel for use in engines. The Taskforce notes, however, that there is no diesel engine manufacturing capacity in Australia and that, as a result, engine manufacturers will need to be guided by overseas testing and practice. The government could work with the Australian fuels and transport industries to settle on B5, B20 and B100 as the standard forms of biodiesel, in part through developing a standard for blends above B5.

Fuel consumption

Fuel consumption is another factor which may impede consumers purchasing ethanol blend fuels if they are sold at equivalent prices to petrol. Some consumers in the 2003 and 2005 ANOP surveys who were not happy to buy ethanol blends specifically cited

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[4] The underlying principle for the FCAI is aligning Australian standards to Europe. In Europe, 95 RON PULP is the standard petrol fuel; this fuel is expected to become the main petrol blend in Australia in the next decade.

fuel consumption as the reason for their concern. The government-mandated ethanol label advises that 'the fuel may cause a small increase in fuel consumption'. The APACE and Orbital Reports found increased fuel consumption for test vehicles using E10 ULP in the order of 2.6–2.8%, close to the predicted increase. While this may seem small, from the consumer point of view it should translate into a price reduction of several cents at the pump based on current prices. Pricing strategies reflecting this would assist in encouraging uptake of ethanol blend fuel.

High levels of commercial risk

A key barrier cited by stakeholders is the high level of commercial risk associated with market entry, particularly for ethanol. Low consumer confidence in ethanol means low demand, especially with no significant price advantage to the consumer. Consequently, the oil majors are reluctant to enter off-take contracts with ethanol suppliers. Without such contracts, prospective producers cannot get investment backing. The majors also have first mover concerns—the first company making a significant commitment to E10 could be seriously disadvantaged if confidence issues are not resolved.

This 'chicken and egg' market entry issue also makes it difficult to establish reliable and multi-source supplies of ethanol, another important aspect for the majors.

Pricing and establishment costs are other risks. Some biofuel producers seek fixed price supply contracts, leaving the risk with the buyer. Alternatively, a biofuel price pegged to a terminal gate price (TGP) of petrol puts petrol-related risk onto biofuel producers. On costs, Mobil has put infrastructure costs to supply ethanol blends at $5–$10 million per terminal and $15,000–$20,000 per service station.

The Taskforce considers there are real and significant commercial risks associated with market entry, facing both fuel suppliers and biofuel producers.

For the oil majors, the Taskforce considers that, at present, there is little commercial incentive for them to develop a mainstream bulk market for ethanol blend fuel and, in the absence of some form of intervention designed to improve confidence and reduce commercial risks, there will be at best, continuation of small, trial-based marketing of fuel ethanol by the oil majors.

For small independent fuel retailers, the Taskforce considers fuel ethanol could represent an attractive market segment if confidence improves.

There are a number of relatively low cost options which the government could consider in this area if it wished to intervene without affecting current market structures. For example, stakeholders have suggested small grants could offset infrastructure costs and assist independent fuel retailers enter the embryonic E10 market and that consideration of biofuel use in the Australian Government fleet would send a strong positive signal.

Impact of fuel taxation reforms, particularly on capital grant recipients

Some submissions have argued that the government's fuel taxation reforms are potentially inconsistent with its alternative fuel policies, particularly the government's decision to provide alternative fuels with a 50% fuel tax concession and capital grants to encourage industry development. The Taskforce notes that the benefit of the 50% fuel tax concession is preserved in all fuel markets for blends of biodiesel that meet the diesel fuel standard (5% biodiesel blends). However, this concession is reduced in the heavy vehicle business market and lost in the off-road market.

The Taskforce also notes that changes to fuel taxation arrangements have been announced progressively in an environment in which the Australian Government has been actively encouraging significant industry investment in biofuels capacity expansion. The complete package of fuel tax reforms was not announced until the release of the government's energy white paper. The interaction of the fuel tax changes is quite complex, and the government has only recently (in May 2005) released the Fuel Tax Credit Reform Discussion Paper outlining the proposed legislative framework to implement the reforms.

The Taskforce considers it reasonable to conclude that, due to the complexity and staged announcement of fuel tax reforms, several biofuel project proponents may not have factored in the full implications of these reforms, at least until the Fuel Tax Credit Reform Discussion Paper was released. While biofuels still receive fuel tax concessions, the net effect of fuel tax reform is to substantially implement a fuel taxation system which transitions to become competitively neutral and applied in a consistent and transparent way to all relevant fuels and fuel users, noting that private and business biofuel use (in vehicles under 4.5 tonnes) will continue to receive a fuel tax advantage.

To encourage new entrants to the biofuels industry, the government announced the $37.6 million Biofuels Capital Grants Program in 2003. Grants were subsequently announced in 2004. The Taskforce notes that the programme decisions to fund biofuel plants were made, at least in part, before the announcement of the full package of the government's fuel taxation reforms and before the release of detailed information outlining the proposed implementation path for these reforms. While reforms were announced in the Energy White Paper in June 2004, detailed implementation plans were not available until May 2005 in the Fuel Tax Credit Reform Discussion Paper. The Taskforce notes that the longer term commercial viability of some grant-funded projects may be questionable in light of the full suite of fuel taxation changes and ABARE's analysis of the prevailing market conditions.

Lack of access to infrastructure

Access to the existing fuel distribution network was also identified as an impediment to the uptake of Biofuels. The Independent Petroleum Group noted difficulties associated with the oil majors accepting trucks pre-loaded with ethanol for blending and many submissions also cited the 'no ethanol' signs as evidence of discrimination against biofuels.

The Taskforce received advice from the Australian Institute of Petroleum that its member companies will not allow in-compartment blending of motor spirit and ethanol at their loading facilities to create E10. This is on the basis of unacceptable risks to people, the facility, and the environment. The AIP also notes, however, that some member companies are prepared to load to 90% tankers that can then be taken to other facilities to have ethanol added.

In relation to concerns raised by some independents about access to petroleum at 'reasonable' prices for ethanol blending, the Taskforce notes that branded retail sites are more likely to be on term contracts for fuel supply and therefore not purchasing at the prevailing TGP. The Taskforce considers that it is not anti-competitive for an oil company to sell fuel at a more competitive price to an aligned site operator on a term contract than to a 'spot' buyer.

Some of the oil majors have also identified access to infrastructure at retail petroleum sites as a barrier to the uptake of biofuels. The major oil companies have noted that, in many service stations, there is typically sufficient infrastructure to deliver two or possibly three grades of petroleum. Some independents see the phase-out of lead replacement petrol, and the resulting freeing up of capacity, as an opportunity to market ethanol.

The Taskforce concludes that access to infrastructure and to petroleum for blending are not artificial barriers to the uptake of biofuels.

Reid vapour pressure

Regulated fuel volatility, measured as Reid vapour pressure (RVP), has the potential to be a barrier to uptake of ethanol blends. This is because E10 raises volatility in summer unless the producer uses more-expensive low volatility blendstock. To date, NSW and Queensland, the only states where ethanol blends are sold in any quantity, have increased the RVP levels to allow E10, after conducting scientific modelling.

The Australian Government is currently in dialogue with the states on how to regulate fuel parameters, including RVP, that are not part of the national fuel standards. The government could, as part of this dialogue, discuss approaches to RVP that are transparent, nationally consistent and take full account of the latest information on the impacts of ethanol blends on air quality. This will create optimal circumstances for suppliers to make commercial decisions about supplying ethanol blends. Given the lack of data and the fact that most states have yet to consider an RVP limit for E10, and to ensure that decision-making is based on the best available science, it may be necessary to commission further data gathering.

Future technology

A new generation of technology offers the prospect of producing biofuels competitively and from more readily available lignocellulosic feedstocks such as wheat straw, grasses and wood waste. Given these prospects, and the International Energy Agency's (IEA) forecasts for a significant and continuing increase in global demand for biofuels, there would be value in a closer examination of this technology as a platform for a potential new industry for Australia.

In addition, the Taskforce suggests that, given the potential for lignocellulosic ethanol to impact materially on the economics of the biofuels industry in the coming decade, further policy interventions based on current industry technologies and feedstocks should be limited, without a close assessment of the potential impact of ethanol made from lignocellulose.

Summary of conclusions

Chapter 3 – Biofuels in Australia

Conclusion 1: *The Taskforce notes the potential for lignocellulosic ethanol technology to impact materially on the economics of the ethanol industry in the coming decade. Policy interventions based on current industry technologies and feedstocks should be limited without further assessment of the impact of lignocellulosic technology.*

Conclusion 2: *There are currently no mechanisms in place for comprehensively measuring and reporting trends in production, sales, stocks, imports and exports of biofuels. Such a mechanism would assist in measuring the success or otherwise of policies to promote biofuels in the Australian transport market.*

Conclusion 3: *While biofuels still receive fuel tax concessions, the net effect of fuel tax reform is to substantially implement a fuel taxation system which transitions to become competitively neutral and applied in a consistent and transparent way to all relevant fuels and fuel users, noting that private and business biofuel use (in vehicles under 4.5 tonnes) will continue to receive a fuel tax advantage. Due to the complexity and staged announcement of fuel tax reforms, several biofuel project proponents may not have factored in the full implications of fuel taxation reforms and the commercial impact of these reforms on their projects' viability.*

Conclusion 4: *The Taskforce notes that the longer term commercial viability of some Biofuel Capital Grants Programme-funded biodiesel projects may be questionable in the light of the full suite of fuel taxation changes and prevailing market conditions.*

Conclusion 5: *The Taskforce considers that clarification of the government's policy position in relation to the target of 350 ML of biofuels in the fuel supply by 2010 is desirable.*

Conclusion 6: *The Taskforce considers that there are real and substantial barriers to achieving the 350 ML target by 2010, and that it is unlikely to be met under current circumstances.*

Chapter 4 – Biofuels internationally

Conclusion 7: *The Taskforce notes that many countries have adopted policies to assist the production and use of biofuels. While national circumstances vary widely, in every case biofuel production has required significant government assistance. The reasons given by governments for adopting these policies are essentially the same as the possible benefits for Australia: air quality and greenhouse benefits; economic benefit through import replacement; energy security, and regional, particularly agricultural, support.*

Conclusion 8: *In the assessment of the Taskforce it is regional, particularly agricultural, support that emerges as the primary driver of biofuel assistance in all cases except in countries with a very limited capacity to increase agricultural production.*

Conclusion 9: *For some European countries, the Taskforce gained the impression that their biofuel policies are driven by EU decisions that they do not see as being in their immediate national interest. This tends to explain differentiated uptake of biofuels within the EU.*

Chapter 5 – Environmental and health costs and benefits

Conclusion 10: *The Taskforce considers that a properly designed Australian in-service vehicle emission (tailpipe and evaporative) study, combined with an air quality monitoring programme and health risk assessment, would be required to assess the air quality impacts of biofuels more effectively.*

Conclusion 11: *Results from recent UK and US studies indicate that the assumption of negligible impact of E10 on PM tailpipe emissions in the 2003 350 ML Target Report needs to be re-visited. An indicative value of 40% has been adopted for life-cycle and health calculations in this Report. However, the Taskforce does not assert that 40% is a scientifically accepted value.*

Conclusion 12: *The Taskforce considers that comprehensive experimental work should be carried out to evaluate the impact of E10 and E5 on PM emissions from petrol vehicles under Australian conditions.*

Conclusion 13: *Secondary particles formed in the atmosphere make up about 30% of all particles in Australian cities and more smog-chamber research is needed to understand properly the effect of adding ethanol to petrol on secondary organic aerosol formation.*

Conclusion 14: *The findings on life-cycle analyses for CO, HC and NO_x have changed little since the 2003 350 ML Target Report. Emissions of CO are reduced under E10 compared with neat petrol; there is little change in VOC emissions, and NO_x emissions are increased.*

Conclusion 15: *On life-cycle analysis, savings in greenhouse gas emissions from E10 over neat petrol are generally from 1–4%, depending on feedstock. However, the Taskforce concludes that a recent life-cycle analysis for a proposed ethanol plant has suggested that savings of between 7 and 11.5% can be achieved with optimum use of non-ethanol co-products.*

Conclusion 16: *The impact on air toxic levels in the atmosphere from the use of E10, relative to petrol, is difficult to assess. Combustion of E10 results in lower tailpipe emissions of some toxic compounds (e.g. benzene and 1,3-butadiene), but higher levels of others (e.g. the aldehydes).*

Conclusion 17: *Assuming robust modelling, the Taskforce considers it is reasonable to conclude that ozone formation arising from waived RVP limits associated with E10 blends is not currently a concern in the Sydney airshed.*

Conclusion 18: *The benefits of the 5% biodiesel blend (B5) diminish against increasingly lower sulphur diesel, with PM emissions even increasing slightly over XLSD (to be introduced in 2009). However, on life-cycle analysis pure biodiesel (B100) has significant benefits over XLSD for CO, VOC and PM (especially with waste cooking oil as the feedstock), but NO_x emissions increase by between 16% and 30%.*

Conclusion 19: *On life-cycle analyses, B100 from waste cooking oil produces 90% less greenhouse gas emissions than XLSD. Biodiesel from tallow or canola reduces emissions by 23% and 29%, respectively. There are negligible benefits for canola or tallow derived B5 against XLSD, though waste cooking oil achieves a 3% reduction.*

Conclusion 20: *The Taskforce notes the emission benefits of diesohol and biodiesel and their potential for specialised fleet and off-road applications. Given the significant volume of diesel used in these applications, there would be value in a closer examination of opportunities to encourage uptake of biodiesel and diesohol.*

Conclusion 21: *There are insufficient data at the present time to assess the air toxic emissions from biodiesel.*

Conclusion 22: *The only significant negative impact of biodiesel blends on air quality is the increased tailpipe emissions of NO_x, which could contribute to an increase in ozone production.*

Conclusion 23: *Additional care should be taken with the handling and storage of ethanol blended fuel, as studies have shown that E10 increases the risk of groundwater contamination.*

Conclusion 24: *Under the scenario of 148 ML ethanol and 202 ML biodiesel by 2010, it is estimated that 442,000 tonnes of CO_2-e will be saved p.a.. At a greenhouse gas abatement value of $15 per tonne, this gives a value of $6.6 million or 1.9c/L.*

Conclusion 25: *Depending on cost-effectiveness, governments could consider tightening the framework of air quality/fuel quality/vehicle particulate emission standards, with the objective of gaining public health benefits.*

Chapter 6 – Economic costs and benefits of biofuels

Conclusion 26: *Reflecting the combined effect of high world oil prices and government assistance to the industry, the rates of return potentially obtainable from fuel ethanol and biodiesel production are currently very high. However, these rates appear likely to fall significantly in the long term as world oil prices moderate, and as assistance to producers is reduced over the period 1 July 2011 to 1 July 2015 and fuel ethanol producers face full import competition at 1 July 2011.*

Conclusion 27: *The likely long-term trajectory for world oil prices is highly uncertain. However, a reasonable consensus range for the long term world trade weighted average oil price (in 2004 dollars) appears to be US$25-45/bbl. The long-term West Texas Intermediate oil price of US$32/bbl (2004 dollars) assumed in ABARE's revised analysis is conservatively placed within the consensus range of world oil price projections.*

Conclusion 28: *At a long-term exchange rate of US65c, the long-term world price of oil (West Texas Intermediate) would need to average US$42-47/bbl in 2004 dollars (depending on the feedstock used) for new ethanol producers to be viable post-2015 without assistance. With assistance, however, the required oil price is estimated to be US$25-30/bbl. Biodiesel producers would require an oil price of US$52-62/bbl without assistance for ethanol, or US$35-45/bbl with assistance provided by current policy settings.*

Conclusion 29: *The Taskforce considers that, on current policy settings, there is real potential for subsidised grain ethanol plants to have a local impact on feedgrain prices in the short to medium term. In the longer term, fuel ethanol rates of return are likely to drop as the policy settings reduce the subsidies—and as ethanol import competition is allowed in 2011. The fuel ethanol industry would then be placed on a more even footing in its ability to bid for grain against the livestock industry.*

Conclusion 30: *The conclusion that the expansion of the Australian biofuels industry will result in costs on particular industries, regions, and the national economy rests on the proposition that much of the industry expansion now being proposed is unlikely to be viable in the long term without continuing assistance. ABARE modelling indicates that the costs likely to be imposed on the national economy through assisted expansion of the industry to 350 ML would be $90 million in 2009–10 and $72 million a year (in 2004–05 terms) in the long term.*

Conclusion 31: *The Taskforce supports the energy white paper conclusion that 'there is currently no case for the government to accelerate the uptake of these fuels on energy security grounds'.*

Chapter 7 – Consumer confidence and engine operability issues

Conclusion 32: *Almost all post-1986 vehicles can operate satisfactorily on E10. As was known when setting the fuel standard in 2003, E10 is not optimal for vehicles that have carburettors or mechanical fuel injectors, mainly pre-1986 vehicles. Drivers should seek advice from manufacturers regarding suitability of fuel types if they are not certain about their particular model.*

Conclusion 33: *As part of a broader campaign to assist in restoring confidence, further testing could usefully validate the suitability of vehicles in the current fleet to operate on E10.*

Conclusion 34: *The Taskforce notes that whilst the 2003 E20 Orbital study was important in determining the ethanol limit and the suitability of certain engines for using ethanol, it is now of limited relevance to an assessment of vehicle operability at 10% ethanol blends. The E10 study of two-stroke outboard and other small engines suggests that E10 may not be suitable for two-stroke engines. The risk of phase separation in ethanol blends, and the resulting risk of these smaller engines stalling, means that use of ethanol blends requires care in a marine environment.*

Conclusion 35: *For post-1986 fuel injected cars using E10 ULP, fuel consumption increases in the order of 2–3%. Pricing strategies reflecting this would assist in encouraging uptake of ethanol blend fuel.*

Conclusion 36: *As part of an awareness campaign, the FCAI vehicle list could be revised into a simplified format and confined to clear and accurate statements about the suitability of vehicles to use ethanol blend fuels. Fuel suitability information should be presented by automotive manufacturers to consumers in a less confusing manner.*

Conclusion 37: *The Taskforce considers that there is no reason for a reduction in the maximum ethanol limit in petrol from 10% to 5%.*

Conclusion 38: *Responsibility for consumer information about the fitness of fuel for its intended purpose rests mainly with fuel retailers and suppliers. In the light of that, the current fuel ethanol information standard could be simplified primarily to require notification that the fuel contains ethanol at up to 10%.*

Conclusion 39: *Given that an even higher percentage of cars can use E5 than E10, the fuel ethanol information standard could be further modified so that labelling is required only above 5% ethanol in petrol, rather than 1% as at present. As in Europe, this would give fuel companies flexibility to use up to 5% ethanol as a fuel extender or octane enhancer, without the costs of dispensing E5 as a separate blend.*

Conclusion 40: *Greater focus on industry-based information dissemination and marketing /promotional activity may improve consumer confidence in ethanol blend fuels.*

Conclusion 41: *As B5 meets the diesel fuel standard, there is no need to label B5 blends. Labelling at higher biodiesel blends is a necessary piece of consumer information but could be relatively straightforward as with the simplified ethanol label suggested previously.*

Conclusion 42: *The government could work with the Australian biodiesel industry to suggest B5, B20, and B100 as the standard forms of biodiesel, in part through fuel standards for biodiesel blends over B5.*

Conclusion 43: *As for E10, there appears to be limited testing of the suitability of biodiesel for use in engines. The Taskforce notes, however, that there is no diesel engine manufacturing capacity in Australia and, as a result, engine manufacturers will need to be guided by overseas testing and practice.*

Chapter 8 – Other market uptake barriers

Conclusion 44: *The Taskforce considers there are real and significant commercial risks, associated with market entry, facing both fuel suppliers and biofuel producers.*

For the oil majors, the Taskforce considers that, at present, there is little commercial incentive for them to develop a mainstream bulk market for ethanol blend fuel and, in the absence of improved confidence and unless first mover risks are managed, there will be at best, continuation of small, trial-based marketing of fuel ethanol by the oil majors.

For the independent fuel retailers, the Taskforce considers fuel ethanol could represent an attractive market segment if confidence is restored.

There are several relatively low cost options which stakeholders have suggested the government could consider in this area without affecting current market structures. For example, stakeholders have suggested small grants to offset infrastructure costs and so assist independent fuel retailers enter the embryonic E10 market and/or consideration of biofuel use in the Australian Government fleet may be beneficial.

Conclusion 45: *The Taskforce concludes that lack of access to infrastructure and petroleum for blending are not artificial barriers to the uptake of biofuels.*

Conclusion 46: *The Taskforce notes the potential for further damage to fragile levels of consumer confidence if consumers fail to understand the nature of octane claims made by some fuel retailers.*

Conclusion 47: *The Australian Government is currently in dialogue with the states on how to regulate fuel parameters, including RVP, that are not part of the national fuel standards. The government could, as part of this dialogue, discuss approaches to RVP that are nationally consistent and take full account of the latest information on the impacts of ethanol blends on air quality. Given the lack of data and the fact that most states have yet to consider an RVP limit for E10, and to ensure that decision-making is based on the best available science, it may be necessary to commission further data gathering.*

Chapter 2 Background

On 30 May 2005, the Prime Minister announced the appointment of a Taskforce on Biofuels.[5]

The Taskforce was asked to examine the latest scientific evidence on the impacts of ethanol and other biofuel use on human health, environmental outcomes and automotive operations.

On this basis, and taking into account the most recent economic analyses of fuel supply in Australia, the Taskforce was asked to assess the costs and benefits of biofuel production.

The Taskforce was asked to examine:

- the findings of the December 2003 desktop study by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Bureau of Agricultural and Resource Economics (ABARE) and the Bureau of Transport and Regional Economics (BTRE) into the appropriateness of a 350 million litre (megalitre, ML) biofuels target
- the findings of the Department of the Environment and Heritage study into the impacts of 10% ethanol (E10) and 20% ethanol (E20) on engine operation
- other international and Australian scientific research on the health and environmental impacts of supplementing fossil fuels with oxygenates such as ethanol and other biofuel blends
- the economic and scientific bases upon which decisions have been made to support ethanol and other biofuel production in North America, Europe and other countries.

The Taskforce comprised:

- Dr Conall O'Connell, Deputy Secretary, Department of the Environment and Heritage
- Dr David Brockway, Chief, Division of Energy Technology, CSIRO
- Dr John Keniry, Chairman, Ridley Corporation Limited
- Mr Max Gillard, Vice President and Chief Operating Officer, Toyota Technical Centre, Asia Pacific, Australia.

The Taskforce was supported by a small whole-of-government secretariat based in the Department of the Prime Minister and Cabinet, and was asked to report to the government by the end of July 2005.

[5] The full text of the Prime Minister's announcement, which constitutes the Taskforce's terms of reference, can be found in Appendix 6.

Methodology and approach

The Taskforce examined the findings of the 2003 report undertaken by CSIRO jointly with BTRE and ABARE (*Appropriateness of a 350 million litre biofuels target*, Beer et al. 2003; referred to as the 2003 350 ML Target Report). This report considered the appropriateness of a 350 ML biofuels target in terms of net environmental, economic and regional benefits and industry viability. The report was published in December 2003.

The Taskforce consulted with those agencies responsible for the development of the 2003 350 ML Target Report to identify whether, since its release, there had been any significant changes to the assumptions or methodology underpinning the report, and whether there had been any new international or Australian scientific research on the health and environmental impacts of supplementing fossil fuels with biofuels. Where either of these events had occurred, the Taskforce pursued the new information and sought clarification of the impact of the new developments on the key findings of the 2003 350 ML Target Report.

The Taskforce examined the findings from the work commissioned by the Department of the Environment and Heritage into the impacts on automotive operation of E10 and E20 in petrol blends. This research included *A testing based assessment to determine impacts of a 20% ethanol gasoline fuel blend on the Australian passenger vehicle fleet* (Orbital 2003), which was undertaken by the Orbital Engine Company and provided to the Australian Government in March 2003.

Further work commissioned by the Department of the Environment and Heritage and undertaken by the Orbital Engine Company on *Vehicle emissions testing to determine the impacts of a 10% ethanol gasoline fuel blend on the greenhouse gases emitted from the Australian passenger vehicle fleet* (Orbital 2004a) and *testing gasoline containing 20% ethanol (E20)—Phase 2B Final Report* (Orbital 2004b) were also examined by the Taskforce.

The Taskforce conducted its own inquiries. In this context, the Taskforce sought updated positions from Australian vehicle manufacturers and importers on the suitability of a 10% ethanol in petrol blend and advice from trucking organisations and manufacturers on the suitability of biodiesel and diesohol for use in diesel engines.

The Taskforce examined the penetration of biofuels into international fuel markets and the underpinning policy approaches adopted by a range of international economies actively promoting biofuels use. In these circumstances, the Taskforce sought information on the economic and/or scientific basis on which support policies had been implemented.

The Taskforce advertised in major national and capital city newspapers on 10 and 11 June 2005, calling for public submissions addressing the terms of reference. Submissions closed on 24 June. Sixty-four submissions were received from a broad range of stakeholders. Some submissions were received late; the Taskforce considered these to the extent possible in the time available. A full list of submissions which were not identified as commercial-in-confidence is in Appendix 1.

Submissions were received from stakeholders in a number of stakeholder categories, including biofuel producers (current and potential), fuel retailers, automotive associations, automotive and heavy vehicle manufacturers, livestock industries, state governments, members of parliament, sugar industry representatives, medical associations, consultants, and research organisations. Issues raised by these groups are set out in the Table 1.

Table 1 Issues raised in submissions and consultations

Stakeholder group	Key issues raised in submission/discussions
Biofuel producers (current and potential)	• Most support a biofuels mandate scheme • Environmental benefits of biofuels, air quality/greenhouse gases • Regional benefits of biofuel production • Energy security benefits of biofuel production • More complete combustion of ethanol-blended fuels offsets ethanol's lower energy content. • Benefits of ethanol as an octane enhancer • Perceived market access barriers imposed on biofuels by oil majors • Seek consistency of Australian biofuels policy with international policy and support • Achievement of 350 ML target • Consumer confidence as a key issue to uptake • Negative impact of fuel tax reform on biodiesel • Ethanol label perceived as a negative impact on confidence • Need to gain waivers for Reid vapour pressure to market ethanol blends • Extension of excise-free period • Results of market trials • Operability issues of E10 considered a perception rather than actual problem • Potential for non-automotive use of biofuels and niche markets (marine and mining) • Higher ethanol plant construction costs in Australia • Higher costs and market access issues associated with coastal shipping • Potential advancements of lignocellulosic ethanol
Independent fuel retailers	• Potential marketing options • Octane benefits of ethanol • Need to gain waivers for Reid vapour pressure to market ethanol blends • Consumer confidence key issue • Ethanol label perceived to be a warning label • Ethanol as a fuel extender • Environmental benefits of biofuels • Market access issues • Fuel standards for biodiesel blends

Stakeholder group	Key issues raised in submission/discussions
Oil majors	• Generally opposed to a biofuels mandate in favour of market flexibility • Commercial viability of biofuels • Impact of consumer confidence on uptake • Need to gain waivers for Reid vapour pressure to market ethanol blends • How to determine biofuels pricing and risk • Potential marketing options • Role of ethanol as an octane enhancer • Level of environmental benefits/costs • Likelihood of meeting 350 ML target • Minimal role for biofuels in contributing to energy security • Additional costs associated with distributing biofuels to the market • Security of supply and availability of feedstocks and imported products • Appropriate limit for biofuels content in fuel blends
Automotive associations	• Opposition to biofuels mandate • Concern about lower energy content of biofuels and additional costs of motoring to consumers • Labelling and consumer choice essential • Advice from vehicle manufacturers key issue • Motorist attitudes towards ethanol blends
Automotive and heavy vehicle manufacturers	• Opposed to biofuels mandate • Setting an appropriate limit for biofuel content in fuel blends • Results of vehicle testing and operability issues • Alignment with European fuel standards and testing completed in Europe
Livestock industries	• Impact of subsidised biofuels or mandate on grain prices • Feedstock cost assumptions
State government	• Regional benefits • Mandated Renewable Fuels Target • Consumer confidence key issue • Extension of excise-free period
Members of parliament	• Mandated Renewable Fuels Target • Importance of 350 ML target
Sugar industry representatives	• Generally supportive of a Mandated Renewable Fuels Target • Potential for significant regional benefits • Energy content levels • Environmental benefits of biofuels • Benefits of ethanol as an octane enhancer

Stakeholder group	Key issues raised in submission/discussions
Medical associations	• Support mandated ethanol content in petrol • Ability of ethanol blend fuels to reduce particulate emissions and lower health costs
Consultants and research organisations	• Health costs of fossil fuels versus biofuels • Biofuels testing • Potential benefits of lignocellulosic ethanol • Importance of small particulates in petrol/diesel

The Taskforce held consultations with key stakeholders in Sydney, Melbourne, Canberra and Brisbane in the period from 29 June to 8 July 2005. A full list of these stakeholder meetings is in Appendix 2. Where submissions or consultations with stakeholders identified significant research reports addressing the terms of reference, these reports were also considered by the Taskforce.

Chapter 3 Biofuels in Australia

Synopsis

- The Taskforce examined biofuels in both their pure form and as blends with fossil fuels.
- There are currently no mechanisms in place for accurately measuring and reporting trends in production, sales, stocks, imports or exports of biofuels.
- There are three commercial producers of fuel ethanol in Australia. Fuel ethanol production in Australia has fallen significantly, from an estimated 75 ML in 2002–03 to 23 ML in 2004–05[6], or less than 0.1% of the automotive gasoline market in Australia.
- Industry practice is to use 10% ethanol as a fuel extender to 91 RON (research octane number) unleaded petrol, although more recently the addition of 10% ethanol to both 91 RON and 95 RON gasoline is being used by some independent market participants to produce high-octane alternative products. Ethanol's potential use (and therefore value to the oil majors) as an octane enhancer is yet to be determined for the Australian market.
- While there is some activity in marketing ethanol-blended fuels, this activity has declined considerably compared with previous years, has been primarily based in regional Queensland and New South Wales, and is small in scale.
- Biodiesel has increased as a fuel constituent in Australia. Production has increased from approximately 1 ML in 2003–04 to 4 ML in 2004–05.[7] The bulk of biodiesel production in Australia is sold in blends of 20% or less with petroleum diesel. Biodiesel growth in Australia (were it to occur) is likely to be at B5 (5% biodiesel blend) as the preferable delivery mechanism for biodiesel into the retail fuel market. There may be niche markets developing for higher biodiesel blends on occupational health and safety and environmental grounds (such as mining and marine applications).
- Biofuels cost more to produce than petroleum fuels. Production costs are coming down and there are new technologies on the horizon. However, barring unexpected scenarios, such as ongoing oil prices over $US47 a barrel at a 65c exchange rate, biofuels will generally remain uncompetitive with conventional fuels without assistance in the longer term.
- The government's policy settings for biofuels have altered considerably over the past two years. Biofuels will increasingly be subject to fuel tax, from an effective rate of zero until 2011 to 19.1c/L for biodiesel and 12.5c/L for ethanol by 2015; reflecting their energy content while retaining a net tax and outlays advantage over traditional petrol and diesel.

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[6] Based on Department of Industry, Tourism and Resources (DITR) expenditures for the ethanol production grant for 2004–05.

[7] Based on Australian Taxation Office advice for the biodiesel production grant.

- Furthermore, because the government's fuel taxation policy is for business use of fuel to become effectively tax free over time, to the extent that ethanol and biodiesel have relied on a relative tax advantage to underpin their competitiveness, this advantage will be reduced in some business markets and lost in others.

- Due to the complexity and staged announcement of the fuel tax reforms, several biofuel project proponents may not have factored in the full implications of these reforms and the commercial impact of these reforms on their project's viability.

- The status of the 350 ML target, whether aspirational or a target to be pursued by policy intervention, is confusing to the fuel supply industry, biofuels industry representatives and investors.

- The Taskforce considers there are real and substantial barriers to achieving the 350 ML target by 2010, and that it is unlikely to be met under current circumstances.

Background

There are two key biofuels with commercial prospects in Australia: ethanol and biodiesel. In this report, the Taskforce has looked at these fuels in both their pure form and as blends with fossil fuels, such as 10% ethanol in petrol (E10) and 5% biodiesel in diesel (B5 biodiesel). Diesohol (15% ethanol in diesel) was also considered for its potential in specialist applications.

Fuel ethanol

Ethanol (C_2H_5OH, an alcohol) is used for a variety of purposes, including as a beverage, in industrial applications and as a fuel. Since 18 September 2002, fuel ethanol produced in Australia has been classified to Item 11 (K) of the Schedule to the *Excise Tariff Act 1921* and subject to excise duty at the rate of 38.143c/L. An equivalent customs duty applies to imported fuel ethanol. The government's decisions about the longer term tax treatment of fuel ethanol are set out later in this chapter. For practical administrative purposes, fuel ethanol is anhydrous ethanol which has been denatured (chemically treated to make it unfit for human consumption, usually by the addition of 1–5% petrol) for use in an internal combustion engine.

Ethanol can be produced industrially or from the fermentation of biomass feedstocks. While ethanol can be produced from a variety of feedstock, renewable ethanol is predominantly produced from agricultural sources, including waste starch, C molasses, corn (maize), sorghum and feed wheat.

The next generation of technology involves ethanol produced from cellulosic feedstocks (crop waste, grasses and trees); however, this technology is still in the process of being proven commercially. This technology will potentially allow ethanol to be produced more economically with significantly larger reductions in full life-cycle CO_2 emissions than current processes, and from widely available feedstock.

Sufficient investment is being made worldwide in emerging lignocellulosic technology to suggest that it will become a commercial reality in the future, although the specific time frame for commercialisation and likely cost of production are uncertain. Without a major study of industry economics, it is unclear whether Australia will have a comparative advantage in a lignocellulosics ethanol market. Given this lack of analysis, the Taskforce has not further considered the implications of lignocellulosics for the costs and benefits of biofuels.

Conclusion 1: *The Taskforce notes the potential for lignocellulosic ethanol technology to impact materially on the economics of the ethanol industry in the coming decade. Policy interventions based on current industry technologies and feedstocks should be limited without further assessment of the impact of lignocellulosic technology.*

Ethanol can be produced in two forms: hydrous (or hydrated) and anhydrous. Hydrous ethanol typically has a purity of about 95% and has been used in Brazil since the late 1970s as a motor fuel in adapted alcohol vehicles with modified engines that can use fuel with up to 85% ethanol content. Ethanol (commonly called E85) is being used as a dedicated fuel in modified diesel engines in buses in Stockholm, Sweden. Hydrous ethanol has also been tested as a 15% emulsion in diesel (referred to as 'diesohol' or 'e-diesel').

A second-stage process is required to produce high-purity anhydrous ethanol for use in petrol blends: in effect, the 95% pure product is dehydrated using azeotropic processes or a molecular sieve to remove the water, resulting in 99% pure ethanol.

Anhydrous ethanol is typically blended with up to 10% volume in petrol for use in most unmodified engines. When ethanol is blended into fuels at levels above 10% volume, some engine modifications may be necessary, although the exact ethanol percentage at which modifications are required varies according to materials used in different fuel systems. The government has established a 10% limit for ethanol in petrol. This limit came into force on 1 July 2003.

In the United States, Brazil, Sweden and the United Kingdom, several automobile manufacturers are marketing vehicles that are capable of operating on various blends of fuel ranging from 100% petrol to 15% petrol with 85% denatured ethanol (E85). These vehicles are called flexible fuel vehicles (FFVs). The main differences between ethanol FFVs and petrol vehicles are the materials used in the engine and fuel management system and modifications to the engine calibration system. There are no FFVs currently available in the Australian market, given that E10 is the maximum ethanol blend allowed.

Ethanol's properties as a fuel

When ethanol is added to petrol it affects a number of fuel parameters, including octane, fuel volatility, vapour pressure, distillation properties and water tolerance.

Volatility (a fuel's ability to change from liquid to vapour) is characterised by three measurements: vapour pressure, flexible volatility index and distillation curve. Volatility is commonly measured by RVP (Reid vapour pressure), which is the fuel's vapour pressure at 37.8°C. Petrol that is too volatile may vaporise easily and boil in the fuel system (fuel pumps, petrol lines or carburettors) at high operating temperatures. If too much vapour is formed, this can cause a decrease in fuel flow to the engine, resulting in symptoms of vapour lock, including loss of power, rough engine operation or complete stoppage. This is a safety issue in vehicles.

Although ethanol itself has an RVP less than that of petrol, its addition to petrol markedly increases the volatility of the blend, which can lead to increased evaporative emissions with potential adverse environmental and health impacts. The peak RVP of ethanol blends occurs between 2 and 10% ethanol concentration, and is about 10% above the RVP of neat petrol. This increase in RVP can be overcome if ethanol is blended with a petrol blend stock which has reduced volatility, ensuring that the final product does not exceed volatility requirements.

RVP is currently managed by the states and territories, not by the Australian Government under the *Fuel Quality Standards Act 2000.* Both Queensland and New South Wales have introduced higher RVP limits in urban areas over summer months to accommodate E10 blends.

Ethanol is hydroscopic; that is, it easily absorbs water from its surroundings, including from fuel distribution systems. To avoid this, the water content of the fuel ethanol must be limited when the ethanol is blended with petrol to reduce the risk of phase separation, or demixing. Phase separation can cause operating problems for normal spark-ignition engines. This is why ethanol blend petrol is not recommended for aircraft or marine use.

The energy content of a litre of fuel ethanol (measured in megajoules per litre) is typically 68% of the energy content of a litre of gasoline, regardless of the feedstock used to produce the ethanol. Testing suggests that the impact of using E10 on the fuel consumption of pre-1986 vehicles (with open-loop fuel systems) may be negligible, but that there will be an increase in fuel consumption of typically 2.8% for post-1986 vehicles because of their closed-loop fuel control.

Further discussion on ethanol's fuel properties can be found in the report prepared by the International Fuel Quality Center for the Department of the Environment and Heritage in the context of the development of a fuel standard for fuel ethanol.[8]

Ethanol's role as an octane enhancer

The requirement that new, petrol-fuelled vehicles sold in Australia meet Euro 3 vehicle emission standards from 2005, and expectations about the future introduction of Euro IV and Euro V compliant emissions technology, suggest that there will be increasing demand for higher octane in Australian fuels. The octane rating of petrol can be increased by:

- utilising higher octane crude oil
- additional refinery processing to convert low-octane components into higher octane components, using a combination of isomerisation, alkylation and reforming

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[8] IFQC (2004); http://www.deh.gov.au/atmosphere/ethanol/publications/standard.html

or

- through the use of chemical additives, of which ethanol is one option.

Ethanol's potential use (and therefore value) as an octane enhancer to the major oil refiners is yet to be determined for the Australian market. Key issues likely to be considered by the oil majors in considering ethanol as an octane solution will include the economics and availability of ethanol. A third issue to be considered includes regulatory constraints imposed on the use of ethanol in fuel through state-based RVP limits.

Some independent retail petroleum suppliers, however, are already marketing ethanol-blended fuels based on the octane advantages that can be derived, suggesting that ethanol's role in increasing octane does have market value—at least to this segment of the petroleum industry.

Biodiesel

Biodiesel is typically produced from a reaction of vegetable oil or animal fat with an alcohol, such as ethanol or methanol, in the presence of a catalyst to yield mono-alkyl esters and glycerine, which is removed. Depending on the feedstocks and processes employed, by-products may include glycerine, fatty acids, fertiliser and oilseed meal (for grain-fed stock). Current potential feedstocks for biodiesel include vegetable oils, animal fats and used cooking oils and fats.

Since 18 September 2003, biodiesel produced in Australia has been classified to Item 11 (L) in the Schedule to the *Excise Tariff Act 1921* and subject to excise duty at a rate of 38.143c/L. An equivalent customs duty applies to imported biodiesel. The government's decisions about the longer term tax treatment of biodiesel are set out later in this chapter.

Biodiesel is used in conventional diesel engines and, subject to the engine manufacturer's advice, can be used as a direct replacement or blend stock component for petroleum-based diesel fuel.

Biodiesel's properties as a fuel

The fuel properties of biodiesel depend on the fatty acid chains of the feedstock used for esterification. Biodiesel produced from tallow, a highly saturated fat, will tend to have a higher freezing point that can inhibit cold flow properties, although it will also have a higher cetane number. The cetane number measures the readiness of a fuel to auto-ignite when injected into the engine and is also an indication of the smoothness of combustion—a desirable characteristic in diesel fuel.

Available data indicates that any addition of biodiesel to diesel would improve the lubricity of the biodiesel blend. Blending diesel with biodiesel also increases its biodegradability, which is an attractive property for marine fuel use. Biodiesel also has a much higher flashpoint than petroleum diesel, which makes it safer to handle and attractive for use in mining applications.

The energy content of biodiesel varies depending on the feedstock and esterification process. Compared with diesel, the energy content of biodiesel varies between 88% and 99% of diesel (the 2003 350 ML Target Report assumed that the relative energy density of biodiesel was 90%).

Further discussion on biodiesel's fuel properties can be found in the discussion paper prepared by the Department of the Environment and Heritage in the context of the development of a fuel standard for biodiesel.[9]

Diesohol

Most blends of diesohol are typically made with 10–15% alcohol, 85–90% automotive diesel and a blending agent. Diesel and alcohol do not mix easily, so formulating diesohol requires the use of additives to create stable blends.

There are two general approaches to making diesohol:

- where the alcohol is hydrous, blends are formulated using an emulsifier that retains the hydrated alcohol as a dispersed phase in the diesel
- where the alcohol is anhydrous, blends are formulated using a solvent or co-solvent that maintains the alcohol more as a solution in the diesel.

Diesohol has been subject to a number of Australian and international trials. Current use of diesohol in Australia occurs on only a small scale, and it is difficult to determine the potential size of the diesohol market. However, due to the stricter storage and handling required because of its reduced flashpoint, it is generally acknowledged that diesohol is likely to remain a niche fuel targeted for use in centrally refuelled fleets. Widespread use of diesohol in general transport would require major investment in fuel handling and storage.

Diesohol, while used in compression ignition engines as an alternative to diesel, behaves quite differently from diesel. The alcohol component in the fuel:

- changes the combustion characteristics of the fuel
- alters tailpipe emissions and engine operability
- changes fuel storage and handling requirements.

The addition of alcohol to diesel also results in a minor reduction in fuel economy and maximum power, and can have some impact on engine fuel systems.

The introduction of diesohol at the retail level is firmly opposed by a number of key stakeholders, including the Federal Chamber of Automotive Industries and the Trucking Industry Council, on the basis of safety and handling considerations.

While the Taskforce notes opposition to diesohol for transport applications, the potential use of diesohol in stationary fuel applications, particularly in the mining sector, is significant on the basis that the quantities of diesel used in some mining applications are very large. One stakeholder has suggested up to 1.5 billion litres a year in Queensland's Bowen Basin alone. Should there be a market for 15% diesohol in this sector it would stimulate significant production.

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[9] *Setting National Fuel Quality Standards—National Standard for Biodiesel*. Discussion paper prepared by Environment Australia, March 2003 (http://www.deh.gov.au/atmosphere/biodiesel/development.html).

Further discussion on the properties of diesohol is contained in the discussion paper prepared by the Department of the Environment and Heritage in the context of setting national fuel quality standards.[10]

Fuel quality standards for ethanol in petrol, and information standard for labelling

The 10% ethanol limit was announced by the government on 11 April 2003 and came into force on 1 July 2003 as an amendment to the fuel quality standard for petrol. This followed testing by Orbital Engine Company of 20% ethanol in petrol (E20) blends on passenger vehicles and marine outboards. The testing concluded that E20 could cause problems including hesitation and difficulties in starting in very cold conditions and deterioration of metal, plastic and rubber components, particularly in pre-1986 vehicles. Over mileage, the testing subsequently found increased tailpipe emission and great levels of engine wear on vehicles operating with E20 compared with those operating on petrol.

Automotive manufacturers subsequently released detailed advice (at http://www.fcai.com.au/ethanol/) as to which vehicles could operate satisfactorily on E10 blends.

To ensure consumers were advised if a fuel contained ethanol, an ethanol fuel quality information standard took effect on 1 March 2004. The *Fuel Quality Information Standard (Ethanol) Determination 2003* specifies the labeling requirements for the sale of ethanol–petrol blends sold in Australia. Although, the 10% limit on ethanol blends, combined with mandatory Australian Government labeling of ethanol blends, was implemented to restore confidence in the use of ethanol blends among consumers and industry, the ethanol information label has been criticised by some parties as having the features of a warning label and therefore acting as a deterrent to the uptake of fuel ethanol. Further discussion on the ethanol label is contained in Chapter 7.

The government is in the process of setting a fuel quality standard that will apply to fuel grade ethanol for use as blend stock for blending with petrol up to the 10% level. Ethanol that will be used as blend stock or as an extender with petrol must meet this standard. When blending fuel-grade ethanol with petrol, the petrol portion will be required to meet the *Fuel Standard (Petrol) Determination 2001* and the ethanol portion will be required to meet the proposed *Fuel Standard (Ethanol) Determination 2005*.

A technical paper on the quality and characteristics of fuel ethanol around the world, prepared by the International Fuel Quality Center, was released in December 2004 to assist in public discussion on setting an Australian quality standard for fuel ethanol. The technical paper is available at http://www.deh.gov.au/atmosphere/ethanol/publications/standard.html.

The Department of the Environment and Heritage has sought submissions from a wide range of stakeholders to assist the government determine the best approach to setting a quality standard for fuel ethanol.

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[10] *Setting National Fuel Quality Standards*. Discussion paper on diesohol prepared by Environment Australia, May 2004 (http://www.deh.gov.au/atmosphere/cleaner-fuels/publications/diesohol.html).

Other fuel quality standards for biofuels

The Department of the Environment and Heritage has developed a fuel standard for biodiesel. The *Fuel Standard (Biodiesel) Determination 2003* was made on 18 September 2003 and is available at http://www.deh.gov.au/atmosphere/biodiesel/index.html.

A fuel standard is being considered for diesohol. A discussion paper on diesohol was released by the Department of the Environment and Heritage on 27 May 2004 for public comment. The discussion paper is available at http://www.deh.gov.au/atmosphere/cleaner-fuels/publications/diesohol.html.

A fuel quality standard for biodiesel blends is being considered.

Australian petrol market

In 2003–04, the demand for petroleum-based transport fuels was about 42,500 ML *p.a.* (730,000 barrels per day). Total demand is growing at 1–2% a year, and by 2010 demand is expected to increase to around 50,000 ML a year. Within this total, the key product components in 2003–04[11] were:

Table 2 Product components of demand for petroleum-based transport fuels

Automotive gasoline:	47%, or 19,962 ML
Automotive diesel:	34% or 14,462 ML
Jet fuel:	10% or 4,329 ML
Liquefied petroleum gas (LPG) —automotive use:	6% or 2,547 ML
Others, including lubricants:	3% or 1,200 ML.

In recent years, diesel demand has been growing at around 3% a year (probably reflecting growth in commercial activity). Demand for automotive gasoline and other products has been growing much more slowly, at around 1.2% a year.

The Australian passenger transport fuel market is dominated by petrol. This is similar to the situation in the United States but unlike that of Europe, where diesel now accounts for 43% of fuel sales and where 71% of new cars sold are diesel powered.

Fuel efficiency targets and vehicle emission standards for passenger and commercial vehicles will play a significant role in shaping future fuel demand. The vehicle industry is currently negotiating the fuel efficiency target framework for passenger vehicles. As part of the drive to increase fuel efficiency, there is a growing demand for higher grades of petrol—that is, 95 and 98 RON petrol. Premium unleaded fuels accounted for 13% of petrol demand in 2003–04, but as the new car fleet increasingly requires 95 RON petrol, this proportion is expected to rise to over 50% early next decade.

[11] Australian Petroleum Statistics, the Department of Industry Tourism and Resources.

The Australian refining industry operates in a market characterised by intense competition, both domestically and in traditional markets in the South Pacific. This competition has arisen from the supply of cheap petrol from bigger, newer refineries in Asia and from 'shopper docket' discounts promoted by strategic alliances between oil majors and Australia's two main supermarket chains. The performance of the refining industry is highly dependent on the market for refined fuel in Asia, with price dictated by the Singapore Mogas price.

Australia's refineries were mainly constructed in the 1950s and 1960s, but have been extensively modified since then to meet domestic fuel standards. However, with a total capacity of 796,500 barrels per day (excluding Port Stanvac in South Australia), these refineries are relatively small in comparison with those in Asia.

To meet the new fuel standards, Australian refineries are making major investments. It is estimated that about $2 billion will be invested over the decade to 2010. However, these investments will not result in any increase in Australian refining capacity. Currently, Australia imports about 13% of its petrol, 17% of diesel and about 3% of jet fuel.

Future fuel supply

ABARE's long-term energy consumption and production projections indicate that Australia's dependence on imported oil and petroleum products will increase considerably over the period to 2019–20.

The combined output of crude oil and naturally occurring LPG is forecast to decline from 1459 petajoules now to 1362 petajoules by 2019–20. Over the same period, the consumption of all liquid fuels is projected to increase by 43% to 2515 petajoules. Therefore primary production of liquid fuels relative to total liquid fuels consumption is expected to fall from 83% currently to 54% by 2019-20, leading to increased dependence on imported liquid fuels — from 17% currently to 46% in 2019–20.

Over the period 2010–11 to 2019–20, refining capacity as well as refinery output in Australia is assumed to increase by around 1% a year. However, at the same time consumption of petroleum products in Australia is projected to increase by around 2% a year. As a result the share of petroleum products sourced from local refineries (as opposed to being imported) is projected to fall from the current level of 93% to less than 80% by 2019–20. [12]

Fuel ethanol capacity, production and use

Current capacity

Currently, the three commercial producers of fuel ethanol in Australia are the Manildra Group, CSR Distilleries, and the Rocky Point Sugar Mill and Distillery.

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[12] ABARE, Australian Energy national and state projections to 2019–20 August 2004

Current fuel ethanol production capacity (but not production levels) is an estimated 75 ML. Manildra, Australia's largest fuel ethanol producer, has some 90% of industry capacity.

Potential capacity

Other ethanol projects that have been proposed could, in theory, increase fuel ethanol production capacity by 930 ML, bringing total fuel ethanol capacity to 1005 ML by 2010. Three projects have been offered funding under the Biofuels Capital Grants Program. Should they proceed, these projects will provide 77.5 ML of new capacity. Two projects involve capacity expansions by existing market participants (CSR and Rocky Point); and the other could introduce a new producer, Lemon Tree Ethanol.

Fuel ethanol production

Fuel ethanol production in Australia has fallen significantly from an estimated 75 ML in 2002–03 to 23 ML for 2004–05[13], or less than 0.1% of the automotive gasoline market in Australia. Of this, the bulk of production is produced from waste starch (and possibly from degraded wheat feedstock) by Manildra Group at its Nowra facility (around 89%) with the remainder produced from C molasses by CSR at its Sarina, Queensland and Yarraville, Victoria facilities, and by Rocky Point at Woongoolba, Queensland.

Ethanol-blended fuel is available at only around 1% of the approximately 6,500 service stations across Australia. Information provided by the Australian Institute of Petroleum indicates that E10 is being marketed at some 70 service stations, where it accounts for between 10% and 25% of ULP sales. The figures are somewhat higher in cases where ethanol producers, fuel distributors and retailers are actively marketing and promoting the product.

Ethanol fuel market

Current practice is to add 10% ethanol as a fuel extender to 91 RON ULP, although more recently both 91 RON and 95 RON gasoline with 10% ethanol are being used by some market participants as high-octane alternative products. Ventura Bus Lines has three buses operating in Melbourne on 100% ethanol in modified diesel engines, but this is the only known use of high-concentration fuel ethanol in vehicles in Australia. The market for fuel ethanol is expected to continue to be based on low-ethanol blends.

Ethanol is being marketed by BP, Caltex, Manildra Park Petroleum, Neumanns, Queensland Fuel Group, United Petroleum, Evolve and a number of other independent service stations, primarily in the Queensland and New South Wales markets.

In May 2002, BP commenced trial marketing of E10 from six Brisbane service stations. The trial was a technical success, but was suspended by BP after the

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[13] Based on the Department of Industry Tourism and Resources expenditures for the ethanol production grant for 2004–05.

nationwide loss of consumer confidence in ethanol-blended petrol. In December 2003, the company announced the recommencement of ethanol trials in selected regional Queensland markets. The trials began at service stations and several depots in the Bundaberg, Nambour and Mackay regions. BP has recently begun selling E10 at several retail outlets in the Brisbane–Gold Coast and Toowoomba regions.

BP announced on 10 May 2005 that the Queensland Government is providing a grant to assist with the cost of establishing an ethanol blending facility at Mackay and a supporting marketing campaign. The grant should significantly improve the logistics of marketing ethanol-blended petrol to the Queensland market.

Caltex announced on 9 May 2005 that its E10 trial had been successful, and that E10 would now be considered a mainstream fuel. The company is currently marketing E10 under various Caltex brands and distributors—Caltex, Ampol and Bogas.

At the ethanol industry roundtable hosted by Minister Macfarlane on 2 June 2005, Shell announced that it was taking active steps to introduce an ethanol blend into its Australian petrol offer**.** Shell's announcement means that three out of the four major fuel suppliers have made a commitment to marketing of biofuels into the Australian market.

Manildra Group began production of fuel ethanol in 1992. Manildra Park Petroleum buys petrol, blends it with ethanol and sells the blended petrol to service stations in and around Sydney. Manildra Park is marketing ethanol in 95 RON fuel and adding 10% ethanol to create a 98 RON octane fuel (Enhance 98).

United Petroleum launched two new products containing 10% ethanol on 29 June 2005. BOOST 98 has a 98 RON and PLUS ULP has a 94 RON.

Overall, whilst there is some activity in marketing ethanol blended fuels, this has declined compared with previous years. It has been primarily based in New South Wales and regional Queensland, and is small in scale. The level of current sales of fuel ethanol (23 ML for 2004–05, compared with an estimated 75 ML in 2002–03) reflects the significant fall in ethanol being sold as a fuel in Australia.

Some stakeholders considered efforts by the major oil companies to market ethanol blends to be 'token efforts' and suggested that the major oil companies are impeding the development of a fuel ethanol market. The oil majors have noted that they are prepared to market ethanol as long as it is commercial to do so and consumers are willing to buy the product. In this context, consumer confidence has been cited as a key barrier to uptake (see Chapter 7).

Biodiesel capacity, production and use

Current capacity and production

Biodiesel has only recently been made commercially available in Australia. There are 10 licensed producers of biodiesel, who collectively produced approximately 1 ML in 2003–04 and 4 ML in 2004–05.[14] Current biodiesel capacity is estimated to be around 15.5 ML *p.a.*.

[14] Australian Taxation Office biodiesel production grant information.

Potential capacity

Other biodiesel projects that have been proposed could, in theory, add 508 ML of biodiesel capacity over the short to medium term. Four projects are being supported by the Biofuels Capital Grants Program, with the potential to produce 157 ML of biodiesel.

Biodiesel fuel market

The bulk of biodiesel production in Australia is sold in blends of 20% or less with petroleum diesel. B5 is a blend of 5% biodiesel with 95% petroleum diesel, and B20 is a blend of 20% biodiesel with 80% petroleum diesel. Biodiesel can also be used neat as B100.

A number of local governments have trialled biodiesel at B100 and B20 in garbage trucks and other diesel vehicles. A key market for biodiesel may be through the sale of biodiesel blends in bulk to centrally fuelled fleets and straight biodiesel for use in sensitive marine and other areas. Internationally, most biodiesel is sold as blends.

Biofuels production and capacity

As shown in Table 3, total biofuels production capacity (as opposed to production levels) in 2004–05 is estimated at 90.7 ML. Current plans to expand production capacity could, in theory, bring total biofuels production capacity to 1,529 ML by 2010. Production of biofuels in 2004–05 is estimated at 26.7 ML, down from 76 ML in 2002–03 (Table 4).

Table 3 Current and proposed ethanol production capacity, 2004–05 to 2009–10 (ML)

Ethanol capacity	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
Manildra	70	70	100	100	100	100
CSR	4	4	32	32	32	32
Rocky Point	1.2	1.2	16.2	16.2	16.2	16.2
Lemon Tree	0	0	67	67	67	67
Primary Energy	0	0	120	120	120	120
Australian Ethanol (Swan Hill)	0	0	90	90	90	90
Australian Ethanol (Colleambally)	0	0	0	0	0	100
Australian Ethanol (Lake Grace)	0	0	0	0	0	100
Dalby Biorefinery	0	0	80	80	80	80
Austcane, Ayr	0	0	100	100	100	100
SymGrain, Quirindi	0	0	0	0	0	100
Symgrain, Western Victoria	0	0	0	0	0	100
Total ethanol	**75.2**	**75.2**	**605.2**	**605.2**	**605.2**	**1005.2**

Table 4 Current and proposed biodiesel production capacity, 2004–05 to 2009–10 (ML)

Biodiesel capacity	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
Biodiesel Industries Australia, Rutherford	0.5	20	20	20	20	20
Australian Biodiesel Group, Berkeley Vale NSW	15	40	45	45	45	45
Biodiesel Producers Australia	0	0	60.2	60.2	60.2	60.2
Australian Renewable Fuels, Adelaide SA	0	44.7	44.7	44.7	44.7	44.7
Riverina Biofuels	0	0	44.7	44.7	44.7	44.7
Australian Renewable Fuels, Picton WA	0	0	44.5	44.5	44.5	44.5
AJ Bush	0	0	60	60	60	60
Australian Biodiesel Group Queensland	0	0	40	40	40	40
Natural Fuels	0	0	150	150	150	150
South Australian Farmers Fuel	0	0	15	15	15	15
Total biodiesel	**15.5**	**104.7**	**524.1**	**524.1**	**524.1**	**524.1**
Total biofuels	**90.7**	**179.9**	**1129.3**	**1129.3**	**1129.3**	**1529.3**

Source: Information provided by biofuel industry participants and Renewable Fuels Australia.

Table 5 Biofuels production, 2002–03 to 2004–05 (ML)[15]

	2002–03e[16]	2003–04	2004–05e
Ethanol	75.0	28.5	22.7
Biodiesel	1.0	1.0	4.0
Total biofuels	**76.0**	**29.5**	**26.7**

Figure 1 Biofuels production capacity, current and potential

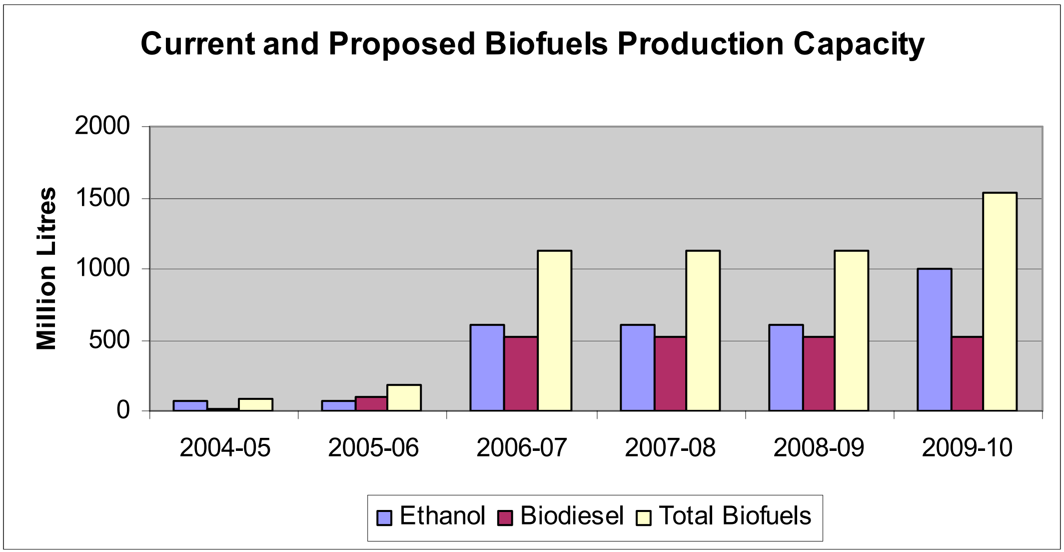
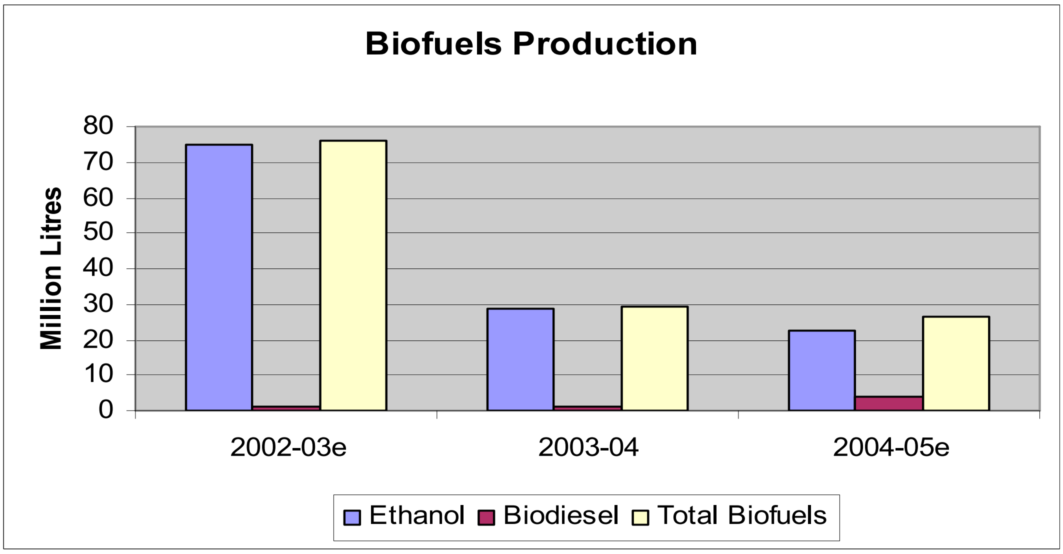


Figure 2 Estimated biofuels production



[15] Ethanol production data sourced from Department of Industry, Tourism and Resources. Biodiesel production sourced from Australian Taxation Office.
[16] Annualised fuel ethanol production grant payments for 2002–03 as the ethanol production grant commenced in September 2002.

Biofuel industry statistics

There are no readily available statistics to determine the level of biofuels production and use in the Australian fuel mix, as there are for other transport fuels. This reflects the fact that these fuels are new to the market.

Production levels for fuel ethanol and biodiesel have been indirectly determined from production grants paid by the government. In the case of biodiesel, the information is collected by the Australian Taxation Office and, given the relative concentrations in the market, there is some sensitivity about its dissemination. Furthermore, even if available, production levels do not necessarily reflect the consumption of biofuels and do not reveal the penetration of particular biofuel blends in the fuel market.

The monthly publication *Australian Petroleum Statistics*, produced by the Department of Industry, Tourism and Resources (DITR), reports levels of production, sales, stocks, imports and exports for a wide range of petroleum products, including automotive gasoline, diesel, LPG, aviation gasoline and avgas. This mechanism could be expanded to incorporate a statistical collection for biofuels.

Conclusion 2: *There are currently no mechanisms in place for comprehensively measuring and reporting trends in production, sales, stocks, imports and exports of biofuels. Such a mechanism would assist in measuring the success or otherwise of policies to promote biofuels in the Australian transport market.*

Biofuel production costs

Globally, and in the absence of subsidies, biofuels cost more to produce than petroleum fuels. Production costs are coming down, and there are new technologies on the horizon. ABARE analysis suggests that, with current technology and feedstocks and without unexpected scenarios such as ongoing oil prices over $US47 per barrel at a 65c exchange rate, Australian biofuels will generally remain uncompetitive with conventional fuels without assistance in the longer term. Depending on market conditions, exceptions could be biofuels that are produced by existing plants with sunk costs, or biofuels made from wastes. These issues are discussed further in Chapter 6.

Biofuels research and development

Research and development to pilot and demonstration plant stages in North America and Europe is offering new processes that may make it cheaper to make biofuels. Lignocellulosic ethanol and Fischer Tropsch (an emerging biodiesel technology) offer opportunities. The IEA notes that the cost of production of cellulose ethanol could fall below the cost of that of grain ethanol in the 2010–2020 time frame, and may already be cheaper (if large-scale conversion plants are built) on a cost per tonne greenhouse gas reduction basis.[17]

Canada is a world leader in new technology to make ethanol from lignocellulosics. One company, Iogen, with a background in enzyme technology, signed an agreement

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[17] International Energy Agency/OECD, *Biofuels for Transport: An international perspective* (2004), p 68.

with Petro-Canada, one of Canada's largest oil companies, to build a demonstration ethanol process. The C$30 million plant was funded by Petro-Canada, Technology Partnerships Canada and Iogen. In 2002, Royal Dutch Shell also invested C$46 million in the strategic partnership. The plant can handle all functions involved in the production of cellulose ethanol, including receipt and pre-treatment of up to 40 tonnes per day of feedstock, conversion of cellulose fibre into glucose, fermentation, and distillation to produce 3–4 ML of fuel annually. The company has plans for a full-scale, commercial plant, costing more than C$250 million.

Government policy settings

The Australian Government's policy settings for biofuels have changed considerably over the past two years. The key changes have been:

- the announced reforms to fuel taxation
- the introduction of capital grants to encourage new biofuels capacity through the $37.6 million Biofuels Capital Grants Program
- the introduction of a 10% ethanol limit in petrol
- the introduction of an information standard for ethanol, requiring labelling
- the pursuit of fuel standards for biofuels.

Fuel taxation reform

The government is in the process of implementing a major programme of reform to modernise and simplify the fuel tax system, commencing on 1 July 2006 and concluding on 1 July 2015. These reforms are outlined in *Securing Australia's Energy Future*, the energy white paper released in June 2004.[18] A discussion paper outlining the proposed legislative model to implement the fuel tax credit elements of the reforms was released by the Hon. Mal Brough MP, Minister for Revenue and Assistant Treasurer, on 27 May 2005.[19]

The government's objective in implementing reform is effectively for fuel tax to be collected only from fuel consumed:

- in the private use of motor vehicles
- for any other private purpose (except for the generation of electricity and use in burner applications)
- in the business use of vehicles with a gross vehicle mass of less than 4.5 tonnes
- in the business use of vehicles with a gross vehicle mass of 4.5 tonnes or more but only to the extent of the applicable road user charge.

[18] *Securing Australia's Energy Future* available at http://www.pmc.gov.au/publications/energy_future/index.htm.
[19] Fuel tax credit reform discussion paper available at http://www.treasury.gov.au/contentitem.asp?NavId=037&ContentID=986.

Fuel tax changes

On 16 December 2003, the government announced new arrangements for applying fuel tax to all fuels used in internal combustion engines. These new arrangements involve the application of fuel tax on an energy-content basis to all fuels used in transport applications. Fuel tax rates for fuels will be based on energy content, with four broad fuel tax band: a high energy content band of 38.143c/L; a mid energy content band of 25c/L; a low energy content band of 17c/L; and a fourth fuel tax category dealing with certain other fuels at a rate of 38 cents per cubic metre.

At this time, the government also announced that alternative fuels would receive a 50% discount on energy-content fuel tax rates on the basis of a range of industry, regional and other factors. In March 2004, the government further announced that the introduction of effective fuel tax on alternative fuels would be postponed from 1 July 2008 to 1 July 2011, and apply in five equal, annual steps to reach the final rates on 1 July 2015. The transition arrangements were extended to provide more time for existing fuel producers (including the LPG industry) and users to adjust, and for new transport fuels (such as biofuels, compressed natural gas and liquefied natural gas) to establish their credentials in the market.

Fuel ethanol and biodiesel are currently both, in effect, fuel-tax free. Fuel tax of 38.143c/L is applied to both, but domestically produced ethanol and imported and domestically produced biodiesel receive equivalent production grants—offsetting fuel tax until 1 July 2011, when effective fuel tax will begin to be applied incrementally to these fuels. The final fuel tax rates (net of production grants) will be 12.5c/L for fuel ethanol and 19.1c/L for biodiesel in 2015 (a 50% discount to the full energy content fuel tax rates).

From 1 July 2011, imported ethanol and domestically produced ethanol will be treated equivalently, opening domestically produced ethanol to full international competition. At present, the Taskforce understands that ethanol can be exported from Brazil at considerably lower prices than Australian ethanol is sold. Unless Australian product becomes significantly more cost competitive, the Taskforce would expect to see much of the Australian consumption of fuel ethanol being supplied from overseas.

The phase-ins of effective fuel tax and applicable fuel tax rates for alternative fuels are detailed in Table 6.

Table 6 Effective fuel tax rates for alternative fuels at 1 July, 2003 to 2015 (cents/L)

Year	Ethanol			Biodiesel		
	Fuel tax	Production grant	Effective tax	Fuel tax	Production grant	Effective tax
2003	38.143	38.143	**0.0**	38.143	38.143	**0.0**
2004	38.143	38.143	**0.0**	38.143	38.143	**0.0**
2005	38.143	38.143	**0.0**	38.143	38.143	**0.0**
2006	38.143	38.143	**0.0**	38.143	38.143	**0.0**
2007	38.143	38.143	**0.0**	38.143	38.143	**0.0**
2008	38.143	38.143	**0.0**	38.143	38.143	**0.0**
2009	38.143	38.143	**0.0**	38.143	38.143	**0.0**
2010	38.143	38.143	**0.0**	38.143	38.143	**0.0**
2011	38.143	35.643	**2.5**	38.143	34.343	**3.8**
2012	38.143	33.143	**5.0**	38.143	30.543	**7.6**
2013	38.143	30.643	**7.5**	38.143	26.743	**11.4**
2014	38.143	28.143	**10.0**	38.143	22.843	**15.3**
2015	38.143	25.643	**12.5**	38.143	19.043	**19.1**

Note: The Australian Government has determined the final net effective fuel tax rates for alternative fuels but the mechanism for delivering these net effective fuel tax rates has not yet been decided. One option is to use a combination of a fuel tax rate and a decreasing production grant which is shown in this table. Another option would be to directly legislate the effective fuel tax rate for the product.

Source: Treasury

Broader reforms to fuel taxation

Further reforms were announced in the 2004 energy white paper to make the fuel tax system simpler for business and to substantially lower the fuel tax burden on businesses and households. The key additional changes include the following:

- Introduction of a full fuel tax credit for all business use of fuel off-road

  This measure will be phased in for newly eligible activities, with a 50% credit being provided from 1 July 2008 and a full credit from 1 July 2012. Credits will apply to all taxable fuels, including petrol and alternative fuels.

- Removal of effective fuel tax on fuels used for power generation (diesel and fuel oil) and burner fuels (heating oil and kerosene) from 1 July 2006

- Extension of partial fuel tax credits to all fuels used in heavy vehicles (gross vehicle mass in excess of 4.5 tonnes) from 1 July 2006

  The net fuel tax paid on all fuels used in heavy vehicles will be converted into a non-hypothecated road user charge from 1 July 2006. The road user charge for petrol and alternative fuels will be the same as for diesel.

  – The road user charge will be set in accordance with the National Transport Commission's heavy vehicle charging determination process. The charge will be adjusted annually in the way that the states and territories adjust registration fees. Changes to the charge will be made by varying the level of the fuel tax credit paid for fuel used in heavy vehicles.

- As fuel tax on alternative fuels is levied at a 50% discount to the full energy content rate, the fuel tax rates for fuels other than petrol or diesel are expected to be below the road user charge for the foreseeable future. Users of these fuels on-road will not be entitled to a fuel tax credit until the rate exceeds the road user charge.

Phase-out of alternative fuel grants under the Energy Grants (Credits) Scheme

On 27 May 2005, the government further announced that grants for the use of alternative fuels on road, currently payable under the Energy Grants (Credits) Scheme (EGCS), would be phased out over five years from 1 July 2006. This announcement was made in conjunction with the release of the Fuel Tax Credit Reform Discussion Paper.

The EGCS replaced the Diesel Fuel Rebate Scheme (off-road scheme) and the Diesel and Alternative Fuels Grants Scheme (on-road scheme) on 1 July 2003. The EGCS currently provides a grant to businesses for fuel used for specified on- and off-road activities. Users of ethanol and biodiesel in on-road applications are currently eligible for alternative fuel grants of \$0.20809/L and \$0.1851/L, respectively. Beginning on 1 July 2006 and ending on 1 July 2010, the grant rates will be progressively reduced to zero. The alternative fuel grant rates for ethanol and biodiesel over the period 1 July 2005 to 1 July 2010 are shown in Table 7.

Table 7 Alternative fuel grant rates at 1 July, 2005 to 2010 (cents/L)

Fuel type	2005	2006	2007	2008	2009	2010
Biodiesel	18.510	14.808	11.106	7.404	3.702	0.000
Ethanol	20.809	16.647	12.485	8.324	4.162	0.000

Source: Treasury Discussion Paper, Fuel Tax Credit Reform.

Current use data suggests that the effect of removing alternative fuel grants for biodiesel and ethanol is likely to be limited. In 2003–04, there were only five claimants for ethanol and none for biodiesel. To qualify for an on-road alternative fuel grant under this arrangement, a user would need to purchase 100% ethanol or 100% biodiesel or a biodiesel blend consisting primarily of biodiesel. There is no evidence to suggest that biodiesel producers are distributing biodiesel to the road transport industry in these concentrations, and vehicle operability concerns could limit the market for high-biodiesel blends in the absence of vehicle modifications. Clearly, however, for vehicles with modified engines (such as E100 buses), the scheme offered benefits to potential users of biofuels. These benefits are being phased out.

Net effect of fuel taxation reforms

The proposed system for applying net effective fuel tax and the implementation path of individual reforms are quite complicated, as a number of separate reforms interact over different time frames. As outlined above, the key reforms include:

- all fuels used off-road for business purposes will become fuel-tax free over time

- partial fuel tax credits will apply to all fuels used for business purposes on-road in vehicles with a gross vehicle mass of at least 4.5 tonnes; the net fuel tax paid on fuels used on-road in these vehicles will be converted to a road user charge
- alternative fuel grants will be phased out
- biofuels will increasingly be subject to fuel tax over time, from an effective fuel tax rate of zero until 2011 to 19.1c/L for biodiesel and 12.5c/L for ethanol by 2015.

Because the government's fuel taxation policy is for business use of fuel to become effectively tax free over time, to the extent that ethanol and biodiesel have relied on a relative tax advantage to underpin their competitiveness, this advantage will be reduced in some business markets and lost in others. This will primarily affect biodiesel, as ethanol is primarily being sold into the retail fuel market.

Some blends of biodiesel, such as B20 and B49, will lose an unintended benefit that they currently enjoy in the on-road and off-road markets. This is because biodiesel blends consisting primarily of diesel (biodiesel blends B49 and below), are currently defined as 'diesel' for both the on-road and the off-road credit and are therefore over-credited in relation to the fuel tax paid on these fuels.

It is proposed to correct this definitional issue under the new fuel tax credit system, with diesel being defined by reference to the diesel fuel standard. Blends that do not meet the diesel fuel standard will not be eligible for the fuel tax credit applying to diesel.

This treatment will allow biodiesel blends that meet the diesel fuel standard (predominantly B5) to retain a 19.1c/L relative tax advantage in all fuel markets as compared with B100, which will retain only a 19.1c/L advantage in the private and on-road business vehicle market (under 4.5 tonne).

This suggests that biodiesel blends that meet the diesel fuel standard may be the preferable delivery mechanism for biodiesel into the retail fuel market. There may be some special purpose applications for higher biodiesel blends on environmental grounds (such as mining and marine applications).

B100 is currently eligible for an on-road alternative fuel grant and this will be phased out from 2006–2010. The effect of this is limited, as it is not expected there will be a significant market for B100 used on-road in heavy vehicles.

Further analysis of the effects of these reforms on biodiesel is contained in ABARE's 2005 viability assessment.

Table 8 Effective fuel tax treatment of biodiesel

Markets	Biodiesel blends meeting diesel fuel standard in 2015	B100 in 2015
Off-road	19.1c/L tax advantage	No tax advantage
Heavy vehicle on-road	19.1c/L tax advantage	Small tax advantage (less than 1c/L)
Private and business on-road under 4.5 tonnes	19.1c/L tax advantage	19.1c/L tax advantage

Some submissions argued that the government's fuel taxation reforms are potentially inconsistent with its alternative fuel policies, particularly the government's decision to provide alternative fuels with a 50% fuel tax concession and capital grants to encourage industry development. The Taskforce notes that the benefit of the 50% fuel tax concession is preserved in all fuel markets for blends of biodiesel that meet the diesel fuel standard (5% biodiesel blends). However, this concession is lost for higher biodiesel blends in the off-road and heavy vehicle on-road markets.

The Taskforce also notes that changes to fuel taxation arrangements have been announced progressively in an environment in which the Australian Government has been actively encouraging significant industry investment in biofuels capacity expansion.

The complete package of fuel tax reforms was not announced until the release of the government's energy white paper. The interaction of the fuel tax changes is quite complex, and the government has only recently (in May 2005) released a Fuel Tax Credit Reform Discussion Paper outlining the proposed legislative framework to implement the reforms.

The Taskforce considers it reasonable to conclude that several biofuel project proponents may not have factored in the full implications of these reforms, at least until the discussion paper was released.

Conclusion 3: *While biofuels still receive fuel tax concessions, the net effect of fuel tax reform is to substantially implement a fuel taxation system which transitions to become competitively neutral and applied in a consistent and transparent way to all relevant fuels and fuel users, noting that private and business biofuel use (in vehicles under 4.5 tonnes) will continue to receive a fuel tax advantage. Due to the complexity and staged announcement of fuel tax reforms, several biofuel project proponents may not have factored in the full implications of fuel taxation reforms and the commercial impact of these reforms on their projects' viability.*

Biofuels Capital Grants Program

To encourage new entrants into the biofuels industry, the government announced on 5 July 2003 that it would provide up to $37.6 million to fund a capital subsidy for projects that provide new or expanded biofuels capacity. The subsidy will be provided at a rate of 16c/L of additional capacity to viable projects producing a minimum of 5 ML of biofuels, and will be limited to $10 million per project.

On 22 June and 23 December 2004, the Minister for Industry, Tourism and Resources, the Hon. Ian Macfarlane MP, announced the successful applicants under the two rounds of the programme. With these announcements, programme funding was fully allocated. Successful grantees were:

- CSR Distilleries Operations for an ethanol plant at Sarina, Queensland ($4.16 million for 26 ML)
- Biodiesel Industries Australia for a biodiesel plant at Rutherford, New South Wales ($1.28 million for 8 ML)
- Schumer Pty Ltd (Rocky Point Sugar Mill and Distillery) for an ethanol plant at Woongoolba, Queensland ($2.4 million for 15 ML)
- Biodiesel Producers Ltd for a biodiesel plant at Barnawatha, Victoria ($9.6 million for 60 ML)
- Australian Renewable Fuels Pty Ltd for a biodiesel plant in Port Adelaide, South Australia ($7.15 million for 44.7 ML)
- Riverina Biofuels Pty Ltd for a biodiesel plant at Deniliquin, New South Wales ($7.15 million for 44.7 ML)
- Lemon Tree Ethanol Pty Ltd for an ethanol plant at Millmerran, Queensland ($5.85 million for 36.6 ML).

Given this grant distribution, the programme is potentially supporting an additional 235 ML of biofuels production capacity (157.4 ML biodiesel and 77.6 ML ethanol).

The Taskforce notes that the programme decisions to fund biofuel plants were made, at least in part, before the announcement of the full package of the government's fuel taxation reforms and before the release of detailed information outlining the proposed implementation path for these reforms. Whilst reforms were announced in the energy white paper in June 2004, detailed implementation plans were not available until May 2005 in the Treasury discussion paper. As noted above, the Taskforce considers that, due to their complexity and staged announcement, several biofuel project proponents may not have factored in the full implications of fuel taxation reform and the commercial impact of these reforms on their project's viability.

ABARE's July 2005 viability assessment (commissioned by the Taskforce, see Chapter 6) indicates that biodiesel produced from used cooking oil and tallow, although able to make reasonable rates of return in the period to 2015, is unlikely to be commercially viable in the longer term. The Taskforce understands that three of the successful biodiesel projects, comprising 95% of the 157 ML of biodiesel funded under the Biofuels Capital Grants Program, are planning to use tallow as their primary feedstock. At this stage, and in the light of the announced changes to fuel taxation, it is unclear how many of these projects will be viable in the longer term and proceed.

Conclusion 4: *The Taskforce notes that the longer term commercial viability of some Biofuel Capital Grant Program funded biodiesel projects may be questionable in the light of the full suite of fuel taxation changes and prevailing market conditions.*

350 million litre biofuels target

As part of its 2001 election commitment, *Biofuels for Cleaner Transport*, the government nominated a target of 350 ML by 2010 for the contribution to Australia's total fuel supply by fuel ethanol and biodiesel from renewable sources. The stated policy objectives and rationale outlined in the election commitment included the following:

- Biofuel production would bring regional benefits, including increased employment, more efficient use of agricultural and forestry residues, and an additional income stream to provide a buffer against shifting commodity prices.
- Biofuels are renewable and therefore have an advantage over other alternative fuels.
- Biofuels could be used as 'drop-in' fuels, and would require little or no modification to distribution infrastructure and no alteration to the general vehicle fleet.
- Biofuels deliver environmental benefits, such as improved air quality and reductions in greenhouse gas emissions.
- Increased domestic biofuel production and use will reduce Australia's reliance on imported fossil fuels.

The Taskforce has noted that the 350 ML biofuels target has not been formally adopted as government policy, either as an aspirational target or as a policy objective to guide policy interventions. However, the government has implemented a range of policy interventions designed to encourage capital investment and increased production of biofuels. These interventions have not been designed to specifically achieve the 350 ML target. This situation has sent unclear signals to the industry about the nature of the government's commitment to the 35 ML target.

Conclusion 5: *The Taskforce considers that clarification of the government's policy position in relation to the target of 350 ML of biofuels in the fuel supply by 2010 is desirable.*

Achieving the target

The Taskforce notes that the government has indicated its belief that the Biofuels Capital Grants Program will stimulate sufficient investment in biofuels production capacity to enable the 350 ML target to be met by 2010 (that is, that current production capacity plus projects funded by the programme plus other projects thought likely to be going ahead will result in production capacity exceeding 350 ML by 2010).

During consultations with the Taskforce, the industry considered that the target is achievable provided a number of market uptake barriers are resolved. These include the establishment of commercial pricing arrangements, improvements in consumer confidence, greater clarity around vehicle operability, waivers of Reid vapour pressure limits, and security of supply. These issues are discussed further in chapters 7 and 8.

The Taskforce notes that ABARE’s July 2005 viability analysis (see Chapter 6 and Appendix 3) considers only the cost of production of biofuels relative to conventional fuels and explicitly ignores issues associated with consumer confidence and market development. Further, no consideration is given in ABARE’s analysis to the possible impact of competition from ethanol imports from 2011 onwards.

Similarly, from a comparative cost of production perspective, the analysis suggests that biodiesel production could be considered viable in the short–medium term due to the high rates of return available. However, this would require biodiesel projects to be constructed and operating as soon as possible to allow sufficient time to maximise the benefits during the fuel tax concessionary period to generate these high rates of return on capital.

ABARE noted:

> …given the limited time available, it is not possible to provide an assessment as to whether the current policy framework provides assistance sufficient to generate the commercial returns to ensure the 350 ML target will be met by 2010.[20]

However, were the 350 ML target to be achieved as a result of all recipients of the Biofuels Capital Grant Program proceeding, ABARE notes it would consist of 148 ML of ethanol and 202 ML of biodiesel.

The Taskforce considers there are real and substantial barriers to achieving the 350 ML target by 2010 and that, although ABARE's analysis demonstrates the potential commercial viability of some biofuel production, the commercial conditions required to meet the target are unlikely to be met under current circumstances (see chapters 6–8).

Conclusion 6: *The Taskforce considers that there are real and substantial barriers to achieving the 350 ML target by 2010, and that it is unlikely to be met under current circumstances.*

Renewable Energy Development Initiative

As part of the energy white paper, the government announced a $100 million Renewable Energy Development Initiative for new renewable energy technology activities. The initiative aims to support the development of new renewable energy technology products, processes, or services that have strong early-stage commercialisation and emissions-reduction potential. Eligible applicants may compete for a grant to assist with the funding of a project involving research and development activities, proof-of-concept activities, and/or early-stage commercialisation activities.

Renewable energy technologies are defined as direct or enabling technologies developed for the purpose of deriving sustainable energy from the sun; wind; geothermal sources; biomass (not derived from fossil fuels); hydro systems; wave, tidal and ocean energy; or any other renewable energy source approved by the programme delegate on the advice of the Australian Greenhouse Office.

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[20] Assessment of the viability of biofuels, ABARE Report for the Biofuels Taskforce July 2005.

Biofuels are eligible under this programme. Applications for Round 1 of the Renewable Energy Development Initiative close on 25 August 2005.

State government support for biofuels

Queensland: ethanol support

In April 2005, Premier Beattie launched the Queensland Government’s Ethanol Industry Action Plan 2005–2007, under which the Queensland Government will provide $7.3 million over two years for programmes to support the development of the Queensland ethanol industry. Specifically, the plan is designed to assist the Queensland ethanol industry to improve its capacity to market ethanol-blended fuels and to assist diesel-based fleet operators with technical conversions to allow the use of diesel–ethanol blends. The plan includes:

- $1.46 million for rebates for cleaning storage tanks so they can hold E10, plus conversion of bowser equipment and signage
- $2.28 million for a marketing campaign to boost public confidence in ethanol
- $1.14 million to aid the introduction of operational guidelines for diesel–ethanol blends, engine conversion and related issues
- $2.2 million for blending and distribution facilities for E10 and diesel–ethanol blends
- $0.2 million to employ two staff to help implement the strategy.

The Queensland Ethanol Industry Blueprint, which preceded the development of the action plan, provided an initial strategy for the development of the ethanol industry. A key part of Queensland Government support includes the use of ethanol-blended fuel in its QFleet.

South Australia: biodiesel support

In February 2005, Premier Rann announced a new clean-fuel initiative as part of the South Australian Government’s plan to reduce greenhouse gas emissions and fuel consumption. Premier Rann announced that, by 1 March 2005, all metro trains and diesel buses will operate using 5% biodiesel, with the proportion to be increased progressively to 20%. The outcomes of a public tender process are currently being examined by the South Australian Government.

New South Wales Government: ethanol support

Premier Carr announced on 21 June 2005 that ethanol-blended fuel could be used in government fleet vehicles for the first time. The New South Wales Government is expected to seek tenders from fuel suppliers for the delivery of ethanol-blended fuel in October.

Local government trials

A number of local governments have been actively interested in biofuels for some time. The Newcastle, Brisbane City and Camden local government authorities have been involved in biodiesel trials in garbage trucks and other diesel vehicles.

Chapter 4 Biofuels internationally

Synopsis

- Ethanol and biodiesel are the dominant biofuels globally. While growing in market share, they remain minor contributors to the overall fuel mix at under 1% of the total road energy use.
- Brazil, closely followed by the USA, dominates fuel ethanol production.
- China, India and Thailand are emerging as significant fuel ethanol producers.
- Europe produces almost all of the world's biodiesel. Biodiesel is over 75% of total European biofuel production, reflecting its agricultural outputs.
- Biofuels globally are supported by subsidies, regulatory preference and explicit supply mandates.
- Globally, various objectives are associated with government support for biofuels, such as regional development, greenhouse gas abatement, air quality benefits and fuel security. In some cases, these have played a significant part in initiating policy development, but the main underlying global driver for effective policy intervention remains agricultural support.

Overview

Internationally, two biofuels, biodiesel and ethanol (and ETBE made from biologically derived ethanol), account for more than 90% of total usage[21]. Biofuels are most commonly used in low concentration blends with petroleum products.

In parts of North America, E10 is common and about 200 retail outlets sell E85 for 'flexible fuel vehicles'. In Brazil, petroleum contains ethanol within the range of 20–25%. In Europe, Sweden is the only country using direct blending extensively (at E5), but France and Spain produce ethanol and convert it to ETBE. Spain and Germany are beginning to produce fuel ethanol. European fuel standards allow up for blends of up to 5% of alternative fuels, including ethanol, without labelling.

Biodiesel as B100 is relatively common in Germany and invariably also as a blend from B5 to B25. The EU accounts for over 95% of the world biodiesel production.

In contrast to Australia, global biofuel production and utilisation are accelerating rapidly, albeit from a low base. According to the IEA, if historical trends were to continue, annual growth rates would lead to a global increase from about 30,000 ML in 2003 to over 40,000 ML in 2020. However, with the Kyoto Protocol entering into

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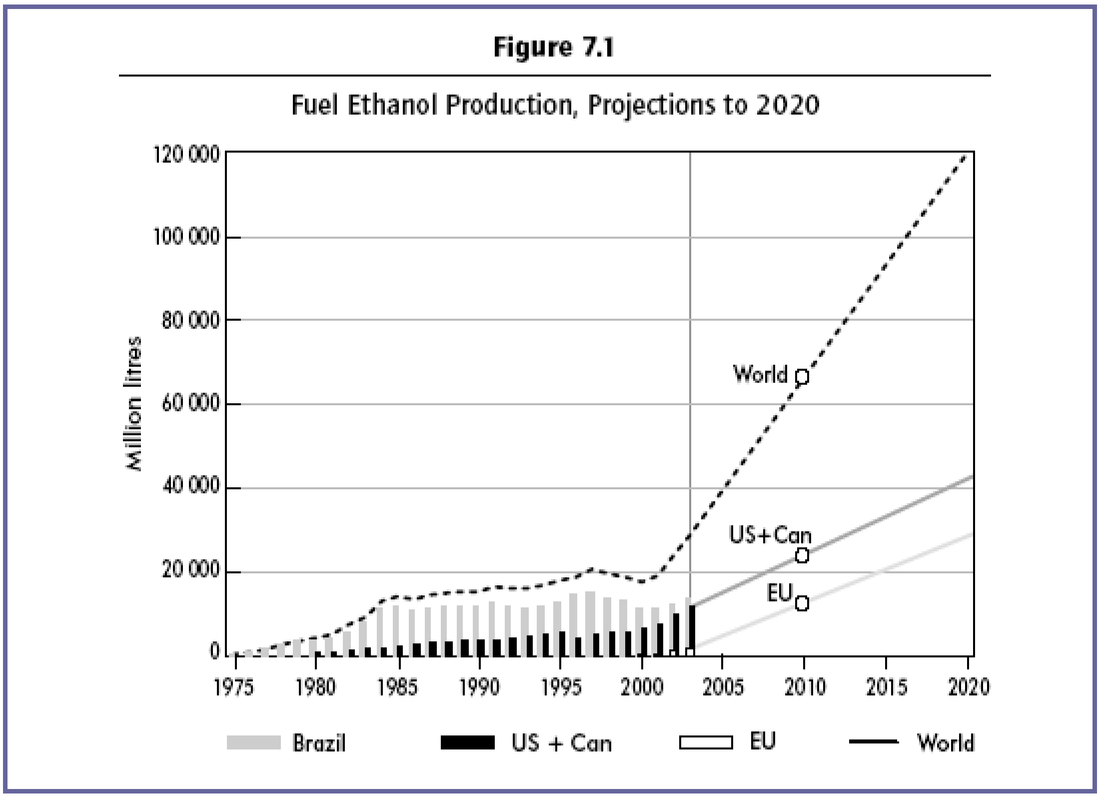
[21] The Taskforce has drawn on three key sources: the International Fuel Quality Center's Biofuels Service at www.ifqcbiofuels.org (by subscription); FO Licht et al., *Ethanol production and costs, a worldwide survey*, Agra Informa Ltd, Kent, UK, 2004 (www.agra-net.com); and the International Energy Agency/OECD *Biofuels for transport: an international perspective*, 2004.

force in February 2005 and the first target period under the EU Biofuels Initiative coming into effect in December 2005 the IEA considers a very different picture might emerge—a quadrupling of world production to over 120,000 ML in 2020. On a petrol equivalent basis, this would likely account for about 6% of world motor petroleum use in 2020, or about 3% of total road energy use.[22] IEA projections for fuel ethanol and biodiesel production to 2020 are at Figures 3 and 4, respectively.

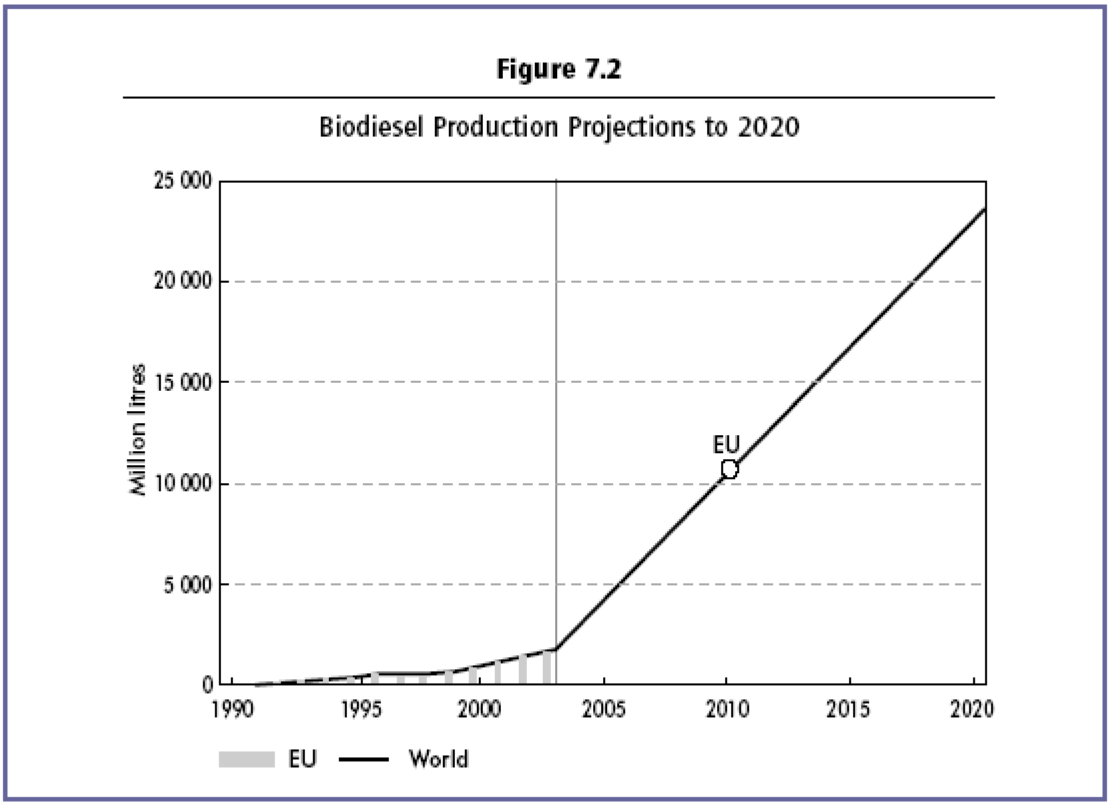
Figure 3 Fuel ethanol production projections, 1975–2020



Source: IEA (2004, p. 167).

[22] International Energy Agency/OECD, *Biofuels for transport: an international perspective* (2004), p 168.

Figure 4 Biodiesel production projections, 1990–2020



Source: IEA/OECD, 2004, p 169.

Ethanol is produced in Europe from fermenting sugars or stalks from beets, corn (maize), barley and wheat. Ethanol represented around 18% of total EU production of biofuels in 2003. In 2003, Spain was the main European producer at 309 KT (392 ML) given the government collects no tax on ethanol.[23]

Biodiesel demonstration plants opened in Europe in the 1980s as a means to develop rural areas while responding to increasing levels of energy demand. Production of biodiesel declined due to falling oil prices in the early 1990s, but subsequent rising energy prices have supported its growth. Biodiesel represents some 77% of total European biofuels capacity.

Biofuels by region

The Taskforce examined biofuels production and consumption in countries covering three broad regions—the Americas, Europe and Asia. This information is summarised in Table 9.

[23] International Energy Agency/OECD, *Biofuels for Transport: An international perspective* (2004), p30.

The Americas

Brazil is the world's dominant producer and exporter of fuel ethanol which it produces from sugar. In 2004, the US was the world's second-largest producer of ethanol, principally from corn, while Canada was also a large producer and is fostering an innovative approach to R&D utilising lignocellullosic[24] material, such as straw.

Brazil

Brazil began to focus on its production of fuel ethanol in the 1970s as a reaction to the oil crisis. At that time Brazil was also facing severe economic difficulties, including the world's largest foreign debt and heavy dependence on imported oil.

The *Proálcool* programme, launched in the 1970s, remains the world's largest commercial application of biomass for energy production and use. The government adopted measures to develop new plantations, produce a fleet of ethanol-fuelled vehicles, extend the number of distilleries, establish new fuel-distribution systems, stimulate alcohol demand, and sought to identify common ground among the agricultural and industrial players. With the mandate for the quantity of ethanol in petrol in 1991, government succeeded in demonstrating the technical feasibility of large-scale production of ethanol as a transport fuel and its use in high level blends.

In recent years, Brazil offered government credit to the sugar industry to cover 60% of its storage costs in order to guarantee ethanol supplies, mandated their use in government fleet vehicles and pioneered flexible fuel vehicles that can operate on anything from straight petrol to E85. Brazil mandates the blend, each year, within the range of 20–25% ethanol in petrol. In 2003, government taxes on petrol containing 25% ethanol were about US$0.30/L (A$0.40/L) and approximately US$0.17/L (A$0.22/L) for hydrous alcohol (E85).

Brazil's ethanol exports are rising rapidly as costs continue to come down and world demand for biofuels increases. A highly regarded industry analyst has assessed the net cost of production, including investment costs, in Brazil in 2003 in a plant with an annual capacity of 55 ML to be about US$0.14/L (A$0.19/L).[25]

Brazil established the *National Programme for the Production and Use of Biodiesel Programme* in 2002 and legislation passed in 2004 year authorised B2 and B5 blends. A mandate will commence in 2008.

United States of America

Biofuels production in the USA is 99% ethanol. The US produced 3.4 billion gallons (12,870 ML) of ethanol in 2004, representing over 2% of US liquid fuel consumption. In the US, corn is the predominant crop used, accounting for 95% of the ethanol produced. The other 5% is derived from barley, wheat and sorghum, sugarcane and wastes from paper mills, potato processing plants, breweries and beverage manufacturers.

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[24] A process to make fuel alcohol using the combination of materials that are high in cellulose and hemicellulose, one that is more complicated that converting starch into sugars and then to alcohol.
[25] *Ethanol production costs: a worldwide survey*, a special study from FO Licht in conjunction with Agra CES Consulting, 2004, p.123.

US interest in fuel ethanol was established as a response to the oil crises of the 1970s. The US began assisting production in the 1980s to address a farm crisis, specifically in the corn industry. Ethanol attracted further interest as an anti-knocking agent when lead was phased out from that role in petrol.

Ethanol production has been given a significant boost as an indirect result of the Clean Air Act Amendments in 1990. These amendments established the oxygenated fuel programme that required petrol sold in areas with high carbon monoxide to contain 2.7% oxygen and later the Reformulated Gasoline Program which required petrol containing 2% oxygen to be sold in areas with high levels of photochemical smog. While MTBE was initially the principal oxygenate used, its progressive banning in a number of states has seen a significant uptake of ethanol to meet the oxygenate requirement.

Several initiatives have stimulated uptake of ethanol. There is a US$0.52/gallon (A$0.20/L) tax credit for ethanol. Federal agencies are required to use alternative fuels in their fleets, the Clean Cities Program created a market for alternative fuelled vehicles and various states offer incentives and assistance, and several have ethanol mandates.

At the time of writing, the 2005 Energy Bill had been forwarded to President Bush for consideration. Among its provisions is a renewable fuels standard (RFS) that 7.5 billion gallons (28,390 ML) of renewable fuels are be used annually by 2012. This represents about 4.5% of expected consumption. The RFS will be implemented through regulations applied by the US EPA. It includes provision for 250 million gallons (946 ML) to be sourced from cellulose feedstock each year from 2013. Loans will be provided for the production of lignocellulosic ethanol and allow RFS credits to be traded for a period of up to 24 months. The foreshadowed cost to revenue from the tax incentives equates to US$375 million (A$495 million) to extend the biofuels incentives from 2006 to 2012 as part of a US$14.3 billion (A$18.9 billion) package.

Biodiesel production was stimulated by the Clean Air Act Amendments in 1990 and the Energy Policy Act of 1992 which established a goal of replacing 30% of motor fuels with non-petroleum alternatives by 2010. Output of biodiesel in 2004 totalled 30 million gallons (7.9 ML), i.e. 0.83% of the total on-road consumption of 36 billion gallons (9523 ML) of diesel. With new federal tax credits in 2004 and a requirement for diesel from 2006 to be sulphur free, demand is increasing.[26]

Agricultural support remains a strong driver for US policy, highlighted by the mandates in the corn growing states, but recent statements by President Bush also emphasise reducing US dependence on oil imports. The USA imports over half (57%) of its oil. The 2005 Energy Bill contains provision for the development of a North American energy policy to achieve energy self-sufficiency by 2025, in an arrangement with Canada and Mexico.[27]

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[26] The Economist, *Stirring in the corn fields*, 12 May 2005.
[27] Conference Committee report, *Energy Policy Act 2005: Sec 1423. United States Commission on North American Energy Freedom*.

Canada

Canadian policy for biofuels is driven by a combination of agricultural support and Kyoto Protocol obligations.

The Canadian Government supports new investment to meet a target that 35% of petrol containing an E10 blend will be in place by 2010 (i.e. a 3.5% target for ethanol). Canada has a C$105 million (A$113 million) Ethanol Expansion Program as part of a larger renewable fuels strategy. The funding is spent principally on capital grants. In parallel, a number of provinces are supporting the development of new plant in an endeavour to be able to mandate the present and future use of biofuel blends. Ontario, for example, announced in November 2004 that a renewable fuels standard of 5% ethanol will be in place from 1 January 2007.

Canada has put a small amount of money into a biodiesel bus trial in Montreal and into a new biodiesel production facility developed by BIOX Canada Ltd.

Canada is a leader in new biofuels technology. Given the success of a demonstration plant, Iogen—a Canadian company with a background in enzyme technology, with Royal Dutch/Shell, Petro-Canada and the Canadian Government, in investing more than C$250 million (A$267 million) constructing a full-scale commercial plant to develop cellulosic ethanol by 2007. The new facility will help enable Canada meet its target of 3.5% biofuels use by 2010.

Europe

Within the European Union, Sweden is making extensive use of E5, France is a leading producer of biodiesel, Germany is a major user of biodiesel and the United Kingdom is examining the means by which it can incorporate biofuels into its energy policy mix.

European Union

The use of biofuels in Europe is not new—EC Directive 85/536/EEC of 1985 proposed reducing dependence on oil imports through substitution, including with biofuels. Two directives were adopted in 2003 to promote energy supply diversification and the reduction of greenhouse gas emissions, given biofuels greatest potential, in the short and medium term, among fuels then available to displace petrol and diesel. However, biofuels in Europe remain predominantly biodiesel. Ethanol production is expanding as countries move to implement EU biofuels directives released in 2003.

Directive 2003/30/EC set a non-binding target for a 2% market share for biofuels (based on energy content) by 2005 and a 5.75% share by 2010. Directive 2003/96/EC allows EU member states to exempt biofuels (among others) in full, or in part, from energy tax. Energy crops are also treated favourably under the Common Agricultural Policy which, in some instances, increases the set-aside subsidy if the land is planted to raw material for biofuels.

Future growth in the biofuels sector will be influenced by the EU report to the European Parliament, due in 2006, on the uptake of the 2003 Directives.

The Commission's Green Paper, which preceded the biofuels directives, *Towards a European Strategy for Energy Supply Security* (2000), emphasised the EU's increasing dependence on external energy, currently 50% but forecast to rise to 70% after 2020, and the need to meet Kyoto targets. However, it is clear that support for agriculture is a major policy driver as noted in the Directive 2003/30/EC of 8 May 2003:

> Promoting the use of biofuels in keeping with sustainable farming and forestry practices laid down in the rules governing the common agricultural policy could create new opportunities for sustainable rural development in a more market-oriented common agricultural policy geared more to the European market and to respect for flourishing country life and multifunctional agriculture, and could open a new market for innovative agricultural products with regard to present and future Member States.

A number of EU countries have implemented tax relief for biofuels, including some, such as Germany, Sweden and Spain, at 100%. Notwithstanding this, it appears that at least eight EU member states will not meet the indicative targets. In some cases they appear to be concerned about the economic costs involved.

Several EC texts govern biofuel use. European Directive 98/70/EC (amended by 2003/17/EC) on motor fuel quality officially authorises, for regular sale at the pump, petrol that contains no more than 5% ethanol or 15% ETBE, unlabelled. A 2005 report notes that for 2003, the specification across the EU for petrol was generally met.[28]

Sweden

Sweden's has long supported biofuels. About 85% of petrol sold contains ethanol at E5 with the balance in E85 available at some 160 service stations for an increasing number of flex fuelled vehicles (FFVs). FFVs cost some A$1600 more than other cars. With biofuels (including imports) exempt from excise, petrol outlets are able to offer blends at the same price as conventional fuels.

Sweden imports (198 ML) significantly more ethanol than it produces (65 ML). Sweden, with Spain, has proposed to the EU that the 5% limit on ethanol in petrol be raised to 10% to help meet the EU biofuels target.

France

France has promoted biofuels since the early 1990s when it introduced measures designed to offset changes to the Common Agricultural Policy. In 2003, biofuels accounted for 0.76% of fuel consumed. It was the largest producer of fuel ethanol in Europe until 2003, when overtaken by Spain.

Plans announced in 2004 will allow France to treble quota production of biofuels to 800,000 tons (951 ML) by 2007 to raise the share of biofuels to be in line with EU targets in 2010. The biofuels strategy is included in the French National Climate Plan but continues to be driven significantly by agricultural policy.

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[28] Commission of the European Communities: Report from the Commission, *Quality of petrol and diesel fuel used for road transport in the European Union*, second annual report, (reporting year 2003) Brussels, 2.3.2005 COM (2005) 69 final.

Germany

Germany has long promoted biodiesel at B100, taking advantage of assistance available under the Common Agricultural Policy for non-food crops on set-aside land. It is Europe's largest biodiesel producer, accounting for about 30% of EU production.

Following the EU biofuels directive in 2003, Germany moved to extend its full excise exemption to all biofuels and blends until 2009. As a result, biofuels production and consumption increased rapidly. Biodiesel production in 2004 was 45% higher than in 2003 and Germany's first fuel-ethanol plant opened in September 2004. Germany's long experience of using B100 means that biodiesel is widely available at service stations, including in unlabelled form as B5.

Germany is investing in synthetic biofuels (biomass to liquids), using a version of the Fischer–Tropsch process to convert wood and other biomass. Still in its experimental stage, Choren Industries is assessing its commercial potential before investing in annual capacity of 13,000 tonnes (15 ML) before a commercial development of 200,000 tonnes (227 ML) planned for 2008. Unlike biodiesel production, biomass-to-liquids uses the entire plant, thus theoretically requiring less land use per unit of energy and offering greater economic potential for the agriculture and forestry sectors.

The uptake of biofuels is now so rapid that commentators are speculating about whether Germany can continue to afford the likely revenue foregone.

United Kingdom

Until recently the UK had shown little interest in biofuels. However, as with other EU member states the UK is moving to address the objectives of the Biofuel Directive (2003/30/EC). The government, through its white paper on energy in 2003, acknowledged that biofuels were an important potential route for achieving the goal of zero carbon transport, noting they could account for some 5% of road transport fuels by 2020.

The UK's main support has been through fuel duty incentives—a 20 p (A$0.45) per litre duty incentive on both biodiesel and ethanol. This represents a 40% reduction until 2008. Other measures are under consideration. At current levels of support, the industry view is that biofuel use may stabilise at less than 1% of road fuel use, well below the EU target, as the duty differential rate of 20 p/L for biofuels is considered insufficient to stimulate production. The government estimates that, under present arrangements, annual fuel duty revenue foregone will total £90 million (A$204 million) if biofuels achieve a 1% market share.

The UK acknowledges it can meet the 5% target by 2010 but at considerable economic cost. The level of its commitment is unclear. The British Transport Minister was recently quoted as saying:

> The government does remain committed to a transport strategy in which biofuels play a key role. But we have to give it the best chance of succeeding. Putting billions of pounds of subsidy prematurely into an industry would do more harm than good.[29]

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[29] EOP News site new.edp24.co.uk/content/news accessed 22 July 2005.

If the UK is able to meet its target, the country would achieve savings of 1 million tonnes of carbon p.a. at a cost of some £350–750 (A$800–1700) per tonne of carbon (equivalent to $A218–$463 per tonne of CO_2-e).

Asia

Japan is exploring means by which it can use biofuels to address its Kyoto targets; India is seeking to capitalise on its large agricultural base; China's goal is to reduce its growing dependence on foreign oil and to improve air quality; and Thailand is keen to find new markets for its agricultural surplus.

Japan

Under pressure to meet its Kyoto targets, Japan has proposed a target of 500,000 ML of biomass derived fuels by 2010. This would equate to about 1% of projected fuel use.

To encourage the uptake of ethanol, the government proposed an E3 standard in 2004 as a prelude to a national E10 blend standard by 2010. In mid 2005, Reuters reported that Japan was considering a 7% ETBE standard rather than E3 after strong industry opposition to costs and concerns about health impacts. Industry claims that ethanol would require blending at the service station while ETBE would reportedly be made using idle facilities previously being used to make MTBE. The ETBE would be blended with petrol at the refinery.

There are problems in developing a biofuels market given there is minimal domestic supply. Initially, there is a need to reduce costs, and later to secure a stable supply from a number of sources. Among others, in May 2005, Japan and Brazil signed a US$500 million loan agreement to finance domestic infrastructure development projects as well as capital investments made by Brazilian exporters, which include local Japanese affiliates.

The Ministry of Economy, Trade and Industry is examining options to make B5 available from April 2006. At present, feedstock such as palm oil and coconut oil are being considered, as are local sources of waste cooking oil. Discussions are under way with the Philippine Coconut Authority to consider exporting coconut-based biodiesel from 2005 to supply around 2500 ML for a B5 blend.

India

The continuing burgeoning supplies of molasses from the large sugar sector have been a major stimulus for India's interest in ethanol for fuel use. Other prompts include the impact of the rapidly expanding vehicle fleet on air quality standards; the need to diversify sources of fuel supply given increasing import dependence (currently 70%); and the opportunity to provide additional income and employment in the rural sector.

The government mandated the use of E5 in a number of sugar-growing states, but as supply could not match demand the programme is being implemented more gradually than was announced.

India is also looking to encourage biodiesel. In 2003, the government foreshadowed a mandate of B20 by 2011. In the meantime it has proposed a demonstration project using *Jatropha curcas*, a non-edible oilseed.

China

China, having replaced Japan as the world's second-largest oil consumer, has annual production levels of ethanol of around 3000 ML, most not for fuel use. Reducing dependency on fuel imports, and urban air quality concerns, are among China's key policy drivers.

The current biofuels policy framework was set by the Renewable Energy Law endorsed in February 2005. This law raises the target up from the present level of 3% of renewable energy to 10% by 2020.

The third largest global producer of ethanol, China's annual production is sourced from surpluses primarily in corn, but also cassava, sweet potato and sugarcane. China began trials of E10 from July 2003 and a market forecast suggests as much as 25–30% of the country will use corn-based ethanol fuels by 2007.[30] Part of that demand will be met by supply from the world's largest fuel ethanol plant, the Jilin Tianhe Ethanol Distillery, which opened in 2004 with an initial capacity of 750 ML.[31]

China consumed 95,000 tonnes (108,000 ML) of diesel in 2004 of which 60,000 tonnes (68 ML) was biodiesel. This low level will increase with new production capacity of 100,000 tonnes (113 ML) by end 2005. Biodiesel is also listed as a R&D priority.

Thailand

Thailand is seeking to follow Brazil as both a major producer and user of ethanol. Its targets for biofuel use in 2010 equate to 2% of projected energy needs to reduce its dependence on oil imports, support local agricultural commodity prices and ease the oversupply of sugarcane.

The government has an alternative fuel support package that involves abolishing tariffs on energy efficient vehicles and encouraging the use of FFVs. It offers tax incentives for private investors and producers of E10 with producers also exempt from contributions to the Oil Fund and the Energy Conservation Fund. MTBE is banned from 2006 and E10 is mandated for all government vehicles. As a result, E10 is cheaper than petrol and consumption is increasingly rapidly. In the lead-up to the 2010 target, the Thai Government has set a target to increase consumption of ethanol to 10% of expected daily demand for gasoline by 2006.

Thailand has a biodiesel production capacity target of 176 ML in 2006 rising to 722 ML in 2010.

Conclusions

The Taskforce sought to identify reasons why various countries have committed significantly more assistance to biofuels than Australia has done to date. Some countries are driven by a much stronger predisposition to subsidise agriculture than is Australia. Others, unlike Australia, are struggling to meet their Kyoto targets and are willing to adopt high-cost measures to mitigate emissions. Still others face a much

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[30] Green Car Congress http://www.worldchanging.com/archives/002964.html accessed 27 June 2005.
[31] Christoph Berg, World fuel ethanol analysis and outlook, April 2004 at http://www.distill.com/WorldFuel-Ethanol-A&O-2004.html accessed 20 July 2005.

greater energy security challenge. Despite declining domestic oil production, Australia will remain a net energy exporter.

Conclusion 7: *The Taskforce notes that many overseas countries have adopted policies to assist the production and use of biofuels. While national circumstances vary widely, in every case biofuel production has required significant government assistance. The reasons given by governments for adopting these policies are essentially the same as the possible benefits for Australia: air quality and greenhouse benefits; economic benefit through import replacement; energy security, and regional, particularly agricultural, support.*

Conclusion 8: *In the assessment of the Taskforce, it is regional, particularly agricultural, support that emerges as the primary driver of biofuel assistance in all cases except countries with a very limited capacity to increase agricultural production.*

Conclusion 9: *For some European countries, the Taskforce gained the impression that their biofuel policies are driven by EU decisions that they do not see as being in their immediate national interest. This tends to explain differentiated uptake of Biofuels within the EU.*

Table 9 Current support measures for Biofuels

Key = B = biodiesel; E = ethanol; ETBE = ethyl tertiary butyl ether; FFV = flexible fuel vehicle; kt = kilotonnes; MTBE = methyl tertiary butyl ether

Size of biofuels market	Existing market share (%)	Official target	Production incentives include	Mandate level (%)	Consumption incentives include	Special vehicle and other requirements	Estimates government assistance include:
Brazil E: 11,500 ML (2004) B: minimal	41% (2004)	See mandate	Tax incentives for oil seed production Loan assistance Reduced levels of industrial tax	E20–25 B5 in 2008	Tax exemptions for vehicles able to use E blends, and FFVs Fuel tax advantage over petrol Price controls	All cars to use ethanol blends By agreement with industry two-thirds of new car sales will be FFVs by 2007	In excess of A$14 billion revenue foregone from 1976 [a]
United States E: 3.4 billion gal (14,384 ML) (2004) B: 30 million gal (11.3 ML) (2004)	2% (2004) (by volume)	The reconciled version of the 2005 Energy Bill requires the increasing use from 4b gallons in 2006 to 7.5b gallons (28,390 ML) for fuel ethanol by 2012 (in effect a target of 2.78% for 2006).	Tax credits Producer payments Grant and loan programmes	Some at state level MTBE bans are an indirect mandate in conjunction with reformulated gasoline requirements	Tax credits Fuel tax exemptions, federal and some states Incentives to acquire FFVs Government fleet requirement Loan assistance	All cars built after 1980 will operate on E10 FFVs on sale In conjunction with present RFG requirements there is an effective oxygenate mandate. The 2005 Energy Bill will remove the oxygenate requirement.	US$140 billion in federal tax foregone to the Highway Trust Fund in net terms from 1978–2004 [b,c] US$345 million (A$456 million) in revenue forgone/ tax incentives in the 2005 energy bill for biofuels 2004 excise exemption of US$1.7b (A$2.26b)
Canada E: 175ML B: 10ML	Below 1%	3.5% for ethanol by 2010	Some provinces exempt ethanol from road tax	Some at provincial level	Exemption from A$0.11/L excise tax	All cars built after 1980 will operate on E10 FFVs on sale	A$101 million in fuel excise exemption plus others in capital grants

Size of biofuels market	Existing market share (%)	Official target	Production incentives include	Mandate level (%)	Consumption incentives include	Special vehicle and other requirements	Estimates government assistance include:
Sweden E: 52 kt (66 ML) ETBE: nil B: 1.4 kt (1.6 ML) (2004)	1.3% (2003)	3% in 2005 (energy content)	Tax incentives for new plant construction Access to EU CAP provisions Capital grants	nil	Exemption from fuel excise	FFVs on sale	SEK1.1 billion in tax exemptions provided to meet a 3% target in 2005
France E: 77 kt (98ML) ETBE: 164 kt B: 3487 kt (396 ML) (2004)	1% (2004)	3% in 2005	Tax credits on equipment using renewable energy Tax penalty on refiners not using biofuels Access to EU CAP provisions Capital grants	nil	Capped fuel tax exemptions Quotas Directives		Biofuel: tax revenues foregone of €540 million (A$860 million) (2007)
Germany E: nil B: 1035 kt (1176 ML) (2004)	1.4% (2003)	2% in 2005	Access to EU CAP provisions Capital grants	nil	Fuel tax exemptions for both pure and blends Directives		Exemption from fuel taxes 1996–2006 equals €2,000 million (A$3200 m) and will treble to €6,000 million (A$9600 m) in 2009
United Kingdom E: nil B: 9 kt (10 ML) (2004)	0.03% (2005)	5% by 2020	Capital grants Access to EU CAP provisions	nil	Part fuel excise exemption		£5 million in tax revenue forgone for each 24 ML of biofuel sales
India small	unknown	5% 'in near future'	Subsidies for inputs Tax credits and loans	E5 in some states	Fuel tax exemptions Guaranteed prices	unknown	unknown

Size of biofuels market	Existing market share (%)	Official target	Production incentives include	Mandate level (%)	Consumption incentives include	Special vehicle and other requirements	Estimates government assistance include:
Japan small	unknown	E3 or 7% ETBE by 2010; approx. 0.8% of total petrol consumption at 500 ML [d]		Under discussion	N/A	Not available	unknown
China E: 820 kt (1039 ML) (capacity in 2005) B: 60,000 t (68 ML) (capacity in 2004)	unknown	Renewable energy consumption at 10% by 2020	US$200 million R&D budget Loan assistance A number of subsidies Tax exemptions	Ethanol blends in some provinces	Yes—details not known	Fuel standards	unknown
Thailand E: 0.13ML (2004) B: 90 ML (2005)	unknown	2% of projected energy needs by 2010	Assistance to farmers 'Full investment incentives' for ethanol projects	B2 by 2010	Road tax halved for vehicles operating on ethanol and biodiesel Waiving of excise and fuel tax on biofuels	FFVs in the market by 2007	Includes A$3,800 million proposal to use farmland to grow fuel crops 2005 to 2009

a Professor Emilio Lèbre La Rovere, Federal University of Rio de Janeiro, at International Conference for Renewable Energies, Bonn, 1–4 June 2004.

b Salvatore Lazzari, Congressional Research Service, *Alcohol Fuel Tax Incentives* (RL32979), 6 July 2005 (at the time of writing still unreleased), quoted in International Fuel Quality Centre, *Special report: US—New federal ethanol tax incentive to have greater economic value than previous exemption*, 12 July 2005, p. 4.

c A 2000 study by the United States General Accounting Office estimates tax exemption led to this Highway Trust Fund revenue foregone from 1979 to 2000 (http://www.gao.gov/archive/2000/rc00301r.pdf, accessed 20 July 2005.

d Policy commitment by the Ministry of the Environment; note that neither E3 nor ETBE is commercially available in 2005.

Chapter 5 Environmental and health costs and benefits

Synopsis

- The Taskforce considers that a properly designed Australian in-service vehicle emission (tailpipe and evaporative) study, combined with an air quality monitoring programme and including health risk assessment, would be required to assess the air quality impacts of biofuels more effectively.
- Results from recent UK and US studies indicate that the assumption of negligible impact of E10 on particulate matter (PM) tailpipe emissions in the 2003 350 ML Target Report needs to be re-visited. An indicative value of 40% reduction in PM tailpipe emissions over petrol has been adopted for life-cycle and health calculations in this report. However, the Taskforce does not assert that 40% is a scientifically accepted value.
- Given the uncertainties surrounding the level of particulate reduction from E10, it is not possible now to quantify the health costs of E10 use. However, it is useful to give a preliminary indication of the potential health benefits should E10 significantly reduce tailpipe emissions. Under the scenario of 290 ML of ethanol and 60 ML of biodiesel by 2010, the annual costs avoided could lie somewhere between the $3.3 million or 1.4 cents per litre (c/L) (2003 dollars) found by the 2003 350 ML Target Report, and $90.4 million, or 30.4c/L (2004–05 dollars) using the indicative 40% reduction adopted for the Taskforce's analysis.
- The Taskforce considers that extensive experimental work should be carried out to evaluate the impact of E10 and E5 on PM emissions from petrol vehicles under Australian conditions.
- Secondary particles formed in the atmosphere make up about 30% of all particles in Australian cities and more smog-chamber research is needed to understand properly the effect of adding ethanol to petrol on secondary organic aerosol formation.
- The findings on life-cycle analyses for carbon monoxide (CO), hydrocarbons (HC) and NO_x have changed little since the 2003 350 ML Target Report. Emissions of CO are reduced under E10 compared with neat petrol, there is little change in volatile organic compounds (VOC) emissions, and NO_x emissions are increased.
- On life-cycle analysis, savings from E10 in greenhouse gas emissions over neat petrol are generally from 1% to 4%, depending on feedstock. However, a recent life-cycle analysis for a proposed ethanol plant has suggested that savings of between 7% and 11.5% can be achieved with optimum use of non-ethanol co-products.
- The impact on air toxic levels in the atmosphere from the use of E10, relative to petrol, is difficult to assess. Combustion of E10 results in lower tailpipe emissions

of some toxic compounds (e.g. benzene and 1,3 butadiene), but higher levels of others (e.g. the aldehydes).

- Assuming robust modelling, the Taskforce considers it reasonable to conclude that ozone formation arising from waived RVP limits associated with E10 blends is not currently a concern in the Sydney airshed.
- The benefits of the 5% biodiesel blend (B5) diminish against increasingly lower sulphur diesel, with PM emissions even increasing slightly over extra low sulphur diesel (XLSD) (to be introduced in 2009). However, on life-cycle analysis, pure biodiesel (B100) has significant benefits over XLSD for CO, VOC and PM (especially with waste cooking oil as the feedstock), but NO_x emissions increase by between 16 and 30%. The increase in NO_x emissions is a concern, as it could contribute to ozone formation.
- On life-cycle analysis B100 from waste cooking oil produces 90% less greenhouse gas emissions than XLSD. Biodiesel from tallow or canola reduces emissions by less than 30%. There are negligible benefits for canola and tallow-derived B5 against XLSD, though waste cooking oil derived B5 achieves a 3% reduction.
- The Taskforce notes the emission benefits of diesohol and biodiesel and their potential for specialised fleet and off-road applications. Given the significant volume of diesel used in off-road applications, there would be value in a closer examination of opportunities to encourage uptake of biodiesel and diesohol in these applications.
- There are insufficient data at the present time to assess the air toxic emissions from biodiesel.
- Additional care should be taken with the handling and storage of ethanol blended fuel, as studies have shown that E10 increases the risk of groundwater contamination compared with neat petrol.
- Depending on cost-effectiveness, governments could consider tightening the framework of air quality/fuel quality/vehicle particulate emission standards, with the objective of gaining public health benefits.
- Under the target scenario of 148 ML ethanol and 202 ML biodiesel by 2010 as used by ABARE for its 2005 analysis, it is estimated that 442,000 tonnes of CO_2-e will be saved per year. At a greenhouse gas abatement value of $15 per tonne, this gives a value of $6.6 million or 1.9c/L.

Introduction

In this chapter, the Taskforce examines the environmental impacts of the use of ethanol blended with petrol, mainly E10 (a 10% ethanol blend), and biodiesel.

Recently, biofuels have been the focus of attention as a possible means of reducing greenhouse gas emissions, and noxious urban emissions from transport. Results from studies that have been conducted throughout the world on exhaust emissions from ethanol-blended fuels are contradictory, making it difficult to generalise on emission outcomes and performance of ethanol blends. The difficulty is compounded by the fact that tailpipe emissions, and to a certain extent evaporative emissions, vary markedly depending on the exact nature of the petrol with which the ethanol is blended and the exact nature of the vehicles that use the fuel. In addition, the air pollution potential of the resulting emissions depends on the exact nature of the airshed.

Methodology

The Taskforce examined the environmental impact of biofuels on the atmosphere, groundwater and land. For the atmosphere, three classes of emissions are considered: criteria air pollutants (those that have legislated air quality measures), air toxics and greenhouse gases. The findings of the extensive environmental analysis carried out in the 2003 350 ML Target Report were closely examined, with the Taskforce also supplementing these results with more-recent findings.

The 2003 350 ML Target Report used the international standards framework for conducting life-cycle analysis contained in the ISO14040 series (International Standards Organization, 1998). A full fuel-cycle analysis of emissions takes into account not only direct emissions from vehicles but also those associated with the extraction, production, transport, processing, conversion and distribution of the fuel, i.e. both upstream (pre-combustion) emissions and downstream (tailpipe, or combustion emissions) were considered. Under the Kyoto rules for greenhouse gas accounting, the carbon dioxide that is emitted from an automotive fuel that is derived completely from non-fossil sources is not counted as a greenhouse gas. Fuels are compared on the basis of the mass of emissions per kilometre of distance travelled. This figure, though environmentally more meaningful, is subject to greater variability than the mass of emissions per unit energy.

Motor vehicles emit a range of tailpipe or exhaust emissions—regulated pollutants (i.e. emissions regulated under Australian Design Rules), greenhouse gases (GHG), air toxics, particulate matter and secondary pollutants. Exhaust emissions are dependent on a wide range of variables including: driving patterns, fuel type, and various vehicle and engine-specific factors such as design, size, state of tune and type and condition of emission control systems. Thus, there is considerable uncertainty associated with tailpipe (downstream) vehicle emissions from E10 (and most other fuels) and the comparison of data between studies is subject to significant uncertainty. The variability in the emission rates noticed in the literature review of the 2003 350 ML Target Report (Appendix I of that report) is considered in the sensitivity and uncertainty analysis (Appendix X of that report).

There have been very few E10 vehicle emission studies conducted that are relevant to Australian conditions (see Appendix I of the 2003 350 ML Target Report for a review). In Australia very limited studies have been attempted to assess the effects of E10 and biodiesel. Studies that have tested the vehicle combustion of biofuels generally restrict tailpipe emission measurement to the pollutants carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NO_x). Reliable data, in particular, for GHG emissions, particulate matter (PM) and air toxics is generally unavailable.

Conclusion 10: *The Taskforce considers that a properly designed Australian in-service vehicle emission (tailpipe and evaporative) study, combined with an air quality monitoring programme and health risk assessment, would be required to assess the air quality impacts of biofuels more effectively.*

The only significant Australian study into the emissions effect of adding E10 in the Australian vehicle fleet was conducted by APACE Research (APACE, 1998). As part of that study, the NSW EPA conducted the 'Petrohol In-Service Vehicle Emission Study', in which it tested 60 in-service light-duty passenger vehicles over a two-year period from 1995 to 1997. The most thorough overseas fuel oxygenates study was conducted by the US Auto/Oil Air Quality Improvement Research Program (AQIRP), which commenced a comprehensive analysis of fuel oxygenates in a variety of fuel types in 1989. The results from the 2003 350 ML Target Report rely heavily on the APACE and AQIRP studies. The post-1986 vehicle values presented by APACE (1998) were considered as tailpipe averages for that study, with those values then normalised on the basis of the Australian Urban Drive Cycle (AUDC) protocol applied to passenger vehicles. The tank-to-wheel (TTW) emission performance was evaluated for a fuel consumption rate of 4.63 MJ/km.

The Taskforce also reports on findings from the recent study by Orbital Engine Company to develop criteria for determining pollutant emissions from Australian passenger vehicles using E10 (Orbital Engine Company, 2004).

Environmental performance of ethanol

Since the 2003 350 ML Target Report, research on the reduction in PM tailpipe emissions from E10 over petrol has shown significantly different values from the 0.1% figure (less than 1%) used in that study.

This is an important finding and indicates that there is an issue for urgent scientific and technical research, considering the significant linkage between PM and morbidity and mortality. After considering three studies (all overseas), the Taskforce has adopted an indicative value of 40% PM tailpipe reduction over petrol to be used for life-cycle and health calculations in this report. However, the Taskforce does not assert that 40% is a scientifically accepted value.

The submission to the Taskforce from the Australian Institute of Petroleum points out that the 2003 350 ML Target Report assumed that petrol 'displaced' by ethanol would be petrol refined in Australia, whereas it would actually be imported petrol that would be reduced. Under Kyoto rules, a reduction in greenhouse emissions can be credited to Australia if the petrol is refined in this country, whereas it cannot if the petrol is refined overseas.

Consequently, the Taskforce commissioned revised estimates of the life-cycle inventory, for both air pollutants and greenhouse gases, incorporating first the 40% reduction in PM tailpipe emissions compared with petrol and second the reduction in imported petrol assumption. Revised health-cost estimates have also been done for the PM tailpipe reduction scenario.

There are five atmospheric issues on which it is difficult to make firm statements in relation to the environmental performance of ethanol (used as E10) because past studies have produced conflicting results. These are:

1. vehicle emissions of particulates
2. ozone-forming potential of ethanol-blended fuels
3. vehicle emissions of air toxics

4. vehicle emissions of methane and nitrous oxide
5. full fuel-cycle greenhouse gas emissions.

Air pollutant emissions

Introduction

There are six categories of criteria pollutants associated with transport: particulate matter, oxides of nitrogen, carbon monoxide, sulphur dioxide (SO_2), ozone (O_3), and lead (Pb). Of these, ozone is not emitted from tailpipes but is formed from a secondary chemical reaction between NO_x and non-methane volatile organic compounds (denoted by VOC in this report). VOC aggregate many species, including hydrocarbons and air toxics. The pollutants SO_2 and Pb are no longer considered to be environmental problems in Australian urban airsheds, and are not considered further in this report.

The effects of ethanol blends on emission performance depend critically on vehicle technology and, to a lesser extent, on the fuels used. Most pre-1986 vehicles have open-loop emission control with carburettors or mechanical fuel injection. In these systems, the fuel/air ratio has a fixed setting chosen to minimise emissions. The addition of ethanol will result in a leaner mixture (equivalent to a lower fuel/air ratio), reducing HC and CO but with a smaller increase in NO_x. Post-1986 vehicles typically have closed-loop emission control systems with electronic fuel injection. The air/fuel ratio is held constant under normal operation by the engine management computer, which analyses the oxygen content of the exhaust and adjusts the fuel injection. However, there are stages of the drive cycle when the computer cannot fully compensate and the fuel/air ratio is decreased by the addition of oxygen in the ethanol, thereby reducing emissions.

To put the issue into perspective, the Taskforce notes advice from the New South Wales Department of Environment and Conservation that pre-1986 vehicles constitute about 4% of the Sydney fleet, and undertake 2% of vehicle kilometres travelled.

Table 10 displays the percentage change in full life-cycle emissions of the criteria pollutants (on a per km basis) for E10 (obtained from four different ethanol feedstocks), as compared to unleaded petrol (ULP). Note that the health effects of each pollutant vary and no equivalence in health effects should be assumed from similar percentage changes in different pollutants.

E10 effects on particulate matter (PM)

The agricultural and industrial activities involved in the production and processing of the ethanol are expected to increase particulate emissions, on a life-cycle basis. This is primarily a result of the particulate emissions involved in providing energy to the mill, the refinery and the distillery, and is ascribed to PM (urban) in Table 10. If the energy is provided by co-generation (column 2 in Table 10), then not all of the resulting PM emissions are ascribed to the ethanol production. In that case, the PM emissions are lower than those of petrol. In all other cases they are increased, being more than 30% higher.

The conclusion of the 2003 350 ML Target Report that the use of ethanol as E10 in fuels is not expected to significantly alter the tailpipe emissions of PM (a reduction of 0.1% was assumed) was made in the light of very few studies, and none involving Australian data. However since then, Whitten (2004) has pointed out that studies in Alaska (Mulawa et al., 1997) and Colorado (Colorado Department of Public Health and Environment, 1999) have shown that oxygenates in the fuel reduce primary exhaust particulates from petrol vehicles. The only statistically significant result from the Colorado study suggests that with 3.5% oxygen, the PM10 (particulate matter with an aerodynamic diameter of less than 10 μm) reduction at 35°F (2°C) is 36%. The Alaska tests on ten vehicles were also carried out at low temperatures, while tests by US EPA on three of the vehicles at a temperature more appropriate to Australian conditions (24°C) resulted in lower PM10 emissions with E10 for two cars and higher for the other one. Whitten refers to a regression analysis on the Alaskan data that suggests that PM10 was reduced on average by 32% when 10% ethanol fuel was used over all temperatures investigated, with no evidence that the reduction percentage was temperature dependent.

Table 10 Percentage change of full life-cycle air pollutants emissions (as g/km) from E10 and ULP (passenger car) (%)

Impact category (%)	E10 (ULP) (molasses cogen energy)	E10 (ULP) (molasses)	E10 (ULP) (sorghum)	E10 (ULP) (wheat)	E10 (ULP) (wheat starch waste)	*ULP (g/km)*
Upstream						
CO	239.1	238.8	18.5	327.5	20.4	*0.085*
NO_x	4.9	11.3	7.9	20.4	7.2	*0.451*
VOC	3.9	3.6	3.4	6.4	3.4	*0.658*
PM (Urban)	1.0	99.0	110.6	110.2	107.5	*0.007*
PM (Non-urban)	0.3	0.0	–.8	7.9	–3.6	*0.007*
Tailpipe						
CO	–26.9	–26.9	–26.9	–26.9	–26.9	*4.850*
NO_x	5.0	5.0	5.0	5.0	5.0	*0.461*
VOC	–14.4	–14.4	–14.4	–14.4	–14.4	*0.168*
PM	–40.0	–40.0	–40.0	–40.0	–40.0	*0.003*
Life cycle						
CO	–22.3	–22.3	–26.1	–20.8	–26.1	*4.935*
NO_x	5.0	8.1	6.5	12.6	6.1	*0.912*
VOC	0.2	–0.1	–0.2	2.2	–0.2	*0.826*
PM	–7.4	30.8	31.2	38.4	32.6	0.017

Note: A 40% reduction in tailpipe PM emissions has now been assumed for E10 (although this has not been scientifically validated), and petrol 'displaced' by ethanol has been assumed to be imported rather than refined in Australia.
Source: Adapted from the 2003 350 ML Target Report.

Further support for PM10 reductions with E10 comes from a six-vehicle study for the U.K. Department of Transport, in which thirteen drive cycles were run for each vehicle and fuel combination (AEA Technology, 2004). There was a strong indication from cumulative mass emissions averaged over all cycles that the addition of ethanol to the base gasoline fuel markedly reduced the particle mass emissions, with a statistically significant reduction of 46.2%, with 95% confidence limits of 33% and 57%).

In the view of the Taskforce, the results from the UK and US studies indicate that the assumption of negligible impact of E10 on PM tailpipe emissions in the 2003 350 ML Target Report needs to be re-visited. However, caution should be used, as a total of three studies (two in near-zero temperatures) is not robust, and the Taskforce considers that there is an urgent need for further experimental work under Australian conditions on the impact of E10 on PM emissions from petrol vehicles. A value of 40% has been adopted in this report for the PM tailpipe reduction, but in light of the small number of studies and in the absence of any theoretical work explaining the relatively large value of the decrease, the Taskforce stresses that this value should be viewed only as a sensitivity factor to examine the health-cost impact of the 350 ML target. This value has been used in the calculations shown in Table 10. It should be noted that 20% of vehicle-PM10 is currently emitted by petrol vehicles in Melbourne (EPA Victoria, personal communication 2005) and 45% in Sydney (NSW Department of Environment and Conservation, personal communication, 2005). Note also that particulate matter is not a regulated pollutant for petrol vehicles in Australia, although for the first time a PM emissions limit has been proposed by the European Commission for Euro-5 petrol cars, with a possible implementation date of 2008.

Conclusion 11: *Results from recent UK and US studies indicate that the assumption of negligible impact of E10 on PM tailpipe emissions in the 2003 350 ML Target Report needs to be re-visited. An indicative value of 40% has been adopted for life-cycle and health calculations in this report. However, the Taskforce does not assert that 40% is a scientifically accepted value.*

Vehicles emissions not only contribute directly to particle concentrations (primary particles), but also play a part in the formation of secondary particles in the atmosphere. Whitten (2004) claims that the use of ethanol in place of aromatics in blended petrol can be expected to reduce secondary PM, quoting the work of Odum et al. (1997) which showed that in smog-chamber studies the secondary organic aerosol formation potential of a gasoline mixture is the incremental sum of the aromatic hydrocarbons that make up that mixture. However, Beer et al. (2005) claim that other compounds that are equally as reactive as aromatics in terms of secondary organic aerosol production, are present when ethanol is added to fuel. More chamber experiments are required to understand properly the effect on secondary organic aerosol formation of adding ethanol to fuel.

Conclusion 12: *The Taskforce considers that comprehensive experimental work should be carried out to evaluate the impact of E10 and E5 on PM emissions from petrol vehicles under Australian conditions.*

Secondary particles make up about 30% of total particles in Australian cities, with *organic* secondary particles found to be about 15% for Brisbane. The impact of ethanol-blended fuels on the *inorganic* sulphates and nitrates (mainly ammonium) must also be considered. For example, the US EPA (2005) agreed with a submission by the Californian Air Resources Board that ethanol-blended petrol (E6) leads to higher concentrations of secondary ammonium nitrate particles than does non-ethanol petrol, because of higher NO_x emissions with the former. While this result cannot be directly applied to Australia, as secondary inorganic particles constitute a higher proportion of the total particles in California than in Australia (typically 40% as against 15%), it does emphasise the need for further research on the impact of ethanol-blended fuels on particles, given their high ranking on the environmental health agenda.

Conclusion 13: *Secondary particles formed in the atmosphere make up about 30% of all particles in Australian cities and more smog chamber research is needed to understand properly the effect of adding ethanol to petrol on secondary organic aerosol formation.*

E10 effects on CO, NO_x and VOC

Compared to ULP, E10 showed lower CO and VOC tailpipe emissions per kilometre, and slightly higher NO_x. In the upstream processes, CO emissions are considerably higher for E10 than ULP, as are NO_x and VOC.

On a full life-cycle basis, CO emissions are significantly reduced: 1–1.5 g/km lower, corresponding to a 21–26% reduction for E10 compared to ULP. NO_x is 0.1–0.6 g/km higher for E10, which corresponds to an increase of 5 to 12%. There is very little change in VOC emissions, except for wheat feedstock (2%). In general, the assumption that the displaced petrol would be imported petrol, rather than refined in Australia, has increased the difference in NO_x emissions by just over 3% and by 1.5% for VOC.

Since the 2003 350 ML Target Report, a further study on E10 tailpipe emissions from Australian vehicles (Orbital Engine Company, 2004) has been carried out. The trend was the same as for the APACE study in Table 10, with reductions in CO and HCs, and increases in NO_x emissions. There was a difference though between the new and old vehicle groups, with larger HC reductions and smaller CO reductions for the post-1986 vehicles, with little difference for NO_x. PM was not measured.

Conclusion 14: *The findings on life-cycle analyses for CO, HC and NO_x have changed little since the 2003 350 ML Target Report. Emissions of CO are reduced under E10 compared with neat petrol; there is little change in VOC emissions, and NO_x emissions are increased.*

Greenhouse gas emissions

The life-cycle inventory presented here considers the major direct contributors to greenhouse gases: CO_2 (the main GHG), CH_4 and N_2O, using the IPCC global warming potential coefficients. Results are shown in Table 11, which displays the change (%) in full life-cycle GHG emissions (on a per km basis) for E10 (obtained from four different ethanol feedstocks), as compared to ULP. Table 11 also contains the upstream and downstream emission factors (g/km) for ULP.

Ethanol blends require more energy in the upstream processes and result in higher GHG emissions. However, the larger reduction in the combustion of E10 leads to savings of between 0.7 and 4.2% for wheat and molasses co-generation, respectively. This range of emission reductions is consistent with overseas studies reviewed in Appendix II of the 2003 350 ML Target Report.

The impact of the imported petrol rather than locally refined petrol being displaced by ethanol led to reduced savings (by 1%) under Kyoto rules for greenhouse gas accounting (in Table 11) than those achieved when the emissions are not considered to be specific to a particular country.

A more recent study has been done for Primary Energy Pty Ltd for a proposed ethanol plant at Gunnedah (Grant et al., 2005). Under the assumption that the entire ethanol production is dedicated to the transport sector and blended as an E10 product, the results indicate that, when compared to the production of unleaded petrol, a reduction in life-cycle greenhouse gas emissions in the range 8–12.5% would occur, depending on the mix of feedstock. The greenhouse emission reductions are derived from two sources. Approximately half the reduction (4–5%) comes from the ethanol production and usage per se in petrol blends and the other half is associated with non-ethanol co-products. A small contribution comes from efficient and sustainable farming practices. The percentage savings in greenhouse gas emissions for a 50:50 wheat and sorghum feedstock are shown in Table 11 for the various stages of the life cycle. The savings contribution of co-products is accounted for in the upstream impact category. Note that the savings are specific to this proposal and that extrapolation of these results should not be extrapolated beyond this specific proposal without a close examination of the detailed specifications of other proposals.

Note that in light of the Taskforce's acceptance of the AIP submission that imported petrol rather than locally refined petrol would be displaced by ethanol, the greenhouse savings found by Primary Energy Pty Ltd have been re-calculated resulting in a reduction of 1%, and it is these values that appear in Table 11.

While the results in Table 11 are for E10, it should be noted that higher percentage blends lead to greater life-cycle savings. Testing of E85 and E95 blends by Wang et al. (1999) showed 24–26% and 30–32% reductions, respectively. An E10 blend in the Wang et al. study gave 2% savings.

Conclusion 15: *On life-cycle analysis, savings in greenhouse gas emissions from E10 over neat petrol are generally from 1–4%, depending on feedstock. However, the Taskforce considers that a recent life-cycle analysis for a proposed ethanol plant has suggested that savings of between 7 and 11.5% can be achieved with optimum use of non-ethanol co-products.*

Table 11 Percentage change of full life-cycle GHG emissions (as g/km) from E10 relative to ULP (%)

Impact category (%)	E10 (ULP) (molasses cogen energy)	E10 (ULP) (molasses)	E10 (ULP) (sorghum)	E10 (ULP) (wheat)	E10 (ULP) (wheat starch waste)	Primary Energy E10 (ULP) (wheat/ sorghum 50:50)	*ULP (g/km)*
Upstream							
CO_2	11.5	22.5	31.9	33.8	24.6	–36.4	*52.76*
CH_4	–3.4	–2.1	2.1	1.9	-0.4	–77.7	*0.51057*
N_2O	1423.2	1454.3	–1220.8	3279.5	55.6	5534.0	*0.00031*
GHG (CO_2-e)	11.1	20.5	25.0	33.3	20.4	–34.9	*63.5811*
Tailpipe							
CO_2	–7.0	–7.0	–7.0	–7.0	–7.0	–7.0	*340.50*
CH_4	3.7	3.7	3.7	3.7	3.7	3.7	*0.00716*
N_2O	–0.1	–0.1	–0.1	–0.1	–0.1	–0.1	*0.00227*
GHG (CO_2-e)	–7.0	–7.0	–7.0	–7.0	–7.0	–7.0	*341.354*
Life cycle							
CO_2	–4.6	–3.1	–1.8	–1.6	–2.8	–11.0	*393.30*
CH_4	–3.3	–2.0	2.1	1.9	–0.3	–76.4	*0.52*
N_2O	170.3	174.0	–146.2	392.4	6.6	664.3	*0.00*
GHG (CO_2-e)	–4.2	–2.7	–2.0	–0.7	–2.7	–11.4	404.98

Note: A 40% reduction in tailpipe PM emissions has now been assumed for E10, and petrol 'displaced' by ethanol has been assumed to be imported rather than refined in Australia.
Sources: Adapted from the 2003 350 ML Target Report, and Grant et al. (2005).

Air toxic emissions

Air toxics are gaseous, aerosol or particulate pollutants that cause adverse health effects. There is a growing international recognition of the potential health risks associated with exposure to air toxics and of the need for action to minimise these risks. There is evidence that cancer, birth defects, genetic damage, immunodeficiency, and respiratory and nervous system disorders can be linked to exposure to occupational levels of air toxics. Motor vehicles contribute to air toxics in the atmosphere through primary pollutant emissions (unburnt hydrocarbons such as benzene and products of incomplete combustion such as formaldehyde). Results of EPA monitoring to date indicate that levels of air toxics in Sydney, Newcastle and Wollongong are generally low in comparison to comparable cities in Europe and North America.[32]

The comparative risks or benefits to air quality from the use of E10, relative to petrol, are difficult to assess. According to the APACE (1998) and other studies (e.g. Correa et al. (2003) in Brazil), combustion of E10 results in lower tailpipe emissions of some toxic compounds (e.g. benzene and 1,3-butadiene), but higher levels of others (e.g. the

[32] http://www.environment.nsw.gov.au/air/toxics.htm.

aldehydes[33]). More recently, the Orbital Engine Company (2004) found statistically significant results only in the BTEX group of toxics (benzene, toluene, ethylbenzene and xylene) for benzene and toluene for post-1986 vehicles over the highway cycle, indicating average decreases of approximately 24% and 30%, respectively, for these emissions. Acetaldehyde emissions generally increased when using E10 with both new and old (pre-1986 and post-1986) vehicle groups, with the majority of the aldehyde emissions for the post-1986 vehicles emitted during the cold start and warm-up phase of the drive cycle.

The Californian EPA's Office of Environmental Health Hazard Assessment has developed an air toxicity index, based on the cancer potency factors of compounds. Applying this index to the tailpipe emissions (as mg/km) from the petrohol study (APACE, 1998), an air toxic index was calculated (for the compounds formaldehyde, acetaldehyde, benzene and 1,3-butadiene) as shown in Table 12. Based on this method, the air toxicity index is reduced for E10 relative to ULP by 17%. This analysis does not include the impact of evaporative emissions, or the air toxic implications of atmospheric reaction products of the emissions, on the air toxic index, but the impact of the increased evaporative emissions from E10 (benzene) would be expected to offset, to some extent, these calculated improvements in air quality.

Conclusion 16: *The impact on air toxic levels in the atmosphere from the use of E10, relative to petrol is difficult to assess. Combustion of E10 results in lower tailpipe emissions of some toxic compounds (e.g. benzene and 1,3-butadiene), but higher levels of others (e.g. the aldehydes).*

Table 12 Impact of tailpipe toxic emissions from petrohol for pre- and post-1986 vehicles using an air toxic index (ATI) derived from air toxic unit risk factors (California EPA)

	Form-aldehyde	Acet-aldehyde	1,3-butadiene	Benzene	Total ATI	% ATI difference
Unit risk factor ($\mu g/m^3)^{-2}$	*6×10^{-6}*	*2.7×10^{-6}*	*1.7×10^{-4}*	*2.9×10^{-5}*		
Relative potency	*0.035*	*0.016*	*1*	*0.170*		
Air toxic index						
Pre-1986 petrol	1.115	0.121	18.600	11.021	30.857	
Pre-1986 petrohol	1.413	0.385	14.020	9.061	24.879	19%
Post-1986 petrol	0.197	0.036	1.350	2.441	4.024	
Post-1986 petrohol	0.251	0.112	1.230	1.760	3.352	17%

Source: Adapted from the 2003 350 ML Target Report.

Effects on ozone formation

Ozone is not emitted directly from vehicles but is produced under warm temperatures in the atmosphere, from reactions between NO_x, VOC and sunlight.

[33] Aldehydes are photochemically reactive and can cause eye and mucous membrane irritation. They are also suspected carcinogens.

In the early 1990s, the US EPA introduced two programmes to reduce air pollution. Firstly, the winter oxygenate program in 1992 was designed to cut carbon monoxide emissions in areas subject to below-freezing temperatures. This required the addition of 2.7% oxygen to petrol sold in the 39 areas of the country that had not attained the national ambient air quality standard for carbon monoxide. As regards air quality of Australian cities, CO is regarded as one of the least significant criteria pollutants, as CO concentrations here are well below current national ambient air quality standards. In 1995, the US federal reformulated gasoline (RFG) program was introduced. It required oxygenates to be added to petrol in nine extreme or severe ozone non-attainment areas across the US. This necessitated various changes in the composition of gasoline parameters, including a minimum 2.0% oxygen content in fuel (11.5% MTBE or 5.7% ethanol blend).

The oxygenate used was originally MTBE, but this is now being phased-out due to its contamination of groundwater from leaking tanks, and ethanol has largely replaced it in the oxygenate role. However, evaporative emissions of hydrocarbons from an ethanol blend are higher than those from non-ethanol petrol (though HC tailpipe emissions are reduced), causing uncertainty as to its suitability as an oxygenate in areas of high ozone levels. The evaporative emissions can be reduced by decreasing the Reid vapour pressure (RVP) of the petrol component, though this can be a relatively costly refining process.

In 1997, the US EPA, with the National Research Council (NRC), formed The Committee on Ozone-forming Potential for Reformulated Gasoline (RFG) to examine the impact on air-quality benefits of the use of oxygenates within the RFG program. The study (NRC, 1999) concluded that the use of an ethanol-containing fuel with a RVP higher by 1 psi (6.9 kPa) is likely to reduce air quality by increasing ozone levels. Howard (NSTC, 1997) also concluded that the addition of ethanol would result in adverse ozone impacts associated with increased NO_x and VOC emissions.

The CSIRO component of the petrohol study (APACE, 1998) conducted VOC speciation of samples from 11 vehicles and estimated the effects of E10 on ozone forming potential (OFP), accounting for the different reactivities of the VOCs present, and found little or no change (+0.24%) overall in total OFP after weighting exhaust and evaporative emissions.

The OFP results are merely an indication and should be treated with caution, as ozone formation is a function of the characteristics of a particular airshed. Photochemistry is a non-linear process and depends on a number of variables that include the ratio of the VOC and NO_x concentrations and the magnitude of their absolute levels. Also, if an airshed is NO_x-limited (i.e. at some stage during the day all NO_x has been consumed) then additional VOC will not strongly affect the ozone levels. Conversely, additional NO_x will increase ozone levels. Generally, it is thought that the airsheds of major Australian cities are not NO_x-limited for single-day ozone events, but may become NO_x-limited if the photochemical plume remains in the airshed for more than one diurnal cycle.

Recently, California applied for exemption from the federal RFG program (requiring compulsory oxygenation) on the grounds that the addition of ethanol leads to higher ozone concentrations in that state. A request for exemption is a statutory process, taking into account both scientific and non-scientific factors. The US EPA, while agreeing that ethanol in California fuel leads to higher emissions of both NO_x and VOC and, by extension, ozone, ruled against an oxygenate exemption (US EPA, 2005). The grounds for the decision were that California did not clearly demonstrate that an oxygenate waiver would in fact accelerate attainment of an air quality standard for ozone or would clearly avoid a delay of attainment. They also considered that granting California's request for a waiver would reduce fossil fuel savings gained from the use of ethanol, and would generate less support for agricultural and rural economies.

Modelling

Although it is acknowledged that emissions of the ozone precursor gases NO_x and VOC increase and CO decrease in ethanol blends, the actual impact on ozone concentrations is uncertain because ozone production is strongly related to the airshed under consideration, being particularly dependent on meteorological conditions, topography and the emissions of ozone precursors from *all* sources, the major sources being motor vehicles, industry, and vegetation (biogenics). Modelling with a complex chemical transport model is one means of taking all these factors into account.

In 2004, the NSW Department of Environment and Conservation (DEC, formerly EPA NSW) commissioned CSIRO to examine the impact on air quality of the introduction of E10 into Sydney. Using a complex-chemistry airshed model, Cope et al. (2005) examined the air quality changes that may result if the Sydney motor vehicle fleet switches from unleaded petrol to unleaded petrol blended with 10% (by volume) ethanol. The impact of the changed fuel characteristics was assessed for photochemical smog (as ozone). Scenarios in which E10 is used by 12%, 50% and 100% of the petrol motor vehicle fleet were modelled. Five different high-ozone events were simulated and the impact of uncertainty in evaporative emissions was examined.

For E10-fuelled vehicles, exhaust emission factors were derived from the petrohol study (APACE, 1998). Compared to vehicles running on unblended fuel, tailpipe emissions from E10-fuelled vehicles were reduced by 29% for CO, by 14% for VOCs, and increased by 5% for NO_x.

In the case of evaporative VOCs, emissions rates were estimated based on the assumption that a 10% ethanol blend (for an unblended fuel RVP of 62 kPA) would lead to a 7 kPA increase in RVP. As a result, evaporative VOC emissions were estimated to increase by approximately 45% compared to the rate assigned to vehicles fuelled by unblended petrol. To illustrate the relatively small impact on total airshed emissions, even in the case of the 100% E10 fleet penetration scenario, daily emission totals for surface-based anthropogenic sources in the Metropolitan Air Quality Study region for NO_x and VOC are projected to increase by 1.4% and 7.1%, respectively, while CO emissions are projected to decrease by 20%.

Because the evaporative VOC emission rates are subject to considerable uncertainties, a third set of emission scenarios was developed in which the evaporative emission rates were varied by ±50% of the best case estimates.

The modelling undertaken using the extreme E10 emissions scenario (100% fleet penetration) and five different meteorological conditions (14 days) characteristic of those observed during Sydney photochemical smog episodes, predicted a maximum *increase* of 2% or less to peak 1-hour and 4–hour ozone concentrations. This level of increase is reduced by an order of magnitude in the case of the more realistic 12% E10 fleet penetration scenario. Note also that an ozone *decrease* was predicted on 70% of days.

When the meteorological variability was combined with a ±50% systematic variation in the fleet-average evaporative VOC emission rates, the level of peak ozone concentration change for a 12% E10 fleet penetration ranged from a 0.5% reduction to a 0.2% increase. Even for the unlikely scenario of 100% E10 fleet penetration, the concentration change ranged from 4% reduction to a less than 2% increase. The modelling findings enabled the implementation of regulated summer petrol volatility limits with a 7 kPa RVP waiver for 10% ethanol blends for a three-year period, from 2004 to 2007.

This does not necessarily mean that ethanol–petrol blends are better for ozone. The CSIRO study showed both increases and decreases in modelled ozone concentrations (depending on the meteorological situation), indicating the complexity of ozone formation. In time, depending on how the chemical mix in Sydney's airshed changes, and given expected improvements in the inputs into the modelling process, future modelling may show a different ozone impact from ethanol blends.

The current RVP waiver for E10 blends applies only for the duration of the regulation (i.e. to 1 September 2007). DEC will be commissioning further modelling before the remake of the regulation in 2007 to review the appropriateness of the higher limit for ethanol petrol blends and will decide on the appropriate means of treating E10 blends based on the best science available at the time. Therefore, a decision on whether or not the current waiver for E10 blends will apply beyond 1 September 2007 will be taken by DEC in 2007.

In Queensland, the regulation that contains the RVP limits does not have a sunset clause (unlike NSW), though it would be picked up in the next ten-yearly review of regulations in 2008. The EPA is doing some modelling for the south-east Queensland airshed that covers E10 and will keep RVP under review (D. Wainwright, EPAQ, personal communication 2005).

Conclusion 17: *Assuming robust modelling, the Taskforce considers it is reasonable to conclude that ozone formation arising from waived RVP limits associated with E10 blends is not currently a concern in the Sydney airshed.*

Environmental performance of biodiesel

This section presents, from the 2003 350 ML Target Report, the emission results per km for low-sulphur diesel (LSD) (S < 500 ppm), ultra low-sulphur diesel (ULSD) (S < 50 ppm, and the standard from 1 January 2006), and extra low-sulphur diesel (XLSD) (S < 10 ppm and the standard from 1 January 2009). The section also presents emission results for canola oil, tallow, and waste oil.

The estimation of the environmental performance of biodiesel was based on combustion testing data presented in the US studies of Graboski et al. (1999), Sharp (1998), and US EPA (2002). The variability in the emission rates described in the literature review was considered by the 2003 350 ML Target Report in an uncertainty analysis, and a normalisation process—to a typical vehicle—was then carried out.

The results presented in this section are restricted to rigid trucks. A complete emission data set is, however, provided in Appendix VII of the 2003 350 ML Target Report, providing the greenhouse gases (GHG) and air pollutant emission rates for the other three categories of vehicles: 4WD, buses, and articulated trucks.

Air pollutant emissions

Tables 13, 14 and 15 present the change (%) in the air pollutant emission rate (per km) of CO, NO_X, VOC, and PM for blend fuels containing 100% biodiesel (BD100), 20% biodiesel (BD20) and 5% biodiesel (BD5), respectively, in relation to LSD, ULSD, and XLSD diesel-base fuels. Again, it is noted that the health effects of each pollutant will vary, and no equivalence in health effects should be assumed from similar percentage changes in different pollutants. Tables examining the emissions per km from 100% biodiesel, and from each of the three diesel-base fuels blended with 20% and 5% of the three biodiesel fuels are presented in Appendix VII of the 2003 350 ML Target Report.

Table 13 Percentage change of full life-cycle air pollutant emissions (as g/km) from BD100, LSD, ULSD, and XLSD (rigid truck) (%)

Impact category (full life cycle) (% change to each diesel type)	Biodiesel (canola) BD100	Biodiesel (tallow) BD100	Biodiesel (waste oil) BD100	LS diesel	ULSD diesel (from 2006)	XLSD diesel (from 2009)
To LSD						
CO	–27.43	–36.86	–47.04	base	–0.26	–1.6
NO_x	6.23	4.9	–5.35	base	–9.04	–18.25
VOC	–32.2	–35.04	–49.77	base	–8.26	–12.75
PM	–32.03	–32.6	–38.64	base	–19.91	–23.56
To ULSD						
CO	–27.24	–36.7	–46.91	0.26	base	–1.35
NO_x	16.79	15.33	4.1	9.94	base	–10.12
VOC	–26.11	–29.2	–45.24	9.0	base	–4.9
PM	–15.14	–15.83	–23.4	24.86	base	–4.55
To XLSD						
CO	–26.25	–35.83	–46.2	1.63	1.37	base
NO_x	29.94	28.31	15.8	22.32	11.26	base
VOC	–22.32	–25.55	–42.43	14.61	5.14	base
PM	–11.1	–11.82	–19.73	30.82	4.77	base

Source: Adapted from the 2003 350 ML Target Report

Table 14 Percentage change of full life-cycle air pollutant emissions (as g/km) of BD20 relative to LSD, ULSD, and XLSD (rigid truck)

Impact category (full life cycle) (% change to each diesel type)	Biodiesel (canola) BD20	Biodiesel (tallow) BD20	Biodiesel (waste oil) BD20
To LSD			
CO	–17.0	–18.68	–20.47
NO_x	–4.71	–4.94	–6.74
VOC	–19.75	–20.25	–22.84
PM	–14.33	–14.42	–15.5
To ULSD			
CO	–16.08	–17.74	–19.54
NO_x	2.51	2.25	0.27
VOC	–13.18	–13.72	–16.54
PM	–4.37	–4.5	–5.81
To XLSD			
CO	–14.13	–15.81	–17.63
NO_x	12.53	12.24	10.04
VOC	–10.34	–10.91	–13.88
PM	–5.75	–5.87	–7.27

Source: 2003 350 ML Target Report

Table 15 Percentage change of full life cycle air pollutant emissions (as g/km) of BD5 relative to LSD, ULSD, and XLSD (rigid truck)

Impact category (full life cycle) (% change to each diesel type)	Biodiesel (canola) BD5	Biodiesel (tallow) BD5	Biodiesel (waste oil) BD5
To LSD			
CO	–14.35	–14.77	–15.21
NO_x	–3.96	–4.02	–4.47
VOC	–15.33	–15.45	–16.1
PM	–2.72	–2.77	–3.02
To ULSD			
CO	–13.41	–13.82	–14.27
NO_x	6.41	6.35	5.85
VOC	–8.17	–8.3	–9.01
PM	–2.14	–1.85	–2.17
To XLSD			
CO	–11.27	–11.69	–12.14
NO_x	10.9	10.81	10.27
VOC	–4.92	–5.07	–5.8
PM	0.08	0.06	–0.28

Source: 2003 350 ML Target Report

The main findings for the pure biodiesels were that:

- CO, VOC, and PM emissions from pure biodiesel are lower than those from all the diesel base fuels
- NO_x emissions from pure canola and tallow biodiesel were higher than for all diesel fuels, and the difference increased with the reduction in sulphur content (less than 6% or 1 g/km for canola, but more than 30% or 3 g/km for XLSD)
- NO_x emissions from waste oil biodiesel were lower than from LSD with 5%, but higher than ULSD with 4% or than XLSD with 16%
- PM emissions from canola and tallow biodiesel are 32% lower than the emissions from LSD, 16% lower than the emissions from ULSD, and 11–12% lower than the emissions from XLSD
- the range of reductions in PM emissions from use of used cooking oil is 39% (LSD) to 20% (XLSD).

Similar findings were obtained with 20% canola biodiesel:

- CO, VOC, and PM were reduced when replacing diesel (regardless of the sulphur content) with 20% canola BD20; these benefits increase from canola oil to waste oil biodiesel, but decrease when the sulphur content decreases (the benefits from LSD to XLSD base diesel fuels)
- on average, the CO emissions benefit diminished from about 0.6 g/km for LSD to 0.5 g/km for XLSD for all biodiesel fuels
- VOC reductions were 0.3–0.35 g/km for biodiesel blends compared to LSD and 0.1–0.2 g/km when the base diesel fuel was XLSD
- PM emission benefits diminished considerably when the base diesel fuel had less than 50 ppm sulphur (the 65–70 g/km PM benefits using BD20, relative to LSD, were reduced to 20–25 g/km relative to ULSD and XLSD)
- BD20 NO_x emissions were 4% lower than from LSD, but higher than the ULSD (2%) and XLSD emissions (10–12%).

For 5% biodiesel blends, CO and VOC emission benefits were still evident, but NO_x emissions were higher for biodiesel blends than for ULSD or XLSD, and PM emissions are similar to those from diesel. This suggests that 5% blends may not be effective as a VOC reduction strategy after 2006, or reduce both VOC and PM after 2009. This is because, after 1 January 2006, the standards for sulphur content become less than 50 ppm, and after 2009, the standards for sulphur content will be less than 10 ppm, in which case the biodiesel blends become even less competitive.

The results presented above suggest that biodiesel obtained from waste oil is a marginally more environmentally friendly fuel than canola and tallow feedstocks (for combustion in rigid trucks).

General conclusions from this analysis were:

- all criteria air pollutants except NO_x were significantly decreased when replacing LSD with biodiesel

- CO and VOC emissions were lower for all types of biodiesel—pure or blend—when compared to ULSD, but NO_x emissions from biodiesel were higher
- with diesel sulphur contents less than 50 ppm, only pure biodiesel or 20% biodiesel blend had lower PM emissions than diesel
- the 5% biodiesel blend was less environmentally friendly than ULSD in terms of particulate matter.

The further reduction in sulphur content accentuated the increase in NO_x emissions between XLSD and biodiesel and diminished the benefits of CO and VOC.

Since the 2003 350 ML Target Report, emission tests on B20 vehicles by Newcastle City Council (Newcastle City Council, 2004) have shown reductions in tailpipe PM10 of 39% over those from LSD (< 500 ppm), and trials by Camden Council (Camden Council, 2005) of B100 on waste-collection trucks produced a 91% decrease of PM10 tailpipe emissions over ULSD. Both of these results are considerably higher than those reported in the review in Appendix I of the 2003 350 ML Target Report.

Conclusion 18: *The benefits of the 5% biodiesel blend (B5) diminish against increasingly lower sulphur diesel, with PM emissions even increasing slightly over XLSD (to be introduced in 2009). However, on life-cycle analysis, pure biodiesel (B100) has significant benefits over XLSD for CO, VOC and PM (especially with waste cooking oil as the feedstock), but* NO_x *emissions increase by between 16% and 30%.*

Greenhouse gas emissions

Table 16 presents the change (%) in the life-cycle GHG emissions per km (for rigid trucks) resulting from using pure biodiesel compared to LSD, ULSD, and XLSD diesel-base fuels. Table 17 shows the change (%) in GHG emissions for BD20 compared to LSD, ULSD, and XLSD diesel-base fuels, and corresponding results for BD5 are presented in Table 18. Tables examining the GHG emissions (per km) from 100% biodiesel, and from each of the three diesel base fuels blended with 20% and 5% of the three biodiesel fuels, are presented in Appendix VII of the 2003 350 ML Target Report.

Table 16 Percentage change of full life cycle GHG emissions (CO_2-e) of BD100 relative to LSD, ULSD, and XLSD (rigid truck) (%)

GHG as CO_2-e (% change to each diesel type)	Biodiesel (canola) BD100	Biodiesel (tallow) BD100	Biodiesel (waste oil) BD100	*LS diesel*	*ULSD diesel*	*XLSD diesel*
To LSD						
GHG (upstream)	341.7	306.8	–44.3	base	10.77	20.69
GHG (tailpipe)	–98.9	–98.9	–98.9	base	–2.18	–3.75
GHG (life cycle)	**–22.96**	**–29.0**	**–89.5**	**base**	**0.05**	**0.46**
To ULSD						
GHG (upstream)	298.8	267.2	–49.7	–9.7	base	8.95
GHG (tailpipe)	–98.9	–98.9	–98.9	2.2	base	–1.6
GHG (life cycle)	**–23.0**	**–29.0**	**–89.5**	**–0.05**	**base**	**0.41**
To XLSD						
GHG (upstream)	266.0	237.0	–53.9	–17.14	–8.22	base
GHG (tailpipe)	–98.8	–98.8	–98.8	3.9	1.63	base
GHG (life cycle)	**–23.32**	**–29.3**	**–89.5**	**–0.46**	**–0.41**	**base**

Source: 2003 350 ML Target Report

Table 17 Percentage change of full life cycle GHG emissions (CO_2-e) of BD20 relative to LSD, ULSD, and XLSD (rigid truck) (%)

GHG as CO_2-e (% change to each diesel type)	Biodiesel (canola) BD20	Biodiesel (tallow) BD20	Biodiesel (waste oil) BD20
To LSD			
GHG (upstream)	57.6	51.4	–10.42
GHG (tailpipe)	–22.4	–22.4	–22.4
GHG (life cycle)	**–8.65**	**–9.7**	**–20.36**
To ULSD			
GHG (upstream)	51.84	46.3	–9.5
GHG (tailpipe)	–21.6	–21.6	–21.6
GHG (life cycle)	**–7.62**	**–8.7**	**–19.32**
To XLSD			
GHG (upstream)	48	42.93	–8.22
GHG (tailpipe)	–21	–21	–21
GHG (life cycle)	**–6.7**	**–7.76**	**–18.34**

Source: 2003 350 ML Target Report

Table 18 Percentage change of full life cycle GHG emissions (CO_2-e) of BD5 relative to LSD, ULSD, and XLSD (rigid truck) (%)

GHG as CO_2-e (% change to each diesel type)	Biodiesel (canola) BD5	Biodiesel (tallow) BD5	Biodiesel (waste oil) BD5
To LSD			
GHG (upstream)	13.9	12.3	–3.08
GHG (tailpipe)	–4.86	–4.86	–4.86
GHG (life cycle)	**–1.6**	**–1.9**	**–4.55**
To ULSD			
GHG (upstream)	14.27	12.9	–1.05
GHG (tailpipe)	–4.9	–4.9	–4.9
GHG (life cycle)	**–1.5**	**–1.5**	**–4.18**
To XLSD			
GHG (upstream)	15.17	13.9	1.16
GHG (tailpipe)	–4.1	–4.1	–4.1
GHG (life cycle)	**–0.1**	**–0.4**	**–3.04**

Source: 2003 350 ML Target Report

The main findings were:

- the upstream processes of growing and harvesting canola lead to high GHG emissions (4.4 times higher than LSD and 3.7 times higher than XLSD)
- the tailpipe GHG emissions are almost zero, which results in a saving in GHG emissions between 23% and 90% (or 230 g CO_2-e/km when replacing any type of diesel with BD100 canola, 289 g CO_2-e/km when replacing with BD100 tallow, and 894 g CO_2-e/km when using BD100 waste oil)—see Appendix VII of the 2003 350 ML Target Report
- the extra upstream processing required for reducing the sulphur content results in higher GHG emissions for ULSD and XLSD
- the highest savings in GHG emissions are obtained by replacing base diesel with biodiesel from waste oil (894 g CO_2-e/km for LSD to 898 g CO_2-e/km for XLSD).
- the large differences between the upstream emissions of tallow and waste oil are based on the assumption that the tallow is being taken from existing market uses and is not a waste product, whereas the waste oil is taken to be a true waste, with no existing market—if low-grade tallow with no other viable markets was available, its emission profile would be the same as that of the waste oil
- when blends with 20% biodiesel are analysed, the highest savings in GHG emissions are again obtained by replacing base diesel with biodiesel from waste oil: savings of 20.4% when the base fuel is LSD and 18.34% when the base fuel is XLSD (or, in absolute values, 204 g CO_2-e/km for LSD base diesel to 180 g CO_2-e/km for XLSD base diesel).
- in the case of 20% tallow blends, the life cycle GHG savings per km from the use of biodiesel are in the range 9.7% to 7.7% (97 to 77 g/km) when the base fuel changes from LSD to XLSD

- in the case of 20% canola blends, the life cycle GHG savings per km vary between 8.65% to 6.7% (86 and 67 g/km) when the base fuel changes from LSD to XLSD.
- blends with 5% biodiesel lead to much smaller GHG savings: the average savings are between 45 g CO_2-e/km to 30 g CO_2-e/km for waste oil blends when base diesel fuel changes from LSD to XLSD; 19 to 4 g CO_2-e/km for tallow biodiesel; 16 to 1.4 g CO_2-e/km for canola oil biodiesel.

Conclusion 19: *On life-cycle analyses, B100 from waste cooking oil produces 90% less greenhouse gas emissions than XLSD. Biodiesel from tallow or canola reduces emissions by 23% and 29%, respectively. There are negligible benefits for canola or tallow derived B5 against XLSD, though waste cooking oil achieves a 3% reduction.*

Whilst the Taskforce noted opposition to diesohol for transport applications from transport industry stakeholders, the potential use of diesohol in stationary fuel applications, particularly in the mining sector, is significant. A major attraction of diesohol is a reduction in greenhouse gas emissions on a life-cycle basis. CSIRO (Beer et al., 2000) report a 6–7% reduction. Biodiesel offers even higher greenhouse reductions as well as other environmental advantages, particularly in mining and sensitive marine environments.

Recipients of more than $3 million in annual fuel excise credits, and proponents of large energy resource development projects, are required to demonstrate effective management of their greenhouse gas emissions through membership of the *Greenhouse Challenge* programme. Much of the diesel consumed by these activities is in off-road applications, where the attributes of these fuels can be marketed.

Conclusion 20: *The Taskforce notes the emission benefits of diesohol and biodiesel and their potential for specialised fleet and off-road applications. Given the significant volume of diesel used in these applications there would be value in a closer examination of opportunities to encourage uptake of biodiesel and diesohol.*

Air toxic emissions

Sharp (1998) analysed transient exhaust emissions from three diesel engines running on diesel, biodiesel, and 25% blend biodiesel with diesel. The results indicated that a similar C_1 to C_{12} mix of compounds was present in the exhaust when using neat biodiesel, BD20 or diesel, but the mass of the compounds was significantly reduced on biodiesel compared to diesel (50% in two engines and 30% in the other). The biodiesel and diesel exhaust hydrocarbons both had about the same reactivity in terms of ozone formation (5–6 g O_3 per g of hydrocarbons).

The 20% biodiesel blend demonstrated many of the trends of neat biodiesel, but proportionally smaller, according to the biodiesel concentration. More importantly, the biodiesel blend did not generate any compounds that were not already present with the neat fuels.

Similar findings have been presented by Graboski et al. (1999) from the Colorado Institute for Fuels and Engine Research in 1999. The tests were performed on 27 neat biodiesels (from seven feedstocks) and 3 blends of BD20. Regarding air toxics, the aldehyde emissions from various biodiesels were not significantly different from the aldehyde emissions from the certification diesel fuel. There were also attempts to perform chemical analysis of gaseous hydrocarbons—both dilute and undiluted exhaust streams—but the qualitative findings suggested no difference between certification diesel and biodiesel.

The most comprehensive study on the sensitivity of exhaust emissions from use of biodiesel blends is the US EPA (2002) study. This study included not only the regulated air pollutants from 39 studies[34], but also a small amount of data on gaseous toxics. The results were considered only 'preliminary and potentially indicative of the true effects', due to the limited nature of data (p. 85). The study investigated 21 mobile air toxics, including 6 metals, MTBE, and acetaldehyde, acrolein, benzene, 1,3-butadiene, ethylbenzene, formaldehyde, polycyclic organic matter, styrene, toluene and xylene.

The study found a significant correlation between the percentage change in aggregate toxics and biodiesel concentration in the blend.

These studies indicate that total air toxics, polycyclic aromatic compounds (PAH) and n-PAH emissions decline with biodiesel. Aldehydes appear to diminish, or stay the same, as Graboski et al. (1999) found, but a study by Krahl (1997) cited by Deni Greene Consulting Services (2002), showed a 20% rise in aldehydes (p. 29). Inconsistent results also appear for benzene, 1,3-butadiene, and toluene (increase or decrease), and show that more research is required to identify the potential effects of biodiesel on the air toxics. It is especially important to take account of all factors such as: type of vehicle, driving cycle/test, type of biodiesel, and of biodiesel in the blend.

Conclusion 21: *There is insufficient data at the present time to assess the air toxic emissions from biodiesel.*

Effects on ozone formation

The only significant negative impact of biodiesel blends on air quality is the increased tailpipe emissions of NO_x, which could contribute to an increase in ozone production. The influence of biodiesel fuels, including rapeseed oil fuels, on the formation of photochemical smog, whose main component is ozone, is especially relevant for all of Australia's major cities, where the projected growth of population and transport will continue to provide challenges in meeting ambient air quality NEPM standards for ozone (DOTARS, 2004).

The 2003 350 ML Target Report stated that there are reduced emissions of evaporative HC (C_1 to C_{12} range) for biodiesel and that the relative reactivity of speciated hydrocarbons with biodiesel was similar to that observed with diesel exhaust hydrocarbons. The speciated HC emissions (exhaust plus evaporative) from biodiesel should therefore result in a lower overall ozone-forming potential than for speciated diesel hydrocarbons.

Conclusion 22: *The only significant negative impact of biodiesel blends on air quality is the increased tailpipe emissions of NO_x, which could contribute to an increase in ozone production.*

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[34] The studies by Sharp (1998) and Graboski et al. (1999) were included in the US EPA analysis.

Other environmental impacts

Groundwater

In the United States, MTBE is being phased out as an oxygenate in fuels due to its contamination of groundwater. In a comprehensive review, Niven (2005) refers to 16 publications suggesting that there are also water-contamination problems with ethanol. Ethanol reduces the interfacial tension of petrol and water, enabling the ethanol–petrol non-aqueous phase liquid (NAPL) to enter smaller pore spaces, and to infiltrate more easily into the watertable. Once in contact with ground- or surface water, the presence of ethanol increases the solubility of petroleum constituents in the groundwater. In particular, the toxics benzene, toluene, ethylbenzene and xylene (BTEX) are rendered more soluble by amounts between 30 and 210%. However, it is noted that there is less benzene in ethanol blends than in petrol. In addition, ethanol inhibits the biodegradation of these pollutants, with the net result that plumes of petrol-contaminated groundwater are able to extend further than those from non-ethanol petrol. Niven quotes a study of contaminated sites where the mean length of benzene plumes from E10 sites was 36% longer than those from petrol sites. Ethanol itself has a very short half-life of 4.1 days and is readily biodegradable.

While the issue of contamination of groundwater by ethanol cannot be ignored, it is the view of the Taskforce that these research findings serve more to guide the design of infrastructure and handling procedures for ethanol than to be used as a recommendation against the use of ethanol in blended fuels.

In the US, ethyl tertiary butyl ether (ETBE) is being used as an oxygenate, though to a much lesser extent than ethanol. In Europe, both MTBE and ETBE are allowable in fuels, with ETBE more widespread than ethanol. ETBE has a slightly higher octane rating than MTBE and a significantly lower blending RVP than MTBE.

To the extent that ETBE has been studied, it appears to have similar, but not identical, chemical and hydrogeologic characteristics to MTBE. It has high solubility and low biodegradability in groundwater, leading to increased detections in drinking water. In 1999, US EPA’s Blue Ribbon Panel on oxygenates in gasoline recommended accelerated study of the health effects and groundwater characteristics of ETBE and other oxygenate ethers before their widespread use was permitted (US EPA, 1999). In 2001, the Californian Department of Health Services added ETBE to a list of the unregulated chemicals for which monitoring of drinking water is required, though there is currently no standard.

In Australia, ETBE has yet to be evaluated for approval as an oxygenate. In view of its having chemical and hydrogeologic properties similar to those of MTBE (already banned in Australia), there may be no reason to consider it.

Conclusion 23: *Additional care should be taken with the handling and storage of ethanol blended fuel, as studies have shown that E10 increases the risk of groundwater contamination.*

Land

While the feedstock for a 350 ML biofuel target can be sourced from existing crops, further expansion of the industry may require farming of additional land, with attendant use of pesticides and fertilisers. A submission raised the point that there is considerable concern over nutrient and pesticide impacts—especially from cane farming—on the Great Barrier Reef along the Queensland coast (Baker et al. 2003). However, to the degree that biofuels will draw feedstock away from current uses such as export, there need be no significant additional land use. In addition, any impacts should be managed by normal state land-use management regimes.

Benefits of avoided health costs and GHG emissions reductions

Avoided health costs

Epidemiological studies have shown a link between concentrations of toxic substances in urban airsheds and morbidity and mortality rates amongst residents. The common criteria ambient air pollutants—CO, NO_x, O_3, SO_x, PM and lead—are associated with a large range of non-cancerous health effects, from temporary impairment of lung function to increases in mortality. Toxic substances, such as benzene and polycyclic aromatic hydrocarbons (PAH), also affect human health. Motor vehicle use in urban areas makes a significant contribution to the concentration of criteria and toxic pollutants in these airsheds. The health impacts of these pollutants are summarised in the following:

- Particles can aggravate existing respiratory and cardiovascular disease, resulting in increased hospital admissions, emergency room visits and increases in daily mortality. Decreases in lung function, exacerbation of asthma and alteration in the body's defence mechanisms and lung clearance mechanisms have also been associated with airborne particles. These effects have been observed at annual average concentrations below 20 $\mu g/m^3$ as PM2.5, or 30 $\mu g/m^3$ as PM10 (WHO, 2000). It is not yet clear how exposure to low ambient mass concentrations of particulates might produce the health effects observed in epidemiological studies and whether certain attributes of particles may be more closely associated to these health effects. Lung cancer is also being linked to long-term effects of particles through epidemiological studies. Metal content of particles, particle size, and particles as carriers of other toxic compounds (such as gases or biological toxins from bacteria and pollens) are currently being investigated for their roles in producing health effects (Health Effects Institute, 1999).
- While the majority of studies on health and particles involve PM10, the submission by Dr Kearney (University of Sydney) points out that there is increasing evidence that the adverse health effects of particulates are more closely associated with the PM2.5, fine particle size fraction. The current emissions inventory for Melbourne (2001) suggests that PM2.5 constitutes 70% of the vehicle exhaust emissions of PM10. Research is also moving towards ultrafine particles (PM0.1), as they can be inhaled deeper and are more readily deposited in the lower respiratory tract, and have been implicated in respiratory and

cardiovascular morbidity and mortality. A health-based ambient standard is set for PM10 and a monitoring standard has recently have been introduced for PM2.5.[35]

- The US EPA estimates that mobile (car, truck, and bus) sources of air toxics account for as many as half of all cancers attributed to outdoor sources of air toxics. This estimate is not based on actual cancer cases, but on models that predict the maximum number of cancers that could be expected from current levels of exposure to mobile source emissions. Benzene, for instance, is a known human carcinogen, while formaldehyde, acetaldehyde, 1,3-butadiene and diesel particulate matter are probable human carcinogens. In Australia, an air toxics measure[36] exists to provide a framework for monitoring, assessing and reporting on ambient levels of five air toxics, benzene, formaldehyde, toluene, xylenes and PAHs, which will assist in the collection of information for the future development of national air quality standards for these pollutants.
- The effects of SO_2 and NO_2 (both known as acid gases) on human health include respiratory problems and damage to the immune system.
- Ozone is the main constituent of photochemical smog. It affects the linings of the throat and lungs, restricting the air passages, and makes breathing difficult. It also increases the risk of respiratory infections. Other substances in the oxidant mix increase the effect of ozone and produce eye irritation.
- Carbon monoxide reduces the oxygen-carrying capacity of blood.

The health costs of vehicle pollutants are uncertain, with empirical estimates varying considerably, particularly estimates of the health cost of particulate matter (PM) emissions. Among all vehicle pollutants, recent empirical studies have generally found PM emissions to have the highest unit health cost, and also to exhibit the widest range of variation in health costs.

There is a range of issues associated with the measurement and application of unit health costs to the cost of vehicle emissions. A BTRE (2005) study identifies two of these issues as of particular concern: multi-collinearity between pollutants, and the consequent risk of double counting health costs; and short-term versus long-term effects.

Multi-collinearity among pollutants makes it difficult to distinguish, statistically, between the health effects of different pollutants. BTRE (2005) cautions against summing the health costs for different pollutants because of the risk of double counting the health effects. Instead, they recommend using a single pollutant, PM, as a proxy for measuring total health costs. BTRE (2005) also recommends the use of long-term health costs, in preference to short-term health costs, because the short-term health costs may understate the morbidity costs attributable to pollutant levels.

Despite these concerns, the 2003 350 ML Target Report costed the health impact arising from a range of pollutants and summed them to derive the total health cost. Any errors arising from double counting are likely to be small, as the health costs of PM emissions dominate the total cost estimates, contributing well over 90% of the

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[35] www.ephc.gov.au/nepms/air/air-varation.html
[36] http://www.ephc.gov.au/pdf/Air_Toxics/FinalAirToxicsNEPM.pdf

change in total health costs. To allow for comparability with the 2003 350 ML Target Report, the results presented in this section estimate the health cost of the change in total emissions resulting from 350 ML of biofuel consumption in 2010.

The health costs depend on both the size and location of any changes in emissions, and the unit health costs assumed for each pollutant. In estimating the impact on total health costs resulting from an increase in biofuels consumption, assumptions were made about the location of production facilities and where consumption of biofuels is most likely to occur. The study has drawn on recently published estimates of the unit health costs of vehicular pollutant emissions. At present, the health costs of air toxics such as acetaldehyde and benzene are incorporated into costings and valuations for VOC emissions.

Biofuel use assumptions

For the purposes of modelling avoided health costs and greenhouse gas reductions, two scenarios have been considered, with results in tables 21 and 22.

Scenario 1 148 ML ethanol and 202 ML biodiesel (as selected by ABARE for its 2005 analysis).

Scenario 2 290 ML ethanol and 60 ML biodiesel (the mix considered in the 2003 350 ML Target Report), assuming current plant design.

In order to present biofuels with the best possible benefits under the assessments, scenario 2 was chosen for air quality and scenario 1 was chosen for greenhouse gas emissions.

At present, most of the ethanol used in transport in Australia is generally consumed in the greater Sydney metropolitan area (taking in Newcastle–Sydney–Wollongong), close to the location of the majority of current production (Manildra's ethanol refinery near Nowra). It is assumed that most of the ethanol produced (under a business as usual scenario (85 ML))in 2010 will be consumed in major metropolitan areas. Likewise, as all the biodiesel production in 2010 (30 ML) is assumed to be produced from waste oil collected from metropolitan centres, all of the transport use of that biodiesel is assumed to be undertaken in metropolitan areas.

In estimating the health impact of upstream emissions, it is assumed that the extra ethanol production needed (205 ML) to achieve the 350 ML target would take place in three separate rural locations: south-western Queensland (using cereal grain feedstock) and northern Queensland (molasses feedstock) and northern NSW (cereal grain feedstock). The extra biodiesel production needed (30 ML) is, for the purposes of this analysis, assumed to occur on the fringe of large metropolitan areas, reasonably close to the raw feedstock. It is assumed that the biodiesel will be blended with diesel (XLSD) at 5% (B5).

In calculating the health impact of emissions produced from the additional transport use of biofuels, it is assumed that most of the transport use occurs in major metropolitan areas. However, it has been assumed that all of the extra ethanol produced from C molasses (60 ML) would be used primarily in markets in central and northern Queensland.[37] The consequent health impact of tailpipe emissions from the ethanol produced from C molasses will be less pronounced because population densities are much lower in central and northern Queensland.

Under the aforementioned assumptions about the location of production and consumption, most of the reduction in CO emissions occurs in urban areas. Much of the overall increase in total NO_x emissions occurs in rural areas due to the increase in NO_x arising from ethanol production. Most of the increase in total VOCs occurs in urban areas, due to increased evaporative emissions from E10 blend fuels. Particle emissions are projected to increase overall, due to the increased particle emissions from ethanol production, and most of this increase in particle emissions occurs in rural areas. Note that this production was assumed to occur in urban areas in the life-cycle analyses in Tables 10 and 11. However, the significant reduction in tailpipe emissions of particles with E10 occurs in urban areas, where the health costs are highest.

Unit health costs of vehicle emissions

There is an increasing literature devoted to estimating the economic cost of increased morbidity and mortality due to increased concentrations of the more common pollutants. Estimates incorporate the monetary value of loss of life (mortality) and lost quality of life (morbidity), as well as health system costs. Empirical studies exhibit a considerable range of variation, with more recent studies generally attributing a higher cost to pollutant emissions, and particularly PM emissions, than earlier studies. This may reflect more recent scientific research, which measures the longer-term rather than shorter-term impact of air pollutants on health (see, for example, BTRE 2005).

Table 19 Assumed unit health costs for pollutant emissions ($A/tonne)

Emission	Band 1	Band 2	Band 3	Band 4
NO_x	1,750	1,750	260	0
CO	3	0.8	0.8	0
VOCs	850	880	180	0
SO_x	11,380	4,380	2,800	50
PM	341,650	93,180	93,180	1,240

Band 1 = inner areas of larger capital cities (Sydney, Melbourne, Brisbane, Adelaide and Perth).
Band 2 = outer areas of larger capital cities.
Band 3 = other urban areas, including other capital cities (Canberra, Hobart and Darwin) and other urban areas.
Band 4 = non-urban areas.

Source Watkiss (2002).

Against this background and to avoid any undue complexity, this study adopts health-cost estimates derived for Australian conditions by Watkiss (2002), presented in Table 19. Watkiss's unit health costs are based on European health cost estimates (derived as part of the ExternE project, http://externe.jrc.es/), adjusted for the

[37] The Survey of Motor Vehicle Use (ABS, 2003) reports a total of over 16 billion kilometres travelled by passenger motor vehicles in Queensland outside Brisbane, which would imply around 1.4 to 1.6 billion litres of petrol consumption—sufficient to blend with the 60 ML of ethanol that would be produced from C molasses.

demographic characteristics of Australian urban areas. Watkiss provides separate unit health cost estimates that vary according to population density ('Bands' 1 to 4). Watkiss's unit health cost estimates for PM, although of the same order of magnitude as some other Australian studies, notably Beer (2002) and Coffey Geosciences (2003), are at the upper end of the range. For example, PM emissions, which typically have the highest unit costs, around $A100,000–300,000 per tonne in built up urban areas, are estimated by Watkiss to be $A341,000 per tonne in the inner areas of major Australian metropolitan centres. (Appendix VIII of the 2003 35 ML Target Report provides a brief review of estimates of the unit health costs of emissions).

In computing the total health costs resulting from obtaining 350 ML of biofuels use, triangular distributions were imposed on Watkiss's (2002) unit cost estimates for each location (Appendix X of the 2003 350 ML Target Report). This procedure slightly alters the mean (average) unit cost estimates for each location. The mean unit health costs estimates used to estimate the total costs are shown in Table 20.

Table 20 Assumed average 'low' and 'high' unit health costs for criteria pollutant emissions ($A/tonne)

Emission	Band 1	Band 2	Band 3	Band 4
CO	2.3	1.5	0.5	0.3
NO_x	1,253.3	756.7	173.3	86.7
VOCs	643.3	411.7	120.0	60.0
PM	258,827	176,003	62,533	31,887

Band 1 = inner areas of larger capital cities (Sydney, Melbourne, Brisbane, Adelaide and Perth).
Band 2 = outer areas of larger capital cities.
Band 3 = other urban areas, including other capital cities (Canberra, Hobart and Darwin) and other urban areas.
Band 4 = non-urban areas.

Source Watkiss (2002).

The most recent study on the health impacts of transport emissions in Australia has been carried out by the Bureau of Transport and Regional Economics (BTRE, 2005). This study used the 'value of statistical life' (VoSL) approach to calculating costs to the economy, using a smaller value for VoSL than most earlier studies, recognising that air-pollution-related deaths reduce life expectancy by only a relatively short time. For example, a VoSL of A$1.3 million was assigned to mortality due to PM10, compared with A$7 million (NEPC, 1998) and A$5 million (Coffey, 2003; Beer, 2002). BTRE (2005) estimates the central economic cost of the health impact for Australia of motor vehicle pollution at A$2.66 billion for the year 2000. This reflects a unit health cost for PM10 of approximately $104,600 per tonne (BTRE, personal communication, 2005) (cf. Table 20).

Health-cost impact

The health-cost impacts include the cost of additional upstream emissions resulting from production of biofuels, and the change in the health costs arising due to the substitution of ethanol blend fuel and biodiesel for ULP/PULP and diesel[38]. In this section, monetary amounts are expressed in 2004–05 dollars.

Table 21 provides estimates of the impact on health costs from the consumption of 350 ML of biofuel in 2010.

It is important to reiterate that a review of the 2003 350 ML Target Report by the Taskforce has identified that the value chosen in that report for the percentage reduction in PM emissions due to E10 (0.1%) was probably underestimated. The value of 40% used in this report's health-cost analysis was reasonably chosen for the purposes of looking at the scale of the possible impact on health cost. It is an indicative value based on only three studies and is used here as a sensitivity factor, and it is not the Taskforce's view that 40% is a scientifically accepted value.

Using the 40% indicative value, the reduction in total 'exbodied' emissions (defined as the cumulative upstream and downstream full fuel-cycle emissions) that would result from a total of 290 ML of ethanol use gives savings in total health costs of $90.4 million in 2010, an average saving of 31.2c/L (Table 21). By far the most savings in health costs are attributable to reduced PM emissions in urban areas, due to the reduced tailpipe emissions. Because of a lack of knowledge about the detailed composition of evaporative emissions from E10, in terms of both ozone precursors and air toxics, the study has not applied a cost to the increase in evaporative emissions. Hence, the health-cost impact for tailpipe VOC emissions from ethanol relates only to the exhaust VOC component.

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[38] Due to time constraints, the calculations do not assume that the petrol displaced by ethanol is imported petrol. It is assumed to be petrol refined in inner-urban areas. A sensitivity calculation showed that the health costs were reduced by only 5% when petrol refineries were assumed to be in non-urban areas, where the unit health cost is minimal compared to that in the inner-urban areas.

Table 21 Annual health cost impact (in 2004–05 dollars) of change in pollutant emissions resulting from consumption of 350 ML of biofuels in 2010

Fuel type Source	Change in biofuels	Change in emissions (tonnes)				Cost	
		CO	NO_x	VOCs	PM	Total	Average
	ML					$ million	c/L
Ethanol							
Upstream	290	1,830.4	298.5	–96.9	79.1	–2.1	–0.7
Tailpipe	290	–78,568.8	1,537.4	3,338.8	–531.6	–88.3	–30.4
Total	290	–76,738.4	1,835.9	3,241.9	–452.5	–90.4	–31.2
Biodiesel							
Upstream	60	–31.9	–174.1	–69.5	–2.6	–1.0	–1.7
Tailpipe	60	–3,316.4	3,053.9	–416.7	–5.5	1.5	2.5
Total	60	–3,348.3	2,879.8	–486.2	–8.1	0.5	0.8
Biofuels							
Upstream	350	1,798.5	124.4	–166.4	76.5	–3.1	–0.9
Tailpipe	350	–81,885.2	4,591.3	2,922.1	–537.1	–86.8	–24.8
Total	350	–80,086.6	4,715.7	2,755.7	–460.6	–89.9	–25.7

Note: An indicative value of 40% has been chosen for reduction of PM tailpipe emissions from E10 over petrol. The Taskforce does not assert that 40% is a scientifically accepted value.

There are no savings in health costs from 60 ML of biodiesel consumption as B5; there is estimated to be an additional cost of $0.5 million in 2010 due to the increased NO_x tailpipe emissions (Table 21). This represents an average cost of 0.8c/L of biodiesel. From Table 15 it can be seen that NOx emissions are higher for B5 than for ULSD or XLSD.

The total health impact of introducing 350 ML of biofuel into the transport market by 2010 is then estimated to be $89.9 million in 2010, an average health cost saving of 25.7c/L of additional biofuel use, taken across both ethanol and biodiesel.

It is also possible to examine the health-cost impact of introducing 350 ML of biofuels into the Australian transport fleet by using results from the BTRE study (BTRE, 2005). Because almost all air pollutants affect and are interrelated with each other (Morgan et al., 1998), BTRE used PM10 as the main indicator of ambient air pollution, while acknowledging that selecting only one pollutant may underestimate the health effects. However, as can be seen in Table 20, the health cost of PM10 is considerably more than the other pollutants. The annual health cost due to vehicle-related air pollution across all of Australia's major airsheds was estimated by BTRE to be A$2.66 billion in 2000.

Figure 5, from Coffey Geosciences (2003), suggests that, by 2010, annual PM10 emissions will have fallen to 52% of their 2000 value, reducing the BTRE 2000 estimate to A$1352 million. By choosing 50:50 for the ratio of petrol to diesel contributions to PM10 in 2010 (EPA Victoria, personal communication, 2005), 290 ML and 60 ML for the ethanol and biodiesel totals in 2010 (as in the 2003 350 ML Target Report), and assuming the blends will be E10 and B5, the annual health-cost saving in 2010 is calculated to be A$30.3 million in 2000 dollars. This translates to A$34.4 million in 2004–05 dollars. As the indicative tailpipe PM10 reduction for E10 over petrol is 40% and the reduction for B5 over diesel is only 0.3% (as diesel in 2010 is 10 ppm sulphur XLSD), the health-cost saving is strongly dependent on the ethanol proportion of the 350 ML.

The difference between the health estimates from the two different approaches illustrates the extent of uncertainty in attempting to estimate a health cost associated with air quality. The value assigned to a statistical life is certainly one area where there is a wide range of disagreement. Our two approaches use different unit health costs for pollutant mass. The approach following the 2003 350 ML Target Report assigns a value of $259,000 per tonne in the inner-city band whereas the BTRE study implicitly used a value of $104,600.

GHG emissions reductions

Consumption in 2010 of 350 ML of biofuels (148 ML ethanol and 202 ML biodiesel), would result in a reduction in total greenhouse emissions in 2010 of approximately 442,000 tonnes. This reduction in greenhouse emissions is estimated to comprise 107,000 tonnes from use of ethanol and 335,000 tonnes from use of biodiesel. In terms of the cost of greenhouse gas emission reductions, the estimated cost to government (in 2010) is estimated to be $267/tonne CO_2-e (in 2004–05 dollars). The total economic cost associated with the reduction in emissions (again in 2010) is estimated to be $204/tonne CO_2-e (in 2004–05 dollars). Note that these figures assume that imported petrol rather than locally refined petrol displaces ethanol. In both cases, these costings attribute all the cost impacts to the greenhouse abatement impact, rather than the more realistic sharing of cost impacts with other benefits such as air quality or regional development.

The benefits that flow to Australia through the mitigation of climate change come in the form of reduced potential economic and environmental damages.

For all practical purposes, the present value of the economic and environmental benefits that flow to Australia from the mitigation of around 442,000 tonnes (CO_2-e) of greenhouse gas emission in 2010, can be taken to be immeasurably small. This is so because first, the contribution (of 442,000 tonnes) to global concentrations of greenhouse gases in the atmosphere is very small; and second, the benefits that accrue do so in the distant future.

However, the present value of the benefits that flow to Australia through the mitigation of greenhouse emissions are likely to represent some positive amount if a workable global resolution to the climate-change problem is achieved and if emission rights were to become tradable assets. In this case, the emissions avoided in each year can be valued positively. In the absence at the present time of an international market value for carbon dioxide equivalent emissions, the New South Wales Greenhouse Gas Abatement Scheme capped value of $15/tonne CO_2-e is used here.

Taking this as a measure of the benefits of a unit of greenhouse abatement, the total value of the abatement associated with the use of biofuel is estimated by multiplying the quantity of emissions avoided by the forecast unit price of emission credits. For example, at $15/tonne CO_2-e, the implied value of the benefits associated with the greenhouse gas abatement achieved from the 350 ML of biofuels used in 2010 is $6.6 million (in 2004–05 dollars), or 1.9c/L. These findings are presented in Table 22.

Table 22 Greenhouse gas savings (CO_2-e) for various scenarios

	Scenario 1	Scenario 2
Tonnes	442,000	360,000
Cost to government ($/tonne)	267	328
Economic cost ($/tonne)	204	250
GG abatement cost ($m)	6.6	5.4
GG abatement cost (c/L)	1.9	1.5

Conclusion 24: *Under the scenario of 148 ML ethanol and 202 ML biodiesel by 2010, it is estimated that 442,000 tonnes of CO_2-e will be saved p.a.. At a greenhouse gas abatement value of $15 per tonne, this gives a value of $6.6 million or 1.9c/L.*

Discussion

While reductions in air pollutants, and particulates in particular, have been identified in submissions to the Taskforce as a benefit associated with the introduction of biofuels into the Australian transport sector, it is instructive to consider their contribution alongside other measures that are being taken to improve air quality. For example, the fuel standards for petrol and diesel—most notably sulphur levels—become progressively tighter over the period to 2006, and this trend continues in the post-2006 standards. On 1 January 2005, a limit of 150 ppm sulphur came into being for all grades of petrol, and on 1 January 2006, sulphur in diesel will be limited to 50-ppm. In addition, further reduction in the sulphur levels of both petrol and diesel take place with 50 ppm sulphur PULP (RON 95) being introduced from 1 January 2008 and 10 ppm for diesel from 1 January 2009. A further reduction to 10 ppm sulphur PULP is presently under examination.

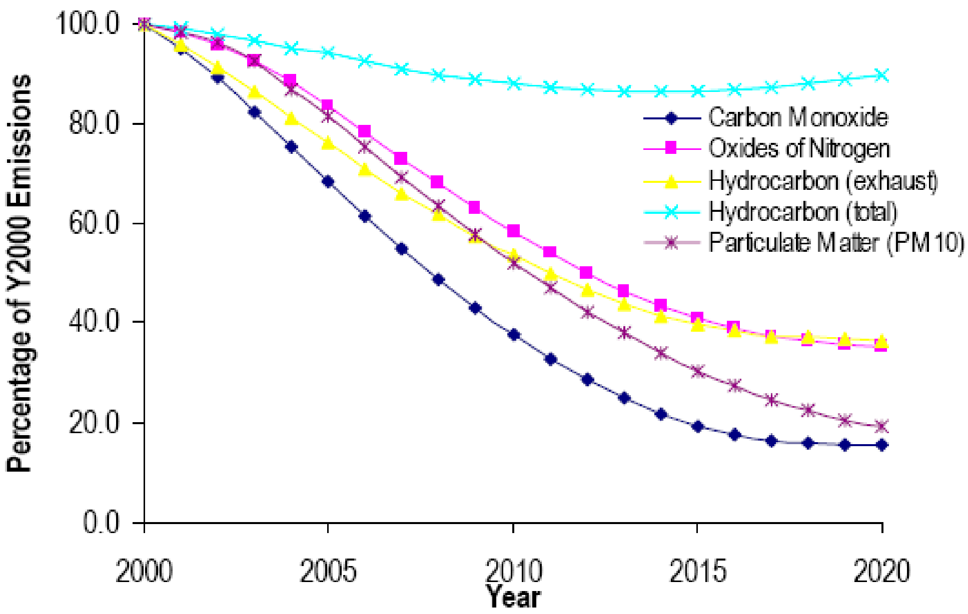
Although these fuel standards are leading, and will lead, to considerable improvements in emissions performance of the vehicle fleet in Australia, motor vehicles continue to grow in numbers and use. According to DOTARS (2004), recent Bureau of Transport and Regional Economics (BTRE) base-case projections have vehicle kilometres travelled (VKT) by all vehicles increasing by 46% for 2000–2020, consisting of an increase of 36% for cars, 107% by light commercial vehicles, and 120% by articulated trucks. This VKT growth is expected to occur even though projections of car ownership rates (number of cars per person) are predicted to essentially plateau by around 2015.

Taking into account fuel standards, fleet mix and vehicle usage, Coffey Geosciences (2003) has projected to 2020 the total vehicle emissions for Australian airsheds. These are shown in Figure 5 for CO, HC, NO_x and PM10 as a percentage of the 2000 emissions. The plots shown are for changes arising only from the fuel standards introduced up to and including 2006, as additional reductions due to later standards will be small. Figure 5 shows that, while improvements in emissions are partly offset by increases in vehicle travel rates, dramatic reductions in average rates of emissions of each pollutant will be achieved by 2020. For example, by 2020 PM10 emissions will have been reduced to only 20% of their 2000 value.

Conclusion 25: *Depending on cost-effectiveness, governments could consider tightening the framework of air quality/fuel quality/vehicle particulate emission standards with the objective of gaining public health benefits.*

Although the above vehicle emissions projections demonstrate the benefits of new vehicle emissions standards, the pattern and scale of urban development in parts of Australia, and the resultant growth in vehicle use, will place increasing pressure on the challenge to maintain improvements in urban air quality, particularly ozone. Discussion of this issue for each of the major Australian airsheds can be found in DOTARS (2004).

Figure 5 Projected emissions for key pollutants, 2000–2020



Source: Coffey GeoSciences (2003)

Chapter 6 Economic costs and benefits

Synopsis

- This chapter describes the modelling undertaken by ABARE on behalf of the Taskforce of biofuels industry viability and the costs to the budget and to the economy of expanding biofuels production to meet the 350 ML target by 2010. It is assumed, when analysing industry viability, that producers are able to sell all they can produce at prevailing market prices—that is, there are no problems with market barriers or consumer confidence. It is also assumed that projects can commence production without undue delay.

- Reflecting the combined effect of high world oil prices and government assistance to the industry, the rates of return potentially obtainable from fuel ethanol and biodiesel production are currently very high. However, these rates appear likely to fall significantly in the long term as world oil prices moderate; assistance to producers is reduced over the period 1 July 2011 to 1 July 2015; and fuel ethanol producers face full import competition from 1 July 2011. As a result, after 1 July 2015, Australia could be left with a small group of producers who are economically viable, and a larger group of producers who have entered and exited the industry during this period.

- Assistance is presently provided to all producers in the form of a production grant of 38.1c/L, which currently fully offsets the excise paid on biofuels. New facilities approved under the Biofuels Capital Grants Program also receive a capital grant that effectively provides around 1c/L in additional assistance over the lifetime of the plant. Assistance to biofuels is scheduled to fall to 12.5c/L for ethanol and 19.1c/L for biodiesel by 1 July 2015, and to continue at those levels indefinitely.

- At a long-term exchange rate of US65c, the long-term world price of oil (West Texas Intermediate) would need to average US$42–47/bbl in 2004 dollars (depending on the feedstock used) for new ethanol producers to be viable post-2015 without assistance. With assistance, however, the required oil price is estimated to be US$25–30/bbl. Biodiesel producers would require an oil price of US$52–62/bbl without assistance, or US$35–45/bbl with assistance.

- The likely long-term trajectory for world oil prices is highly uncertain. However, a reasonable consensus range for the long-term world trade weighted average oil price (in 2004 dollars) appears to be US$25–45/bbl. The oil price used in the ABARE analysis is the West Texas Intermediate (WTI), which trades at a premium to the world trade weighted average price. In WTI terms, the consensus range would be US$27.5–50/bbl. The long-term WTI oil price of US$32/bbl (2004 dollars) assumed in ABARE's revised analysis is conservatively placed within the consensus range of world oil price projections.

- At a long-term WTI world oil price of US$32/bbl as assumed by ABARE, new ethanol producers would appear to be viable in the long term with the level of assistance currently scheduled to be provided in the long term. However, new biodiesel producers would appear to be unviable in the long term even with the level of assistance currently scheduled to be provided.

- The conclusion that the expansion of the Australian biofuels industry will result in costs on particular industries, regions and the national economy rests on the proposition that much of the industry expansion now being proposed is unlikely to be viable in the long term without continuing assistance. ABARE modelling indicates that the costs likely to be imposed on the national economy through assisted expansion of the industry to a level of 350 ML would be $90 million in 2009–10, and $72 million a year (in 2004–05 terms) in the long term (post-2015).

- The Taskforce supports the energy white paper conclusion that 'there is currently no case for the government to accelerate the uptake of these fuels on energy security grounds'.

Main economic findings of the 2003 350 ML Target Report

Industry viability

The 2003 350 ML Target Report found that, at the then-projected long-term real world oil price, Australian exchange rate, feedstock prices, and when assistance was completely phased out in 2012 (as was then government policy):

- existing manufacturers of ethanol from waste starch and biodiesel from used cooking oil should still be able to cover operating costs, and therefore would be economically viable until capital replacement was required
- new biofuels producers, who would need to cover the cost of their capital borrowings as well as their operating costs, would not be economically viable in the long term
- that said, both existing and new producers appeared likely to earn relatively high commercial rates of return in the short term, until world oil prices moderated, and assistance was phased out.

Government expenditure required to meet the 350 ML target by 2010

The 2003 350 ML Target Report estimated the likely level of biofuels production in 2010 without assistance to be 115 ML. To meet the 350 ML target, an additional 235 ML would need to be produced with assistance. If assistance were confined to the additional 235 ML, the cost to the budget would be $30.2 million a year post-2012 (in 2003–04 terms). If assistance were provided on the full 350 ML, the cost to the budget would be $43.6 million a year post-2012.

Benefits from new biofuels production

The main potential benefits from new biofuels production identified by the 2003 350 ML Target Report were the boost in regional employment and incomes associated with new industry in the regions, avoided health costs, and reduced greenhouse gas emissions from replacing fossil fuels with biofuels.

The 2003 350 ML Target Report estimated that four new ethanol plants would be required to produce an additional 235 ML of biofuels in the regions. The likely number of new jobs generated by these plants would be 432 (144 direct jobs and 288 indirect jobs).

The 2003 350 ML Target Report cautioned, however, that in a situation of high employment, the net effect of encouraging industry development in a particular region may be only to transfer jobs from one region to another, with little net gain to national employment or incomes. On the other hand, there were likely to be small net benefits in terms of avoided health costs and reduced greenhouse gas emissions, the monetary value of which was estimated to be of the order of $6 million a year (in 2003–04 terms).

Costs of new biofuels production

The 2003 350 ML Target Report estimated that the annual cost to the budget of maintaining regional employment in a subsidised biofuels industry would be around $210,000 to $303,000 per direct job, and $70,000 to $100,000 per job overall. Additional costs would also be imposed on the economy because resources would be redirected from their most efficient use, and additional tax would have to be collected to meet the additional cost to the budget. Using a general equilibrium model of the Australian economy, the report estimated the total likely costs to the economy at $71–74 million a year in the long term (post-2012), leading to the conclusion that the costs of assisting the biofuels industry in order to reach a production target of 350 ML appeared to outweigh the benefits.

ABARE 2005 revised assessment of the viability of biofuels production

Since the 2003 350 ML Target Report was published, world oil prices have risen significantly, leading some industry stakeholders to suggest that biofuels production may now be viable in the long term without government assistance. If this were true, then many of the costs calculated in the 2003 350 ML Target Report would essentially disappear, as these costs were predicated on the assumption that the biofuels industry would require a large and continuing government subsidy.

To assess the long-term economic viability of biofuels production using current projected values for key variables such as the long-term level of the world oil price, the Australian exchange rate, and feedstock prices, the Taskforce commissioned ABARE to revise its original analysis. The values used in the 2003 350 ML Target Report and in ABARE’s July 2005 revised analysis are shown in Table 23.

Table 23 Revised medium-term assumptions

		Medium-term assumptions	
		December 2003 study	July 2005 revised analysis
Ex-refinery price inputs			
Oil[a]	US$/bbl	23	32
Exchange rate	US$/A$	0.60	0.65
Refining costs[b]	US$/bbl	3.10	3.10
Transport cost	USc/L	1	1
Biofuel fixed and operating costs			
Capital costs – ethanol	$m/ML	1	1
Capital costs – biodiesel	$m/ML	0.63	0.63
Cost of capital	%	7	7
Operating costs (labour, energy etc.)[c]	c/L	5–10	5–10
Ethanol feed stocks			
Sorghum/feed grains	$/t	137	152
C molasses	$/t	50	50
B molasses	$/t	114	–
A molasses	$/t	250	–
Biodiesel feed stocks			
Used cooking oil	$/t	170	350
Tallow	$/t	450	450
Canola seed	$/t	353	–
Canola oil	$/t	910	–

a West Texas Intermediate.
b The revised analysis also assumes increased petrol refining costs of 1–2c/L in the long term associated with moving to Euro IV and Euro V standards.
c In the study, the average of 7.5c/L was used.

The Taskforce also commissioned ACIL Tasman to independently assess both the methodology used by ABARE, and whether ABARE's current estimated values lay in what might be considered a reasonable 'consensus range' for these values.

The methodology used by ABARE to assess long-term industry viability involves the following steps:

- A benchmark price (in Australian c/L) is estimated for petrol and diesel imported into Australia, based on a long-term projected world oil price in US dollars per barrel (see Box 1)
- The ethanol and biodiesel energy equivalents of these prices are calculated (the energy density of ethanol being 68% that of petrol, and the energy density of biodiesel produced from used cooking oil being 94% and that of biodiesel produced from tallow being 98% that of diesel).

- Threshold prices for ethanol and biodiesel that incorporate any benefit that is offered to the producers of these products but not to their competitors (petrol or diesel producers) are then calculated.[39]
- The cost of producing biofuels using different feedstocks is then calculated. For new producers, both capital and operating costs are considered. For existing producers, only operating costs are taken into account.
- The cost of production for biofuels is then compared with the threshold price and the energy equivalent of the benchmark price.

Box 1 World oil prices

As petrol and diesel can be readily imported, local producers of these products need to price at around import parity to sell. A significant proportion of the petrol and diesel imported is sourced from Singapore, so the relevant import parity prices are taken to be ex-Singapore.

Since the 1990s the Australian Consumer and Competition Commission and other Australian Government agencies have used this method to calculate how changes in world oil prices can be expected to translate into changes in the price of imported petrol and diesel (see Roarty and Barber, 2004). For example, if the average world trade weighted oil price is US$30/bbl, the price of petrol imported from Singapore should, in theory, be around US$41/bbl. At an exchange rate of US75c, this would be equivalent to an Australian price around $A55/bbl, or A35c/L (using a conversion of 159 litres of petrol per barrel).

To compare the price of imported petrol with the cost of domestically produced ethanol, allowance must be made for the different energy densities of ethanol and petrol. The energy density of ethanol is around only 68% that of petrol. In a competitive market, ethanol might be expected to be priced lower than petrol to reflect this energy difference. That is, if the import price of petrol was 35c/L, then ethanol would have be priced at 24c/L (35c/L * 0.68) to compete on an energy basis with petrol.

The future trajectory of world oil prices is extremely uncertain. ACIL Tasman have suggested that a reasonable consensus range for the long-term world oil price would be US$25-45/bbl. In its most recent set of long-term energy projections published in February 2005, the Energy Information Agency of the US Department of Energy discussed a number of factors likely to affect this trajectory, which include: the likely level of future production of conventional and unconventional oil; long-term prospects for synthetic petroleum production (gas-to-liquids and coal-to-liquids); likely consumer and government responses to prolonged periods of high oil prices; technology changes which would affect consumer or manufacturer behaviour; and potential developments in the world natural gas markets (as gas is a partial substitute for oil) (EIA, 2005).

The US Department of Energy believes that the most critical uncertainty for long-term oil prices will be the future production decisions of the OPEC cartel. In the Department of Energy's 'reference case', the world price of oil in 2010 is projected to be US$25 per barrel, rising to US$28.50 per barrel by 2020. In an alternative case where the OPEC countries produce only enough oil to maintain OPEC's share of the market as it grows from year to year, the world price of oil in 2010 is projected to be US$34 per barrel, rising to US$37 per barrel by 2020.

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[39] Ethanol and biodiesel, and petrol and diesel, producers all currently pay fuel excise at 38.1c/L, but ethanol and biodiesel producers receive a production grant of 38.1c/L which, in effect, fully offsets the excise paid by producers. Some new biofuels producers also receive Biofuels Capital Grants, the value of which is estimated to be of the order of around 1c/L of production capacity.

If the cost of production[40] is below the energy equivalent of the benchmark price, the operation is viable. If the cost of production is between the threshold price and the energy equivalent of the benchmark price, the operation is commercially viable but not economically viable. If the cost of production is above the threshold price, the operation is unviable.

It is assumed, when analysing industry viability, that producers are able to sell all they can produce at prevailing market prices—that is, there are no problems with market barriers or consumer confidence. It is also assumed that projects can commence production without undue delay.

In its July 2005 revision, ABARE revised upward its projected long-term world oil price, Australian exchange rate, and sorghum price, although not its long-term C molasses price of $50/t (Table 24, column 4). As discussed in the 2003 350 ML Target Report, the price of C molasses in Australia has typically been in the $25–75 a tonne range. Currently, the price of C molasses is reported to be around $100 per tonne. If this price prevailed in the long term it would significantly alter the economics of producing ethanol using C molasses, raising the estimated long-term cost of production from 33c/L to 51c/L.

The long-term price for used cooking oil was also adjusted upward (Table 25, column 4). At the time that analysis was being undertaken for the 2003 350 ML Target Report, the Australian Taxation Office estimated that the price of used cooking oil was around $170 a tonne. Recent information from industry participants suggests that this figure is more reflective of the costs of collecting used cooking oil, and does not include the costs of processing and reselling it. In the revised analysis, the used cooking oil feedstock price was increased to $350 a tonne in the long run.

ABARE's long-term estimate of the tallow price was left unchanged. Since 1994, tallow prices in Australia have been between $400 and $650 a tonne in nominal terms. In real terms, the unit value of exports averaged almost $650/tonne (in 2004–05 dollars) over the period 1988–89 to 2002–03. But over that period, the real unit values have been declining at an average 4% a year from $807/tonne in 1994–95 to an estimated $568 in 2002–03 (in 2004–05 terms). Given export unit tonne values at the time and the current trend decline in real prices ABARE has assumed that the real price of tallow in the medium term will average $450/tonne.

A recent analysis of the Australian feedstock market undertaken for Australian Renewable Fuels Limited concluded that 'a long-term tallow feedstock price of $481 is a reasonable basis on which to conduct long-term financial projections' (slightly higher than ABARE's assumed long-term price).

ABARE's July 2005 revision also incorporated the likely effect of increased petrol refining costs associated with moving to Euro IV and Euro V standards, and the effect of recent changes to the long-term levels of production grants and the basis for levying excise on liquid fuels and the new Biofuels Capital Grants Program.

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[40] Including a commercial return on capital invested.

Ethanol

For ethanol, the 2003 350 ML Target Report concluded that once assistance had been fully phased-out, new producers appeared unviable, because the estimated cost of producing ethanol in new facilities using C molasses was 13c/L above, and using sorghum was 12c/L above, the energy equivalent benchmark price for ethanol (Table 24, column 3).

Table 24 Long-term viability of ethanol production—new producers

		2003 study	2005 revision
World oil price[a]	US$/bbl	23	32
Exchange rate	US$/$A	0.60	0.65
Benchmark price for petrol[b]	Ac/L	29	39
Energy equivalent benchmark price for ethanol[c]	Ac/L	20	26
Threshold price for ethanol[d]	Ac/L	20	38
Cost of production using C molasses	Ac/L	33	33
Cost of production using sorghum[e]	Ac/L	32	36
Feedstock cost – C molasses	A$/t	50	50
Feedstock cost – sorghum	A$/t	137	152

a West Texas Intermediate (WTI).
b Assuming the cost of refining Singapore Mogas 95 is US$3.10/bbl, and the cost of transport to Australia is US1c/L, and additional costs of 1–2c/L in the long term for refining to Euro IV and Euro V standards.
c Based on ethanol having 68% of the energy density of petrol.
d Includes effective excise relief. When the 2003 study was undertaken, the production grants that provide effective excise relief for biofuels were scheduled to be phased out over the period 2008–12. Currently, the production grant for ethanol is scheduled to be reduced in 2011, then phased down progressively from 2011 to 2015 to a long-term level of 12.5c/L (nominal). New biofuels producers approved for funding under the Biofuels Capital Grants Program may also receive a benefit equivalent to around 1c/L over the lifetime of their facility.
e The analysis allows for the revenue obtained from the sale of distillers grain.

Based on the July 2005 revision figures shown in Table 24, new ethanol production still appears economically unviable in the long term, because the estimated cost of producing ethanol in new facilities using C molasses is 7c/L above, and using sorghum is 10c/L above, the long-term energy equivalent benchmark price for ethanol. However, new ethanol producers appear commercially viable provided assistance is maintained, as is presently planned, at a level of 12.5c/L (nominal) post-2015. The provision of assistance raises the long-term price against which ethanol producers are required to compete from 26c/L to 38c/L. At a threshold price of 38c/L the estimated cost of producing ethanol in new facilities using C molasses is 5c/L below, and using sorghum is 2c/L below, the ethanol price required for commercial viability.

Biodiesel

Table 25 Long-term viability assessment for biodiesel—new producers

		2003 study	2005 revision
World oil price[a]	US$/bbl	23	32
Exchange rate	US$/$A	0.60	0.65
Benchmark price for diesel[b]	Ac/L	33	41
Energy equivalent benchmark price for biodiesel[c]	Ac/L	30	38 or 40
Threshold price for biodiesel[d]	Ac/L	30	52 or 55
Cost of production using used cooking oil	Ac/L	35	56
Cost of production using tallow	Ac/L	66	66
Feedstock cost – used cooking oil	A$/t	170	350
Feedstock cost – tallow	A$/t	450	450

a West Texas Intermediate (WTI).
b Assuming cost of refining to Singapore Gasoil is US$3.10/bbl, and cost of transport to Australia is US$1c/L.
c The 2003 350 ML Target Report assumed that biodiesel had 90% the energy density of diesel. In the 2005 revision, biodiesel made from used cooking oil was assumed to have an energy density 94% of that of diesel, while biodiesel made from tallow was assumed to have an energy density 98% of that of diesel.
d Includes effective excise relief. When the 2003 study was undertaken, the production grants which provided effective excise relief for biodiesel were scheduled to be phased out over the period 2008–12. Currently, effective fuel tax rate for biodiesel are scheduled to be phased down progressively from 2011 to 2015 to a long-term level of 19.1c/L (nominal). New biofuels producers approved for funding under the Biofuels Capital Grants Program may also receive a benefit equivalent to around 1c/L over the lifetime of their facility. The threshold price of 52c/L is for biodiesel made from used cooking oil, and the threshold price of 55c/L is for biodiesel made from tallow.

For biodiesel, the 2003 350 ML Target Report concluded that once assistance had been fully phased out, new producers appeared unviable, because the estimated cost of producing biodiesel in new facilities using used cooking oil was 5c/L above, and using tallow was 36c/L above, the energy equivalent benchmark price for biodiesel (Table 25, column 1).

Based on the July 2005 revision figures shown in Table 25, new biodiesel production still appears economically unviable in the long term, because the estimated cost of producing biodiesel in new facilities using used cooking oil is 18c/L above, and using tallow is 24c/L above, the long-term energy equivalent benchmark price for biodiesel.

Furthermore, new biodiesel producers would appear to be commercially still unviable in the long term even if the production grant is maintained at 19.1c/L (nominal) post-2015, as the estimated cost of producing biodiesel in new facilities using used cooking oil is 4c/L above, and using tallow 11c/L above, the threshold price that includes all long-term assistance provided to producers.

To be commercially viable (and achieve a 7% return on capital) over the longer term, ABARE has identified that biodiesel produced from used cooking oil would require a fuel tax subsidy of 21c/L and tallow-based biodiesel would require a fuel tax subsidy of 32c/L in nominal terms over the longer term. These estimates compare with the current fuel tax subsidy of 19.1c/L.

Rates of return

In the July 2005 revision, the long-term annual rate of return on investment for new ethanol plants using C molasses was estimated to be 12%, and using sorghum, 10% (assuming continued assistance). Whether an expected rate of return of 10–12% would be sufficient to induce commercial operators to invest in new ethanol plants would depend on the risk-adjusted expected rates of return from alternative investments. Estimated short-term annual rates of return were considerably higher—well over 30% a year. A C molasses-based ethanol plant that commenced operation in 2006–07 was estimated to average a 25% annual return on invested capital between 2006–07 and 2015–16.

The estimated long-term rates of return for new biodiesel plants using used cooking oil or tallow are negative. However, as with ethanol, the estimated short-term rates of return were relatively high. A biodiesel plant using tallow that commenced operation in 2006–07 was estimated to average a 19% return on capital invested between 2006–07 and 2015–16, despite the significant losses occurring late in the period.

Conclusion 26: *Reflecting the combined effect of high world oil prices and government assistance to the industry, the rates of return potentially obtainable from fuel ethanol and biodiesel production are currently very high. However, these rates appear likely to fall significantly in the long term as world oil prices moderate, and as assistance to producers is reduced over the period 1 July 2011 to 1 July 2015 and fuel ethanol producers face full import competition.*

Sensitivity of the viability analysis to changes in key prices

The future excise arrangements for biofuels are known, and therefore would already be factored into potential investors' assessments of future commercial viability. Appropriate long-term values for other key factors such as the world oil price, the Australian exchange rate, and feedstock prices, are more uncertain. ABARE has provided a revised viability analysis based on its own view of long-term values. However, potential investors may take either a more optimistic or a more pessimistic view than ABARE. The Taskforce has attempted to take into account the wide range of prevailing views by exploring the reasonable 'consensus range' for key input values.

In its independent assessment of ABARE's current medium term assumptions, ACIL Tasman (2005) suggested that a reasonable consensus range for the long-term oil price was US$25–45/bbl[41], and a range for the Australian exchange rate would be US60–80c.

A combination of a low exchange rate and a high oil price would make it easier for producers to operate viably, while a combination of a high exchange rate and a low oil price would make it more difficult. Simultaneous rises or falls in the world oil price and the exchange rate would tend to be largely offsetting insofar as they affect viability.

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[41] In West Texas Intermediate terms this would be equivalent to US$27.50-50/bbl.

Conclusion 27: *The likely long-term trajectory for world oil prices is highly uncertain. However, a reasonable consensus range for the long-term world trade weighted average oil price (in 2004 dollars) appears to be US$25–45/bbl. The long-term West Texas Intermediate oil price of US$32/bbl (2004 dollars) assumed in ABARE's revised analysis is conservatively placed within the consensus range of world oil price projections.*

The Taskforce asked ABARE to calculate threshold prices for ethanol and biodiesel with and without assistance at different alternative combinations of long-term world oil prices and exchange rates (see Chapter 5 of ABARE's July 2005 report). ABARE provided these calculations as a 'what-if' analysis, with no particular view as to the probability of any combination actually occurring, or of the actual feasibility, based on fundamentals, of any particular combination.[42]

The key results of the sensitivity analysis are shown in Figures 6 and 7 (for ethanol and biodiesel, respectively). At a long-term exchange rate of US65c, the price of West Texas Intermediate would need to average US$42/bbl in 2004 dollars in the long term for new ethanol producers using C molasses to be viable, and US$47/bbl for new producers using sorghum to be viable, in the long term. At a long-term exchange rate of US75c, the price of West Texas Intermediate would need to average above US$50/bbl for new producers to be viable in the long term. With assistance, however, at a long-term exchange rate of US65c, new ethanol producers using C molasses require a West Texas Intermediate price of only US$25/bbl to be commercially viable in the long term, while new producers using sorghum require US$30/bbl. At a long-term exchange rate of US75c, production is commercially viable in the long term in the West Texas Intermediate price range US$30–35/bbl.

For biodiesel, at a long-term exchange rate of US65c, the required West Texas Intermediate price range for viability without assistance is US$52–62/bbl (depending on feedstock), and for viability at currently scheduled rates of long-term assistance, US$35–45/bbl. At a long-term exchange rate of US75c, the price of West Texas Intermediate would need to average above US$60/bbl for new producers to be viable in the long term without assistance.

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[42] It could be argued that, because Australia is a 'commodity-based economy', there is a strong likelihood that Australia's exchange rate will appreciate when world commodity prices (including world oil prices) are rising, and depreciate when they are falling. The cost of production was held constant in the 'what-if' analysis. In reality, an increase in the world oil price, if reflected in higher Australian dollar prices for petroleum-based products, could feed back into production costs in the form of higher prices for fuel and for feedstocks (the inputs required to produce the latter including fuel, fertiliser and chemicals). On the other hand, an appreciation of the exchange rate would tend to reduce the cost of imported inputs, which could feed back into production costs in the form of lower prices for imported inputs. It is believed that incorporating these complex interactions could alter the results slightly, but not enough to materially alter the main conclusions.

Figure 6 Sensitivity of ethanol threshold price to changes in the oil price and exchange rate

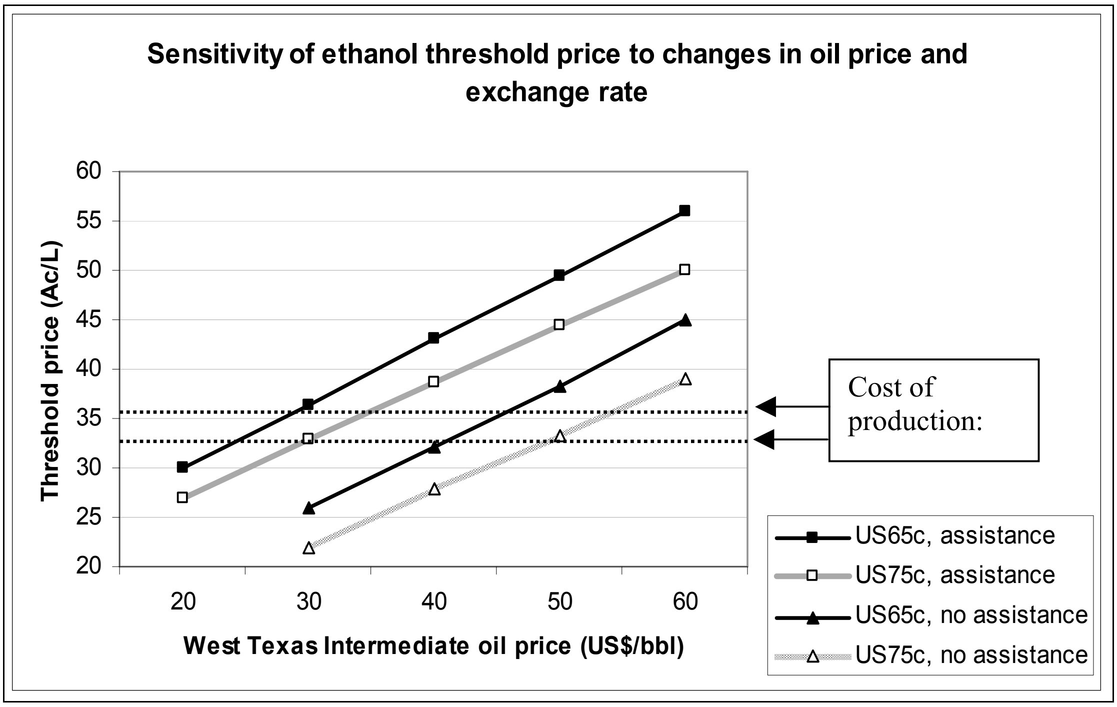
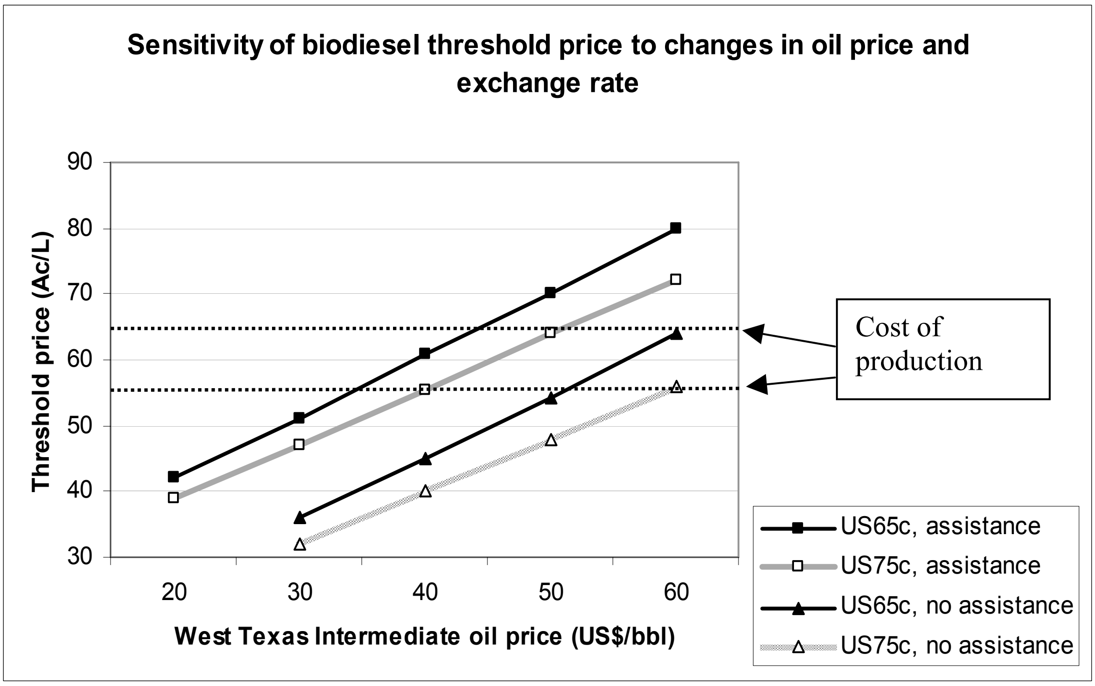


Figure 7 Sensitivity of biodiesel threshold price to changes in the oil price and exchange rate



Conclusion 28: *At a long-term exchange rate of US65c, the long-term world price of oil (West Texas Intermediate) would need to average US$42–47/bbl in 2004 dollars (depending on the feedstock used) for new ethanol producers to be viable after 2015 without assistance. With assistance, however, the required oil price is estimated to be US$25–30/bbl. Biodiesel producers would require an oil price of US$52–62/bbl*

without assistance, or US$35–45/bbl with assistance provided by current policy settings.

The Taskforce notes that ABARE's analysis is undertaken strictly on a cost of production basis and necessarily puts to one side a number of issues which the Taskforce considers will be critical. The analysis assumes adequate market penetration of biofuels in the longer term (ie there are no obstacles to selling whatever level of biofuels are produced), projects proceed immediately and domestic biofuels production is competitive with imported production. The Taskforce considers that:

- consumer confidence remains a serious impediment to the uptake of ethanol and the longer this inhibits uptake and capacity expansion, the shorter the fuel tax concession window becomes
- biofuels are an emerging market with growth likely to be incremental from a low base
- biofuel plants would need to be constructed and operating as soon as possible to capture sufficient benefits during the fuel-tax concession period to generate acceptable rates of return on capital—most biofuel plants, however, still require capital and supply contracts to proceed
- import competition will have an effect on domestically produced ethanol from 1 July 2011. The impact of this will depend on the relative competitiveness of imported ethanol compared with domestically produced ethanol. While the Taskforce is unable to predict this for 2011, it notes that the F.O. Licht's (Licht 2004) quote for the world ethanol price in April 2005, at about US120c/gallon or $A0.42 (based on an exchange rate of 0.75 and 3.78 litres to the gallon), is well below the mid $A0.60-plus that Australian fuel ethanol producers are understood to be seeking for their product (even accounting for additional transportation costs).

Regional employment effects

The 2003 350 ML Target Report examined the question of what benefits biofuels plants could bring to regional economies, and at what cost. The main benefits suggested by biofuels proponents were an increase in employment and incomes in the regions, and that diversifying crops and industries in the region could provide greater stability and resilience to market shocks for the region's farmers and communities.

Examining the likely effect on regional employment, the 2003 350 ML Target Report reviewed a number of Australian and US studies and concluded that a new ethanol plant with a production capacity of around 50–60 ML a year would provide around 30–40 ongoing direct jobs per plant. In estimating the number of indirect jobs generated, the Australian and US studies used a wide range of multipliers, 5–6 being the most common. Based on the size of the multipliers typically used in general equilibrium models, however, which take account of inter-regional effects, the 2003 350 ML Target Report suggested that a multiplier of around two would be more reasonable when estimating the number of indirect jobs generated, in a situation of relatively low unemployment. In its independent review of the methodology and values used in the 2003 350 ML Target Report, ACIL Tasman agreed that general equilibrium models generally used a multiplier of around two.

The 2003 350 ML Target Report assumed that the additional production of biofuels required to meet the 350 ML target would be provided by four regional ethanol producing plants. New biodiesel plants were assumed to be located in urban rather than regional areas, on the argument that the feedstock most likely to be used would be used cooking oil sourced from urban areas. Based on the number of direct jobs per plant estimated from the Australian and US studies, a multiplier of two, and a requirement for four new regional plants, the 2003 350 ML Target Report estimated that a total of 432 new jobs, (144 direct and 288 indirect) would be created in regional areas from an assisted biofuels industry.

In its July 2005 revision, ABARE estimated that if the projects that have been successful to date in the Capital Grants Program all proceed, the number of ongoing direct jobs generated by these projects could be in the vicinity of 216 (assuming an average of 36 jobs per plant). The Taskforce notes that if a multiplier of two is assumed, the number of indirect jobs created could be 432, and the total number of jobs, 648.

National and regional costs

Examining the likely costs of a subsidised biofuels industry, the 2003 350 ML Target Report concluded that subsidising a biofuels industry in a particular region could:

- distort markets and lead to inefficient outcomes, reduced employment and economic activity in other regions
- compete directly and unfairly with other industries using the same inputs and those industries producing competing products (including by-products)
- lead to the promotion of unsustainable development
- represent an expensive, inefficient and indiscriminate approach to achieving regional policy development goals.

A number of submissions drew the Taskforce's attention to a study by Urbanchuk et al. (2005) which found that significant regional benefits could flow from the development of an ethanol industry in Queensland. The Taskforce examined this report and noted that many of the regional benefits in terms of number of jobs created depended on the size of the employment multiplier assumed, which was in the vicinity of 12 (Urbanchuck et al., 2005, p. 25). The Taskforce also noted that, in the high potential profit margin calculated for ethanol (p. 21), there was an implicit assumption that blenders would not seek to discount the price of ethanol relative to petrol to reflect the relatively lower energy density of ethanol. If blenders did seek to discount the price of ethanol based on its lower energy density, this could reduce the potential profit margin for ethanol calculated in the paper, and affect project viability and therefore regional production prospects. Finally, the analysis in the paper does not extend to estimating the possible costs to other regions or to the national economy of developing an ethanol industry in Queensland.

A number of submissions also drew the Taskforce's attention to the possibility that if a government-assisted ethanol industry emerged as a significant new source of demand for feed grains, this would tend to drive up domestic feed grains prices, particularly when domestic supplies were reduced due to drought. In other words, a government-assisted ethanol industry would compete directly and unfairly with the existing livestock feeding industries for feed grains.

Under current policy settings, the high rates of return that could be obtained by the subsidised fuel ethanol industry in the short term would allow it to bid strongly against the livestock industry for grain feedstock where necessary.

The Taskforce notes that, in its 2005 report, ABARE suggests that, under average seasonal conditions and at around the target level of 350 ML biofuels, fuel ethanol feedstock demands are likely to be met by redirected grain exports, with no significant effect on domestic price.

This is without factoring issues relevant to local grain markets such as transport costs, especially for low-priced grains such as sorghum, and that export grain from Western Australia is of little relevance to ethanol plants that are planned for southern Queensland and northern NSW. These are areas where feedgrain usage by feedlotters, poultry and pork producers is high and growing.

A full-scale sorghum-to-ethanol plant in a particular locality would try to source about 200,000 tonnes p.a. of sorghum from its locality. The probability that the locality would not have such a surplus is high. Accordingly, the local price may increase as freight costs from further afield get built in and/or growers shift from other crops to sorghum to get a premium driven by the ethanol plant's subsidies. Either way, a feedgrain user in the locality may pay more for feedgrain. In poorer than average seasonal conditions, this would be exacerbated.

Conclusion 29: *The Taskforce considers that on current policy settings there is real potential for subsidised grain ethanol plants to have a local impact on feedgrain prices in the short to medium term. In the longer term, fuel ethanol rates of return are likely to drop as the policy settings reduce the subsidies —and as ethanol import competition is allowed in 2011. The fuel ethanol industry would then be placed on a more even footing in its ability to bid for grain against the livestock industry.*

In the time available to the Taskforce it was not possible to commission a detailed regional study of the type that could be undertaken using a general equilibrium regional model such as ABARE's AUSREGION, which would have allowed the Taskforce to explore in more detail the different implications for particular regions and particular industries of the expansion of Australia's biofuels industry. The Taskforce concluded, however, that the argument that the creation of a biofuels industry in the regions would impose a variety of costs essentially rests on the proposition that the industry would need substantial ongoing government assistance to be commercially viable. If the industry could operate in the long run without substantial ongoing government assistance, then the consequent changes in resource flows—the diversion of product from the export to the domestic market, and from one domestic market to another—merely represent the workings of a commercial market.

Budgetary costs of job creation

The 2003 350 ML Target Report estimated the level of government assistance required to encourage enough new producers into the industry to meet the 350 ML target could be between $30.2 million and $43.6 million a year (in 2003–04 dollars) in the long term (depending on whether assistance was extended only to the additional 235 ML required to meet the target, or the full 350 ML of production), which would be equivalent to $210,000 to $303,000 per direct job, or $70000 to $100,000 per ongoing job overall.

ABARE has estimated that under the current policy settings, and based on the currently identified composition of the 350 ML target, the government expenditure required to assist the industry to meet the 350 ML target would be $118 million in 2009–10. This would be equivalent to a government expenditure of $546,000 per ongoing direct job created, or $182 000 per total job if a jobs multiplier of two is assumed (Table 26), assuming that the only objective was regional job creation.

The government expenditure required in 2009–10 is based on the cost (in 2004–05) of assistance in this year (38c per litre, nominal). In the longer term (post-2015), the level of government assistance to the industry will be reduced. ABARE has calculated that in the long term the government expenditure argument to assist the industry would be $44 million a year (in 2004–05 dollars). This would be equivalent to a government expenditure of $204,000 per ongoing job created or $68,000 per total job assuming a multiplier of two, in the long term, assuming the target continued to be met.

Table 26 Estimated government assistance per job

		December 2003 study	December 2003 study	2005 revision (2009–10)	2005 revision (2015–16)
Biofuel production	ML	235	350	350	350
Government expenditure	$M	30.2	43.6	118	44
Number of plants	No.	4	4	6	6
Direct jobs per plant	No.	36	36	36	36
Total direct employment	No.	144	144	216	216
Indirect jobs per plant[a]	No.	288	288	432	432
Expenditure per job (direct)	$000	210	303	546	204
Expenditure per job (direct and indirect)	$000	70	101	182	68

a Assuming a multiplier of 2.

This seems relatively high when compared with the cost of creating new and sustainable regional jobs reported for other programmes; for example, the Commonwealth Dairy Regional Assistance Programme. It has been estimated that that programme, in the period it operated, created the equivalent of 2.2 new and sustainable jobs for every $50,000 of programme expenditure during the funding period, and 2.8 new jobs for every $50,000 of programme expenditure after the funding period (see Box 2). However, if the objectives of the current policy settings are widened—for example, to include greenhouse gas reduction and air quality outcomes—the cost per job of meeting the 350 ML target would have to be discounted accordingly.

Box 2 Regional job creation case study—the Commonwealth Dairy Regional Assistance Programme

In 2004, the Department of Transport and Regional Services commissioned Deloitte to evaluate the results of the Commonwealth Dairy Regional Assistance Programme (Dairy RAP) (Deloitte, 2004). The Dairy RAP commenced in early 2000, and through to June 2003, when the programme was officially subsumed into Regional Partnerships, initially funded 326 projects at a cost of approximately $66 million. Of these, 308 projects progressed through to implementation at a total cost of approximately $62 million.

The principal aim of the programme was to generate new job opportunities within regions affected by dairy deregulation. Funding was directed at organisations outside the dairy sector itself, so that dairy workers displaced as a result of deregulation would find gainful employment in other forms of economic activity within or close to the regions in which they lived. Jobs created for displaced dairy workers through the programme were expected to be sustainable beyond the period in which funding was used by the recipients.

Deloitte estimated that the Dairy RAP had created the equivalent of 2.2 new jobs for every $50,000 of programme expenditure during the funding period, or one new job for every $23,251 of programme outlays, and 2.8 new jobs for every $50,000 of programme expenditure after the funding period, or one new and sustainable job for every $17,596 of programme outlays.

Costs to the national economy

The economic effects of subsidising biofuels production in order to meet a biofuels target involve more than the budgetary costs of job creation. They can also include the losses in economic efficiency likely to arise from the use of transport fuels that were more costly to produce (such as ethanol and biodiesel) rather than the least-cost fuel (petrol or diesel), the economic losses associated with attracting resources such as labour and capital away from their most efficient use in other sectors of the economy, and the cost of having to raise additional taxation revenue.

Using ABARE's AUSTEM general equilibrium model of the Australian economy, the 2003 350 ML Target Report estimated that the full cost to the economy of meeting the 350 ML target would be $70.9–$74.3 million, depending on whether assistance was provided only for the additional biofuels production of 235 ML, or on total production of 350 ML. ABARE's recalculation based on current figures, and assuming the full 350 ML of production is assisted, yields an estimate of $90 million (in 2004–05 terms in 2009–10) and $72 million (in 2004–05 dollars) in the long term (post-2015). These economic effects can be partially offset by externalities that are not explicitly modelled, such as air quality, health outcomes, and greenhouse gas outcomes.

Even if increased biofuels production is uneconomic in the absence of government assistance, it can still be argued that increased biofuels production might be desirable from a regional development perspective. In such circumstances, government policy would be trading off lower average incomes across the economy with what might be perceived as a more equitable distribution of the remaining income across regions. It would also be reasonable to compare any perceived regional development benefits from supporting biofuels to alternative regional development policies that might be more cost effective or capable of being better targeted.

Conclusion 30: *The conclusion that the expansion of the Australian biofuels industry will result in costs on particular industries, regions, and the national economy rests on the proposition that much of the industry expansion now being proposed is unlikely to be viable in the long term without continuing assistance. ABARE modelling indicates that the costs likely to be imposed on the national economy through assisted expansion of the industry to 350 ML would be $90 million in 2009–10 and $72 million a year (in 2004–05 terms) in the long term.*

Balance-of-payments effects

Some submissions suggested that there may be various balance-of-trade benefits from the increased use of biofuels in Australia. However, many of these benefits would arise only if biofuels could be produced without government assistance.

When considering the trade deficit, it is important to consider what impact increased biofuels production would have on other industries. For example, increased biofuels production implies less availability of labour and of capital for other industries. If the industries from which the labour and capital are displaced are export producing, or import competing, the direct effect could be to more than offset any direct trade benefit from lower oil imports.

To determine the net impact of increased biofuels production on GDP, it is necessary to consider the relative profitability of the biofuels industry and the industries from which labour and capital is displaced by the expansion in the biofuels industry. When performing this comparison, it is appropriate to consider relative profitability net of any subsidies or assistance that the industries might be receiving. The reason that assistance needs to be excluded from the comparison is that, from a whole of economy perspective, they are merely a transfer from one part of the economy to another since, in the absence of the assistance, governments could reduce taxes on other parts of the economy or increase other expenditures[43].

Applying these principles to the biofuels industry suggests that were there no other reasons to promote biofuels production in Australia, it would be desirable for biofuels to be produced in Australia only if they can be produced more cheaply than other fuels (including oil) can be produced or imported. Average US and Brazilian ethanol prices reported for April–June 2005 were 37.4 USc/L[44], equating to 49.9 Ac/L. Whilst an allowance would need to be made for transportation costs, it would appear that biofuels can be sourced on world markets at significantly lower cost than domestic supply, given reported Australian ethanol sale prices in the mid-60 Ac/L range.

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[43] This point is also demonstrated by the fact that subsidies are subtracted when estimating GDP using the income definition: GDP = profits + wages + indirect taxes – subsidies.
[44] Starch and Fermentation LMC International June 2005.

Energy security implications of increased biofuels use

Submissions

Some submissions have argued that the government's policy position on energy security, as outlined in the energy white paper, *Securing Australia's Energy Future,* is out of date and doesn't fully incorporate the potential benefits that could attribute to energy security from increased biofuels use.

Renewable Fuels Australia identified increased energy security as a benefit to be attained from encouraging the development of a biofuels industry in Australia. Potential energy security benefits were articulated as:

- a greater level of energy security from a physical supply perspective as a result of
  - indigenous biofuels production extending fuel supplies and helping to reduce dependence on imported petroleum
  - indigenous biofuels production providing greater fuel diversity (and therefore lower risk) in both the source of, and type of, transport fuels used in Australia
- a greater level of energy security in an economic sense as a result of
  - indigenous biofuels replacing imported oil and hence lowering the cost of oil imports and assisting to offset higher costs from a balance of trade perspective
  - indigenous biofuels helping to offset the impact of greater reliance on imported oil, and higher world oil prices, on domestic petroleum prices faced by the consumer.

On the other hand, the Australian Institute of Petroleum questioned:

- whether or not biofuels have a meaningful role in increasing supplies of liquid fuels in a situation when crude oil and/or petroleum product supplies are curtailed
- whether or not biofuels have a meaningful role in reducing price spikes in crude oil and petroleum product prices
- whether or not biofuels have a meaningful role in replacing crude oil supplies as crude production declines in Australia and elsewhere
- whether or not biofuels have a meaningful role in reducing the import bill for crude oil and imported petroleum products and hence the national balance of payments.

Energy white paper

The government's policy on energy security is articulated in the energy white paper, *Securing Australia's Energy Future,* released in June 2004. At that time, the government concluded that Australia has a high level of energy security due to its:

- natural endowment of crude oil, vast coal and gas reserves, potential for renewable energy, and access to imported fuels
- extensive infrastructure to deliver power, gas and transport fuels to business and households
- good access to world markets.

The white paper also concluded that the level of security in transport fuels was not under threat.

In this context, the government considered energy security from a physical access perspective, noting that past disruptions have had a relatively small impact on world oil flows and have not had a major impact on the reliability of oil supplies to Australia. The government considered that multilateral efforts to ensure world markets remain open and effective response mechanisms to mitigate the impact of short-term supply disruptions were Australia's best path for providing continuity of oil supplies.

The government noted the benefits that could be derived as a result of Australia's access to potentially large sources of alternative fuels, including naturally occurring LPG and biofuels. However, the government considered the energy security value of biofuels to be limited by the availability of suitable feedstocks (without requiring the transfer of land use from other productive purposes) and by the significant subsidies required to develop biofuels compared with their conventional alternatives.

On that basis, the government concluded there was no case to accelerate the uptake of biofuels on energy security grounds. To do so would impose additional costs on consumers or taxpayers, with few energy security benefits.

The white paper included a requirement that a re-assessment of Australia's energy security position be undertaken every two years. The first biennial review of energy security will be considered by government in the second half of 2005.

The 2003 350 ML Target Report, completed in December 2003, also concluded that the 350 ML biofuels objective, representing 1.1% of Australia's total motor vehicle demand, was too small to make a material contribution to greater energy security. 'Moreover, achieving a higher target at greater economic cost appears unlikely to be a cost effective energy security strategy' (Beer et al., 2003, p. 27).

Since these assessments of the potential for biofuels to contribute to energy security were made, some stakeholders consider that a number of factors have altered and therefore consider that this policy is out of date and doesn't fully incorporate the potential benefits that could accrue to energy security from increased biofuels use.

In particular, stakeholders point to the greater clarity in expectations of a decline in Australia's level of oil self-sufficiency and a corresponding increase in net import reliance for petroleum fuels; and the substantial increase in oil prices since 2003.

Australia's level of oil self-sufficiency

ABARE[45] has predicted that Australia's dependence on imported oil and petroleum products will increase considerably over the medium to long term. Australia is a net importer of crude oil, with imports of 23.4 GL and exports of 17.5 GL in 2003–04. Current ABARE projections suggest that the consumption of petroleum products in Australia is likely to increase by 2.0% p.a., whereas domestic crude production is

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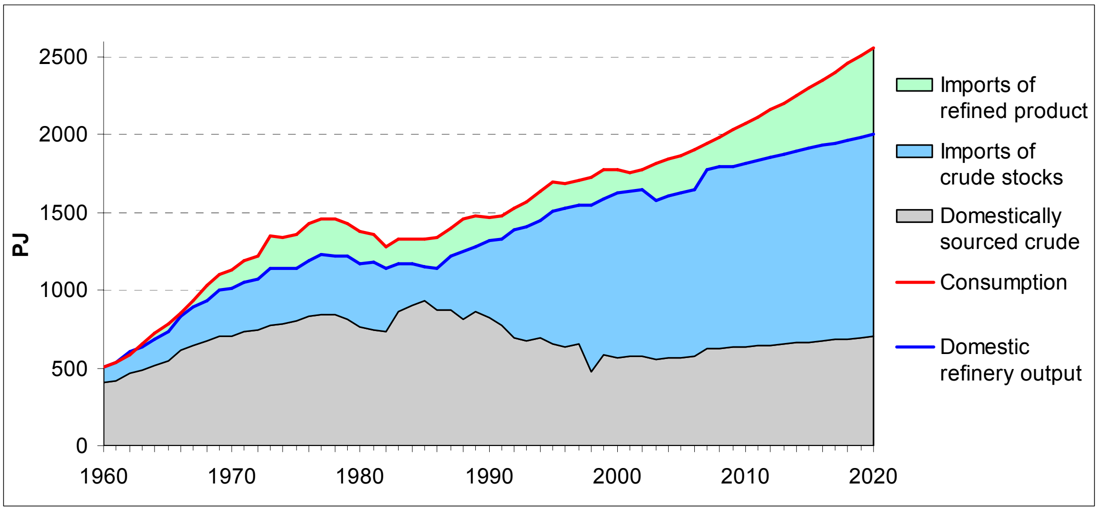
[45] ABARE, Australian Energy national and state projections to 2019–20 August 2004.

projected to fall by 0.6% p.a. over the period 2001–02 to 2019–20. ABARE forecasts Australia's reliance on imported liquid fuels to increase from 24% currently to 46% by 2019–20. This situation is reflected in Figure 8.

Figure 8 Australia's forecast demand and changing level of self-sufficiency



With an increase in the size of net oil imports, two questions can be considered:

- Does the nature of the risks change with the level of oil imports?
- Does the nature of the risks depend on the source of supply?

In a 2004 discussion paper on the *Liquid Fuel Emergency Act 1984*, ACIL Tasman identified a number of circumstances which could result in a disruption to oil supplies. These included:

- domestic events
  - damage to refinery/oil infrastructure, disrupting domestic supplies
  - industrial action
- global events
  - curtailment of global oil supply
  - damage to infrastructure.

The Taskforce considers that, irrespective of the source, the probability of events occurring that could result in fuel supply disruptions, and therefore raise the level of risk, does not increase with the level of Australian imports. This is because Australia is already dependent on imported oil for its crude-oil requirements and is a price taker on world markets:

- Australian crude oils are lighter and sweeter and can command higher prices on export markets, and Australian refineries source around 60% of their crude oil from international markets.
- Australian consumption of oil accounts for around 1% of world consumption and has an imperceptible impact on world oil prices. Further, domestic oil producers are unlikely to be prepared to sell crude oil or refinery output for less than can be received on the export market.

Consequently, Australian transport fuel consumers are already exposed to international supply disruptions to crude oil and, regardless of the level of oil imports, any unanticipated curtailment of international supply that results in increased international oil prices will also flow through to domestic oil prices in Australia. There is therefore no change in the level of risk faced and no change in the price of refined products to the Australian economy associated with changes in levels of domestic production of oil or refined products. Based on this, the level of import dependence is not an appropriate measure of energy security.

Nor does greater reliance on imported petroleum products with a longer associated supply chain (for example, from having to source greater quantities of oil from the Middle East) necessarily imply an increase in the level of energy security risk. The political instability of some countries in the Middle East has been a major factor behind concerns about transport fuel security, but these concerns should be placed in context. Past disruptions have had a relatively small impact on world oil flows and have not had a major impact on the reliability of oil supplies to Australia. Australia, like other countries, has faced increases in oil prices, often with significant economic impacts, but access to oil has not been a major problem. There is no reason to believe this situation will change as the level of crude-oil self-sufficiency declines in Australia over the next two decades.

Whether or not the risk changes, depends mainly on the ability of domestic importers to source supplies at short notice. It could be argued that greater reliance on imports and longer supply chains result in more regular and larger shipping volumes, leading to increased supply reliability due to greater flexibility in the supply chain.

Overall, the nature of the risk does not fundamentally change with an increase in the level of imports; nor does it change with the source of those imports. This is because increased Australian import requirements can be expected to have a negligible price impact and imports are likely to be sourced either through increased output from refineries in the region or through purchases via bilateral negotiations with trading partners or on spot markets. In any case, if greater reliance on imports is considered to increase the level of supply 'risk', the fuel supply industry is better placed to manage this risk than the government, whether through increased stock levels or other arrangements.

Fuel diversity

Energy security can be defined as 'the reliable and adequate supply of energy at reasonable prices' (Bielecki 2002). Diversifying the range of cost-effective transport fuels available to potential users can enhance reliability. Biofuels can also contribute to diversity of fuel supply and fuel type, subject to cost-effectiveness.

Increased diversity would be desirable if supplies of conventional fuels were threatened by physical disruptions to domestic or international production or distribution infrastructure. The Taskforce considers that there is no evidence to suggest this is a concern for Australia. This issue is being appropriately managed by the fuel supply industry, as evidenced by the fact that there have not been any significant, extended fuel shortfalls to the market.

Further, the extent of the potential contribution that biofuels can make to energy security is limited in scope and expensive to achieve. Biofuels currently contribute less than 0.1% of the automotive gasoline and diesel fuel market in Australia. If the 350 ML biofuel target is achieved by 2010, the contribution rises to around 1%.

Biofuels are not cost-competitive compared with conventional fuel alternatives and are expected to continue to require substantial and ongoing support to maintain their production and use. Therefore, achieving a level of biofuels production and use high enough to make a meaningful contribution to energy security (whether through excise subsidies or higher costs to consumers imposed through a mandate arrangement) would impose significant economic costs which would not be justified, given the government's assessment of energy security.

Were the government to consider there is a need to purchase a higher level of fuel energy security, the cost-effectiveness of developing biofuels as a strategy to increase fuel security would need to be considered against other options, such as developing other alternative fuel sources/technologies (such as coal to liquids; shale oil or gas to liquids), oil stockpiles and measures to encourage greater fuel-efficiency.

Conclusion

The Taskforce can identify no valid arguments to suggest that the Australian Government's policy position on energy security is not appropriate.

The government has determined that the level of Australia's energy security is already sufficient and that there is no need to purchase any more. The operation of a strong market for transport fuels, mitigation strategies by industry, and emergency response arrangements provide confidence in Australia's ability to provide reliable supplies and competitively priced fuels into the future.

Conclusion 31: *The Taskforce supports the energy white paper conclusion that 'there is currently no case for the government to accelerate the uptake of these fuels on energy security grounds'.*

Chapter 7 Consumer confidence and engine operability

Synopsis

- The Taskforce analysed consumer confidence in biofuels, and assessed that consumer confidence in ethanol, while having slightly improved, is still a significant problem for the ethanol industry. Biodiesel does not have the same consumer confidence issues associated with ethanol petrol blends. However, the Taskforce notes that confidence can be fragile and biofuel suppliers will need to ensure that consumers are properly advised on fuel blends and take care to meet fuel quality standards.

- Almost all post-1986 vehicles can operate satisfactorily on E10. As was known when setting the fuel standard in 2003, E10 is not optimal for vehicles that have carburettors or mechanical fuel injectors, mainly pre-1986 vehicles.

- As part of a broader campaign to assist in restoring confidence, and to assist vehicle manufacturers in determining the suitability of their vehicles for E10, further E10 vehicle operability testing is warranted.

- For post-1986 cars using E10 ULP, fuel consumption increases in the order of 2.6–2.8%. Discounted pricing strategies that reflected this would assist in encouraging uptake of ethanol-blended fuel.

- As part of an awareness campaign, the Federal Chamber of Automotive Industries (FCAI) vehicle list related to E10 suitability could be revised into a simplified format and confined to clear and accurate statements about the suitability of vehicles to use ethanol blend fuels.

- The Taskforce considers that there is no reason to reduce the maximum ethanol limit in petrol from 10% to 5%.

- Responsibility for consumer information about the fitness of fuel for its intended purpose rests mainly with fuel retailers and suppliers. In the light of that, the current fuel ethanol information standard could be simplified, primarily to require notification that the fuel contains ethanol at up to 10%.

- Given that an even higher percentage of cars can use E5 than E10, the information standard for fuel ethanol could be further modified so that labelling is required only above 5% ethanol in petrol, rather than 1% as at present. As in Europe, this would give fuel companies flexibility to use up to 5% ethanol as a fuel extender or octane enhancer, without the costs of dispensing E5 as a separate blend.

- A greater focus on industry-based information dissemination and marketing/promotional activity may improve consumer confidence in ethanol blend fuels.

- As B5 meets the diesel fuel standard, there is no justification for labelling B5 blends. Labelling higher biodiesel blends is a necessary piece of consumer information. Such labelling should be consistent with the proposed simplified ethanol label information standard.

- The government could work with the Australian fuels and transport industries to settle on B5, B20 and B100 as the standard forms of biodiesel, in part through developing a standard for blends above B5.

- There appears to be limited testing of the suitability of biodiesel for use in engines. The Taskforce notes, however, that there is no diesel engine manufacturing capacity in Australia and that, as a result, engine manufacturers will need to be guided by overseas testing and practice.

Ethanol

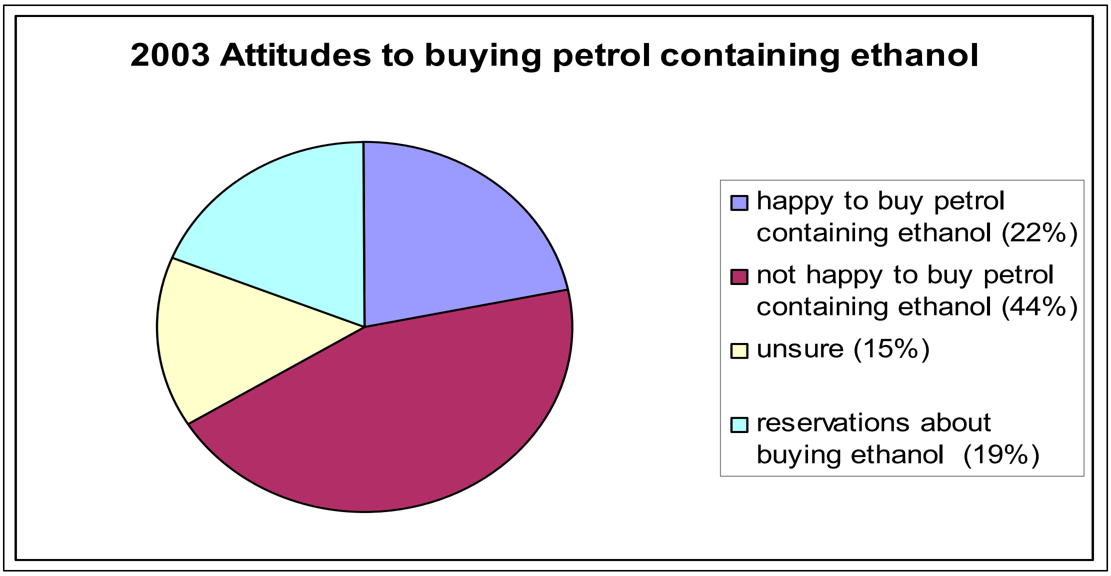
Consumer confidence remains a key barrier to the uptake of ethanol-blended fuels in Australia. Stakeholders, including representatives of the ethanol industry, oil companies and consumer groups, consider that consumer confidence needs to be addressed urgently if an Australian ethanol industry is to be further developed. A key aspect of consumer confidence is clear advice on which vehicles and engines can use ethanol blends.

Background

Consumer confidence was damaged significantly in 2002–2003 after reports of the distribution of high-concentration (20–30%) ethanol blends around Sydney, and widely publicised allegations of vehicle damage. At the time, the Australian Automobile Association (AAA) and other consumer advocates became concerned about the potential operability and additional motoring costs associated with ethanol-blended fuels.

In 2003, ANOP, on behalf of the AAA, conducted research on consumer sentiment. The research found that 22% of motorists were happy to buy petrol containing ethanol, while 44% were not, 19% had reservations and 15% were unsure (Figure 9). Of those who were not happy to buy ethanol or had reservations, 55% cited concerns about vehicle damage.

Figure 9 Attitudes to buying petrol containing ethanol, 2003



Source: ANOP (2003)

During 2003, evidence of low consumer confidence could also be seen in the suspension of petroleum company trials in Queensland. The ‘no ethanol’ signs, which appeared at many retail petroleum sites, reinforced low consumer confidence.

In 2002, BP received a grant under the Greenhouse Gas Abatement Programme (GGAP) for the production and marketing of E10 in the Brisbane region. Phase one, which commenced in May 2002, was a marketing trial at six Brisbane service stations testing E10 as 91 RON and 95 RON, with most volume sold as 91 RON. BP advised that phase one of the trial was technically very successful, with about 10 ML of E10 sold. However, in early 2003, BP suspended its trials in the wake of loss of confidence associated with public concerns that ethanol blends were causing vehicle damage in the Sydney region.

A 10% ethanol limit was announced by the government on 11 April 2003 and came into force on 1 July 2003 as an amendment to the fuel quality standard for petrol. This followed testing by the Orbital Engine Company (Orbital 2004a,b) of 20% ethanol in petrol (E20) blends on passenger vehicles and marine outboards. Orbital also tested outboards and other small non-automotive engines on E10.

Vehicle testing

APACE 1998 Report

The APACE report *Intensive field trial of ethanol/petrol blend in vehicles* (APACE 1998) compared E10 and regular unleaded petrol in terms of: greenhouse gas and noxious emissions; fuel consumption; vehicle driveability; fuel system component material compatibility; engine wear; and water tolerance.

In terms of hot and cold driveability, the research found that E10 blends reduced the tendency for engine knock under both hot and cold conditions, and observed no other significant differences. In terms of materials compatibility, APACE found no discernible effect on any plastic or elastomer materials, and no discernible corrosion in fuel-wetted metal parts such as fuel tanks, lines, or pressure regulators. In terms of engine wear, the research found no additional increase in wear metals or decrease in the total base number of the lubricating oil, and no additional or unusual wear than would normally be expected.

The APACE study confirmed that most cars in the fleet can operate satisfactorily on E10. The only adverse APACE findings for E10 related to water tolerance. The research found that pre-1986 vehicles are more prone to phase separation when first fuelled with E10. The research also found that subsequent E10 fuelling prevents water accumulation and thus separation is not a concern, provided that good housekeeping is adopted. The research concluded that: the quality of ethanol produced and stored in its neat form must be of a high standard and the water content maintained below 1.25% w/w; and an ethanol compatible water detecting paste must be used to establish the water content of underground storage tanks.

The NSW EPA provided figures to the Taskforce indicating that pre-1986 models represent about 4.09% of the number of cars in the 2005 Sydney fleet and 1.98% of the kilometres travelled (because of older cars driving fewer kilometres).

Orbital's 2004 E20 Report

Orbital's passenger vehicle study (Orbital 2004b) focused on the impact of E20 on vehicle performance in terms of emissions and operability, and on the durability impacts on post-1986 vehicles. Overall, impacts on post-1986 vehicles were found to be small.

Orbital's testing concluded that E20 could cause problems (including hesitation and problems with starting) in very cold conditions, and deterioration of metal, plastic and rubber components, particularly in pre-1986 vehicles. Over mileage, the testing subsequently found increased tailpipe emissions and greater levels of engine wear in vehicles operating with E20 compared with those operating with petrol.

The fuel system assessments highlighted some small differences in durability performance between the two fuels; the most significant finding related to the 'fuel filter pressure drop' assessment. While no changes were identified as significant in absolute terms (that is, there were no blockages or failures), Orbital found that the filter systems operating with E20 were relatively less restrictive after the mileage accumulation cycle than those systems operating on gasoline. This suggested that E20 might affect the filter element. The fuel pumps running on E20 generally had a slightly higher relative increase in electrical current draw after the mileage accumulation cycle. The trend was for current draw to increase as the pumps wore. Orbital argued that the relative increase in the E20 fuel pumps could suggest an increased level of wear.

The vehicles that completed the 80,000-kilometre durability assessment did so without major incidents related to the fuel type used. However, there was some evidence suggesting differences in both wear and deposits. Two of the vehicles tested also showed problems with their catalytic converters, evidenced by increasing emissions. Greater levels of wear were observed for engines run on E20 compared with those run on gasoline. Even though wear levels were small in absolute terms, differences could be seen in the piston skirt wear, cylinder bore wear, valve seat recession and piston ring gaps.

Orbital also found that the vehicles tested on E20 had greater levels of deposit on the intake and exhaust port, piston rings, skirt and crown and exhaust and/or intake valves. The effects of the mileage accumulation cycle on the fuel system in terms of deposits and durability were small, with no major failures or changes observed that would compromise the vehicle system's performance. There were no significant fuel specific trends observed in this area.

The APACE 1998 report and the Orbital E20 study compared

The method used for the Orbital testing was different from the 1998 APACE report. While the Orbital study tested five vehicle pairs run over the scheduled 80,000-kilometre accumulation for all assessment categories, the APACE report tested four vehicles in some assessment categories, and assessed only one catalytic converter for example. It is unclear how accurately the assessed vehicles represented the Australian vehicle fleet and there was no formal drive cycle. For the 2004 Orbital study, new cars were selected on the basis of sales volume in the Australian market for 2001. While the Orbital study undertook testing on both imported and domestically manufactured vehicles, the APACE study tested domestically built vehicles only.

The Taskforce, however, notes that there is limited recent testing on the suitability of the current Australian vehicle fleet for E10 blend fuels. While the APACE report was a valuable study, it was done seven years ago and was not representative of the Australian vehicle fleet, and the Orbital work tested E20, which is now not a legal fuel blend.

The AAA has indicated its willingness to undertake in-service testing on the suitability of E10 for the Australian vehicle fleet with government support. The AAA believes that a testing programme would cost about $1 million.

Conclusion 32: *Almost all post-1986 vehicles can operate satisfactorily on E10. As was known when setting the fuel standard in 2003, E10 is not optimal for vehicles that have carburettors or mechanical fuel injectors—mainly pre-1986 vehicles. Drivers should seek advice from manufactures about the suitability of fuel types if they are not certain about their particular model.*

Conclusion 33: *As part of a broader campaign to assist in restoring confidence, further testing could usefully validate the suitability of vehicles in the current fleet to operate on E10.*

Marine outboard and other small non-automotive engine testing

Orbital also tested a sample of two-stroke outboard marine engines with petrol containing both E10 and E20 (Orbital 2003). For E20, Orbital found that, during wide-open throttle acceleration, the two-stroke outboard marine engines would stall. Orbital also found that engine misfire frequency increased and that it was hard to maintain a constant engine operating speed during the in-gear motoring test. Orbital argued that this engine stall characteristic potentially adversely affects engine operation.

In general, Orbital detected little performance difference when comparing two-stroke outboard marine engines run on E10 versus regular unleaded petrol. However, Orbital did find during the demand of wide-open throttle acceleration following the in-gear low-speed test at the lowest tested speed, that one of the ten tested engines stalled. For both E10 and E20, Orbital found that those engines that had stalled could be restarted immediately. As ethanol blends are prone to phase separation if there is water in the tank, use of ethanol blends in marine environments requires care.

Victa Lawncare, a major supplier of lawnmowers in Australia, in 2003 reported experiencing problems related to ethanol blends with its two-stroke engines. Victa has argued that the high percentage blends of ethanol in circulation at the time affected many components, especially plastic and rubber parts. Victa saw an increase in warranty claims, and reported a higher incidence of concerns about engine performance.

Conclusion 34: *The Taskforce notes that, while the 2003 E20 Orbital study was important in determining the ethanol limit and the suitability of certain engines for using ethanol, it is now of limited relevance to an assessment of vehicle operability at 10% ethanol blends. The E10 study of two-stroke outboard and other small engines suggests that E10 may not be suitable for two-stroke engines. The risk of phase separation in ethanol blends, and the resulting risk of these smaller engines stalling, means that use of ethanol blends requires care in a marine environment.*

Fuel consumption

Fuel consumption is another factor that may impede consumers purchasing ethanol blend fuels if they are sold at equivalent prices to petrol. The ANOP surveys in both 2003 and 2005 identified consumer concern about vehicle performance as a specific reason for their lack of interest in ethanol fuel.

More E10 fuel is required than petrol to do the same amount of work, because ethanol has a lower energy density (68% compared with petrol in terms of MJ/kg). Therefore, fuel consumption should theoretically increase when ethanol is blended with petrol due to the lower energy content of ethanol. Post-1986 vehicles that operate with E10 in closed loop control should see a theoretical increase in fuel consumption of approximately 3.6% in volumetric terms, or 4.3% in mass terms.

The Orbital Engine Company examined the fuel consumption (petrol and E10) of vehicles then representative of the Australian fleet. Five post-1986 vehicles and four pre-1986 vehicles were evaluated for the experimental study. The study found fuel consumption (in terms of L/100 km) to increase for *post-1986 vehicles* using E10 over both the city and highway drive cycles by 2.9% and 2.7%, respectively. The variation between theoretical and actual fuel consumption may be the result of subtle differences in both the calibration strategies and the engine management system adaptation process. Any improvement in combustion efficiency is of a second order compared to the relative change in energy content of the two fuels. Oxygen entrained with the fuel mixture may well improve the flame propagation, and hence the thermal efficiency, but its relative magnitude would appear to be small (Orbital Engine Company, personal communication 2005).

On the other hand, fuel consumption was found to be unchanged for pre-1986 vehicles, operating open loop, probably because of the leaner air/fuel mixture. This finding agrees with Orbital's E20 literature review (Orbital, 2002).

In summary, the Orbital study suggests that the impact of E10 on the fuel consumption of pre-1986 vehicles (with open-loop fuel systems) may be negligible, but that there will be an increase in consumption of typically 2.8% for post-1986 vehicles, because of their closed-loop fuel control. APACE Research found that E10 increases fuel consumption by 2.6% for both the city and highway cycles.

The Taskforce also considered the findings of the 2004 AEA Technology Report[46] but found that, in relation to fuel consumption, there were no overall statistically significant results from this study. Six cars were tested, two of which showed statistically significant results, one for increased fuel consumption and one for decreased fuel consumption.

The Manildra Group's submission noted that the use of ethanol blend fuel increases the combustion efficiency of the fuel and argued that consumers do not detect a difference in their fuel economy. While it is likely that a consumer would find it difficult to detect a 2–3% difference in fuel economy, available test data suggests these increases are real for post-1986 vehicles. The Taskforce notes that the actual increases in fuel consumption are lower than what would have been theoretically expected.

From a consumer perspective, on a pure energy content it is reasonable to expect that this increase in fuel consumption should translate into ethanol blend fuels costing 2–3% less at the pump. The Taskforce notes that ethanol fuels are, in some cases, being marketed at an equivalent price to traditional fuels. While this is a commercial decision on the part of fuel suppliers, a pricing strategy reflecting increased fuel consumption with E10 could assist in encouraging uptake.

Conclusion 35: *For post-1986 fuel-injected cars using E10 ULP, fuel consumption increases in the order of 2–3%. Pricing strategies reflecting this would assist in encouraging uptake of ethanol blend fuel.*

FCAI vehicle list

As part of the work of the Ethanol Confidence Working Group, established in May 2003 to assist in building consumer confidence, the Federal Chamber of Automotive Industries (FCAI) released detailed advice as to which vehicles could operate satisfactorily on E10 blends. This advice is available at Appendix 5.

The list provides advice from individual vehicle manufacturers and importers on which vehicle models will, may not or do not operate satisfactorily on E10. The list was meant to be an authoritative statement of manufacturers' advice on the suitability of E10 for their vehicles. The FCAI endorsed the statement that 'most new and many' pre-1986 vehicles can run on E10 blend petrol. Local manufacturers Holden, Ford,

[46] Ethanol Emissions Testing for the UK Department for Transport, Local Government and the Regions by AEA Technology, March 2002, revised in September 2004

Toyota and Mitsubishi indicated that their petrol engine vehicles since 1986 will operate satisfactorily on E10, with the exception of some specific models. The list also gives technical reasons as to why the manufacturer does not consider certain models suitable for E10.

The biofuels industry has argued that the advice provided by manufacturers in Australia differs from the position taken by those same manufacturers in the United States, where all cars are warranted to run on E10. In response, vehicle manufacturers have indicated that components are tailored to particular markets and that even cars which appear identical to the casual observer, use different components in different markets.

Renewable Fuels Australia has argued that manufacturers are not prepared to endorse the use of E10 in pre-1986 vehicles, because of liability concerns. In consultations with the Taskforce, manufacturers' representatives acknowledged that, at least in some cases, vehicle manufacturer statements concerning the suitability of particular vehicle models to satisfactorily use E10 were limited to what could be said on the basis of European testing on E5 blends. In the absence of testing, which they asserted could not be justified commercially for non-current models, manufacturers adopted a cautious approach to statements about E10 suitability for their models.

On this basis, the Taskforce notes that much of the caution evident in the information contained in the FCAI vehicle list is not supported by vehicle testing.

The Taskforce notes the concern of vehicle manufacturers about the E10 vehicle list being used by consumers as a statement about whether or not vehicle manufacturers warrant vehicles to use ethanol blend fuels or even recommend these fuels. While the position of vehicle manufacturers is understandable, the E10 list was meant to be a statement of the suitability of ethanol blend fuels for certain vehicles, not a statement representing warranty positions or fuel recommendations.

The Taskforce also notes the complexity of the vehicle list could be undermining consumer confidence and that information advising consumers of the suitability of a particular vehicle to use ethanol blend fuels could be provided in a less confusing manner, for example in automotive handbooks or somewhere on the vehicle. This could include information on fuel filler caps or in pamphlets available at the service station.

Conclusion 36: *As part of an awareness campaign, the FCAI vehicle list could be revised into a simplified format and confined to clear and accurate statements about the suitability of vehicles to use ethanol blend fuels. Automotive manufacturers should present fuel suitability information to consumers in a less confusing manner.*

PULP E5 versus E10

During consultations with the Taskforce and in its submission, the FCAI argued that the limit for ethanol in premium unleaded petrol (PULP) in Australia should be 5%, rather than 10%.

The FCAI noted that many imported vehicles, particularly high-performance vehicles, increasingly use advanced emission control technologies and therefore have more stringent fuel quality requirements, and will increasingly need PULP 95 RON fuel. According to the FCAI, if vehicles with engines optimised to run on 95 RON and a maximum of E5 use petrol blends with greater than 5% ethanol, they may suffer driveability problems and have increased levels of exhaust and evaporative emissions.

The FCAI notes that Australian fuel and vehicle emission standards are being broadly harmonised with UNECE (United Nations Economic Commission for Europe) standards, although the unlabelled ethanol limit in petrol under the UNECE standard is 5%, while Australia allows 10% labelled. This alignment with European fuel standards is facilitating the use in Australia of the latest engine technologies to reduce both emissions and fuel consumption.

Given that there is an E5 limit in Europe and that about 70% of post-1986 vehicles are imported, the FCAI advocates an E5 cap on PULP.

The FCAI also noted that post-1986 vehicles have been tested and certified in Europe for E5 fuel. On this basis, the FCAI considered that a reduction in the ethanol limit from 10% to 5% could provide the basis for a clearer statement from vehicle manufacturers about vehicle suitability for ethanol-blended fuel. The FCAI indicated that all post-1986 vehicles could operate satisfactorily on E5.

The Australian Government set an ethanol limit of 10%, with a consumer label, in response to concerns about the impact of ethanol blends above 10% on vehicle operability. While the limit of ethanol in PULP to 5% may result in fewer (especially European) manufacturers advising against ethanol blends, vehicle studies and experience with the Australian fleet do not identify operability problems that would justify revising the ethanol limit downwards. The Taskforce considers that there no reason for a reduction in the limit and in consumer choice. The Taskforce notes that the UNECE fuel standard does allow for higher than 5% ethanol blends, subject to them being labelled.

The 1998 APACE study indicates that most cars in the fleet can operate satisfactorily on E10. The FCAI has also endorsed the statement that ‘most new and many pre-1986 vehicles can run satisfactorily on E10 blend petrol’. In consultations with the Taskforce, the FCAI was unable to identify a single incident of vehicle operability concern associated with E10 since the 10% ethanol in petrol limit came into force.

Further, BP, Caltex, Manildra Park and a number of independents have been marketing ethanol-blended fuels at 10% for over two years without a single technical problem reported. BP has sold a total of 13 ML of E10 and fully endorses E10 as part of its brand. E10 has been sold under Caltex’s Bogas brand since 1996, with about 40 ML of ethanol (or about 400 ML of E10) sold over that period, and Manildra has consistently noted a similar view.

On the whole, testing and trials show that E10 does not cause operability problems in post-1986 vehicles (that is, those vehicles with electronic fuel injection systems).

There are also other drawbacks with a reduction in the ethanol limit including:

- given that almost all new cars can use E10, such a step could be seen as going backwards, potentially being perceived as the government having less confidence in ethanol fuels and further undermining consumer confidence

- an E5 limit would reduce marketing flexibility by not allowing E10 to be blended in both unleaded petrol and premium unleaded petrol.

Conclusion 37: *The Taskforce considers that there is no reason for a reduction in the maximum ethanol limit in petrol from 10% to 5%.*

Ethanol labelling

With the intent of ensuring consumers are advised if a fuel contains ethanol, an ethanol fuel quality information standard took effect on 1 March 2004. The *Fuel Quality Information Standard (Ethanol) Determination 2003* specifies the labelling requirements for the ethanol–petrol blends sold in Australia.

The ethanol label in its current form (Figure 10) is regarded by the fuel ethanol industry as having, unnecessarily in its view, the character of a warning label.

Figure 10 The mandatory label in its current form

The Taskforce sought legal advice on government labelling regulations. In light of that legal advice, which draws attention to the fact that retailers already have trade practices and commercial law obligations regarding the fitness of the fuel for its intended purpose, the Taskforce considers that the government's current labelling requirements can be simplified. For E10, the label would simply identify the fuel as a blend of ULP or PULP (octane specified) with up to 10% ethanol.

Advice to the Taskforce has confirmed that labelling of ethanol in petrol in Europe is required only when ethanol blends are greater than E5. This is because up to 5% ethanol is permitted as an oxygenate in the European fuel standard for petrol (European directive 98/70EC), and the Worldwide Fuel Charter also nominates a maximum of 5% ethanol in petrol. Therefore, ethanol can be present in petrol in Europe up to 5% without a requirement to separately advise consumers. This is because European vehicles are designed, tested and certified for use of E5.

Conclusion 38: *Responsibility for consumer information about the fitness of fuel for its intended purpose rests mainly with fuel retailers and suppliers. In the light of that, the current fuel ethanol information standard could be simplified primarily to require notification that the fuel contains ethanol at up to 10%.*

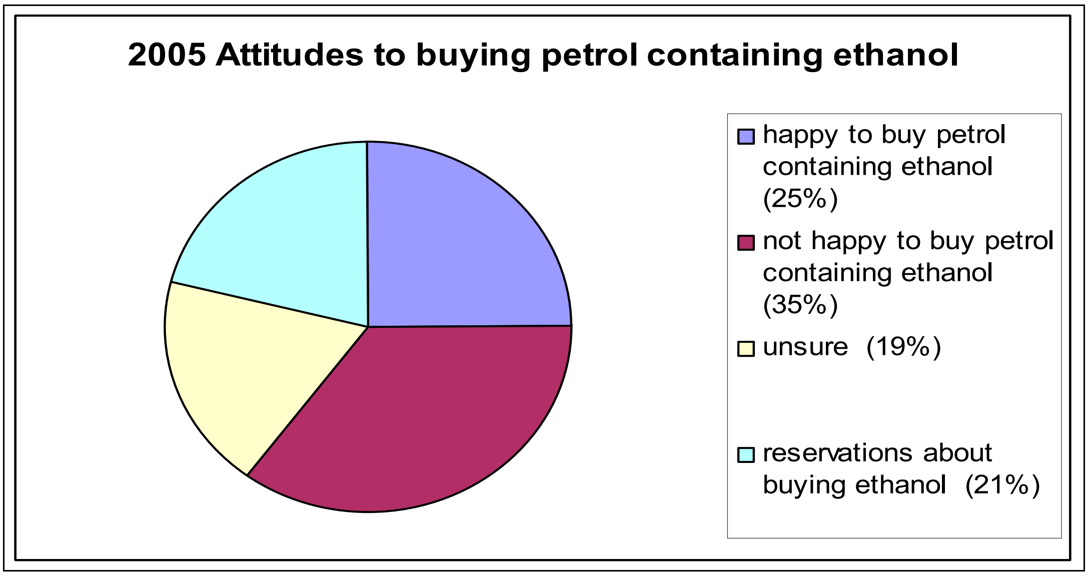
Conclusion 39: *Given that an even higher percentage of cars can use E5 than E10, the fuel ethanol information standard could be further modified so that labelling is required only above 5% ethanol in petrol, rather than 1% as at present. As in Europe, this would give fuel companies flexibility to use up to 5% ethanol as a fuel extender or octane enhancer, without the costs of dispensing E5 as a separate blend.*

Recent trends in confidence

There are some signs that consumer confidence has recovered slightly since 2003. These include the results of the 2005 ANOP motorist survey, the recommencement of trials by BP and Caltex, and recent indications from Shell and some independents that they are intending to become involved in marketing E10.

The 2003 ANOP research was repeated in 2005, showing small improvements in consumer confidence. Key findings were that 25% of motorists were happy to buy petrol containing ethanol, 35% were not, 21% had reservations and 19% were unsure (Figure 11). Of motorists who were not happy to buy ethanol or had reservations, 50% still had concerns about vehicle damage and 23% wanted more information.

Figure 11 Attitudes to buying petrol containing ethanol, 2005



Source: ANOP (2005:14).

Figure 12 Attitudes to buying ethanol in petrol, 2003 versus 2005

Main Reasons for Attitudes to Ethanol in Petrol	2005	COMPARE 2003 TOTAL
Why happy to buy:	The 25%	The 22%
	▽	▽
1. No problem with it. Makes no difference	13	13
2. Environmental benefits. Renewable source	5	3
3. Provided it's limited. If it doesn't affect car	4	5
Why have doubts:	The 56%	The 63%
	▽	▽
1. Concerned about damage to engine. Unsafe	28	35
2. Don't know enough. Need more information, facts	13	14
3. Concerned about performance. Not suitable for my car	5	4

- Main responses to open-ended question -

Source: ANOP (2005:14).

Despite the small improvements in consumer attitudes to ethanol identified by the 2005 ANOP survey, it is clear that consumer confidence in ethanol blends is still low and remains a key barrier to their further uptake in Australia.

Confidential research conducted by oil majors also identified consumer confidence as still being a major barrier. Consumers indicated that they need more information about E10 and the effect of the fuel on car engines.

Some fuel retailers in Queensland and New South Wales display 'no ethanol' signs either on price billboards or at the pump. These signs were first displayed in 2003 after the controversy about reportedly high-percentage ethanol blends and vehicle damage, and have reduced consumer confidence even further. Some effort has been made to encourage relevant players to remove the signs.

Queensland Government response on consumer confidence

As part of its boarder ethanol industry development policies, the Queensland Government has implemented a range of initiatives during the past two years designed to assist the development of consumer confidence in ethanol blends. The V-8 Ethanol Blueprint announced on 21 June 2004 included a commitment that the government's vehicle fleet (approximately 13,000 vehicles) would run on E10 where possible and would also display pro-ethanol stickers. While the blueprint focused heavily on the promotion of ethanol and the provision of information to consumers, it contained no significant financial support. Consumer confidence elements of the blueprint include: the inclusion of information about the suitability of E10 (consistent with manufacturers' advice) in all motor vehicle registration renewal notices; the launch of an ethanol website providing the latest information to consumers and industry[47]; working with vehicle manufacturers to ensure that fuel and engine technologies are optimally compatible; and encouraging service stations in Queensland to sell E10.

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[47] http://www.ethanol.qld.gov.au

The Queensland Ethanol Industry Action Plan announced in April 2005 has also sought to: raise public awareness of and confidence in ethanol-blended fuels; increase domestic demand and export capacity; create links between industry and the Queensland Government to promote a market for ethanol; and assist the development of retail and distribution networks.

On 9 May 2005, Premier Peter Beattie announced the Ethanol Conversion Initiative, a programme designed to assist the Queensland ethanol industry to improve its capacity to market ethanol-blended fuels and to assist diesel-based fleet operators with technical conversions to allow the use of diesel–ethanol blends. The conversion initiative falls under the previously announced Queensland Ethanol Industry Action Plan. Targeted projects under the conversion initiative include: conversion of existing fuel storage tanks to support E10; establishment of E10 storage and blending facilities; signing and rebadging of fuel distribution facilities; and conversion of fleet vehicles for the use of diesel–ethanol blends.

Effectiveness of the Queensland policies

Reports suggest that the Queensland Government's use of E10 in its fleet uptake has been low but is improving. Sales of fuel ethanol by the two Queensland-based fuel ethanol producers have increased to 2.55 ML in 2004–05, or by 146% compared with 2003–04. Fuel purchasing data indicates that in the six-month period January–June 2005 E10 purchases by volume for QFleet increased from 31,486 litres to 171,302 litres.

There are 51 service stations that currently retail E10 in Queensland, more than half of them located in major regional centres including Cairns, Townsville, Mackay, Rockhampton, and Toowoomba. The remainder are in the Brisbane and Gold Coast regions.

In February 2005, in conjunction with assistance provided by the Queensland Government, BP launched a promotional campaign in the Mackay region which included an E10 logo, a mail-out including a $10 voucher for the fourth E10 fill, and radio, television, and billboard advertising.

The 2005 ANOP research also found that motorists in Queensland are more favourably disposed to buying petrol with ethanol (35% of Queensland motorists—versus a national average of 25%—were found to be 'happy to buy' ethanol), indicating that targeted efforts have had some impact.

Discussion

The Taskforce considers that consumer confidence is a key issue impeding market uptake. Almost all submissions identified this:

- ExxonMobil noted it will take time and the concerted efforts of all parties to restore consumer confidence in ethanol-blended fuels.
- CSR suggested that the Australian Government should find ways to positively assist the industry to build confidence in fuel ethanol.

- The Australian Institute of Petroleum suggested that a sophisticated communications strategy is needed to address consumer confidence issues and that the government's role could be strengthened in this area.
- The Independent Petroleum Group called for the government to be proactive in promoting ethanol and biodiesel blends to the automotive industries.

In the light of the positive results possible from targeted promotional activity (as noted in discussions with fuel suppliers and the Queensland Government), the Taskforce considers that greater focus on industry-based information dissemination and marketing/promotional activity can assist in building consumer confidence and, in turn, encourage greater consumer uptake of ethanol-blended fuels. The Taskforce notes that confidence-building measures are likely to work only if they have the support and involvement of vehicle manufacturers and automobile associations and if the messages to consumers are accurate and complementary. The Taskforce believes that some of the findings of this report could form the basis of accurate and positive consumer information about biofuels.

Conclusion 40: *Greater focus on industry-based information dissemination and marketing /promotional activity may improve consumer confidence in ethanol blend fuels.*

Biodiesel

Consumer confidence

Biodiesel does not have the same consumer confidence problems as ethanol blends. However, the Taskforce notes that confidence can be fragile, and that the biodiesel industry will need to ensure that consumers are properly advised on fuel blends.

Vehicle operability

Advice from engine manufacturers is that the maximum biodiesel blend for the current fleet should be no greater than 5% (B5). Manufacturers have indicated that higher blends raise significant issues involving engine performance, efficiency, emissions and warranties. The Trucking Industry Council and the Australian Trucking Association support the manufacturers' advice.

In Europe, vehicles are designed for diesel fuel containing a maximum biodiesel content of 5%. This limit is a requirement of the fuel injection equipment manufacturers. As the diesel fuel specification permits up to 5% biodiesel, its presence does not require labelling (as for E5) in Europe. The Taskforce understands that there are proposals to increase the maximum level of biodiesel in European fuel standards to 10%.

Several local governments in Australia have undertaken trials of biodiesel at higher percentages.

Camden (NSW) Council trial

In 2003–04, Camden Council conducted a six-month trial comparing the performance of 100% biodiesel (B100) to that of ultra-low sulphur diesel (ULSD) in two of the council's waste collection vehicles under normal operating conditions. In particular, the council sought to reduce tailpipe emissions from its diesel-powered waste collection fleet. The vehicles' engines were not modified for the trials.

The trial showed no increase in biodiesel fuel consumption measured in litres per hour and a slight increase (3%) measured in litres per kilometre. A power loss of 17% at 80 kph was recorded under test conditions on the dynamometer. The drivers did not readily observe the loss of performance attributed to the reported power loss from the biodiesel during the operational trial.

Before the trial, the biodiesel truck engine was dismantled and assessed for condition. Two independent mechanical assessments undertaken at the completion of the trial showed no evidence of abnormal mechanical wear and tear for biodiesel compared with petroleum diesel. The engine oil in the biodiesel vehicle was tested after each service to monitor potential dilution. The results showed no difference in oil dilution.

Newcastle (NSW) City Council trial

The Newcastle City Council has also undertaken a biodiesel trial, which involved 12 vehicles using diesel, filtered diesel and biodiesel (B20). The vehicles' engines were not modified for the trials. The vehicles used included light-duty four-wheel drives, light- and medium-duty trucks, and garbage collection vehicles. While the trials largely sought to measure emissions from the vehicles using the various fuels, the council also conducted a maintenance testing regime. The engines were disassembled and inspected before and after the trials.

While the maintenance testing is still being undertaken (the final report is due by the end of 2005), at this stage there is no evidence of vehicle damage or operability problems in the vehicles operating on B20. The council reports that B20 biodiesel fuel had no significant affect on fuel consumption and power at 80 kph.

South Australian biodiesel trial

A trial of a bus run on B20 was conducted in South Australia from June 2002 to February 2003. At the conclusion of the trial, the vehicle had travelled over 25,000 kilometres. Vehicle performance using B20 was found to be comparable to performance using petroleum diesel.

Peugeot biodiesel passenger vehicle testing

Peugeot Automobiles Australia provided the Taskforce with the results from extensive testing of passenger vehicles run on up to B30 in Europe since 1991. Peugeot tested B30 on: 800 vehicles driving under normal conditions and seven vehicles on endurance testing covering a total of 614,000 kilometres; Peugeot passenger cars since 1991 in the Paris area; and over 4000 vehicles covering a total of 200 million kilometres.

Peugeot reported no vehicle operability problems from any of its testing. The company considers that biodiesel provides good lubricity of the injection system and requires no major modification of the engine or vehicle. Peugeot considers that B100 is unsuitable for engines because of its low stability, low cetane and high viscosity, causing oxidation, deposits and fouling. The company considers that B100 would require the adaptation of materials, particularly elastomers, in the engine. In Europe, Peugeot and Citroën diesel cars are guaranteed to run on B30, as long as the biodiesel blends conform to quality norms.

A number of oil companies, including majors and independents, have indicated to the Taskforce their intention to become involved in the marketing of biodiesel blends.

While there have to date been no serious consumer confidence issues associated with biodiesel, and it is important that this circumstance be maintained. Currently, biodiesel is being marketed in Australia at a range of different blends, with consumers not always aware of the percentage of biodiesel in the blend. It is important for consumers to be told what they are buying, ie pure biodiesel or a blend and, if a blend, the concentration of biodiesel in the blend. It is also important that information be available to assist consumers in making appropriate fuel choices. The Taskforce considers that there is a gap in this information.

Standard international practice is for the marketing of B5, B20 and B100 biodiesel blends, with the dominant blends being B5 and B20. There appears to be little or no original engine manufacturer acceptance of blends other than B5 or B20. Warranty acceptance is a key factor in growing the biodiesel industry domestically, and these two standard blends offer the best prospects for market growth. The Taskforce notes advice from fuel companies and others that biodiesel blends of up to 5% meet the Australian fuel standards for diesel.

Conclusion 41: *As B5 meets the diesel fuel standard, there is no need to label B5 blends. Labelling at higher biodiesel blends is a necessary piece of consumer information but could be relatively straightforward with the simplified ethanol label suggested previously.*

Conclusion 42: *The government could work with the Australian biodiesel industry to suggest B5, B20, and B100 as the standard forms of biodiesel, in part through fuel standards for biodiesel blends.*

Conclusion 43: *As for E10, there appears to be limited testing of the suitability of biodiesel for use in engines. The Taskforce notes, however, that there is no diesel engine manufacturing capacity in Australia and, as a result, engine manufacturers will need to be guided by overseas testing and practice.*

Chapter 8 Other market uptake barriers

Synopsis

- A key barrier to uptake of biofuels into the market, cited by both oil companies and biofuel producers, is the high level of commercial risk associated with market entry.

- Two situations are considered in this analysis: ethanol producers selling their product to the oil majors with the oil majors responsible for the delivery of ethanol blend petrol; and the ethanol producers purchasing petroleum from the oil majors for blending with ethanol to then supply ethanol blend petrol.

- Commercial risks for the oil majors are very high and are associated with low levels of consumer confidence and therefore a lack of consumer demand for the product; establishing a pricing regime that appropriately balances risk and results in reasonable returns; and additional infrastructure costs and supply reliability concerns. These risks are higher for 'first movers'.

- For new biofuel producers, long-term supply contracts are required by project financiers and investors to underpin investments, and investments are considered high risk given the lack of consumer demand.

- For the oil majors, commercial benefits from the use of biofuels could be to use them as fuel extenders and, potentially, to use of ethanol as an octane enhancer, although the oil majors need for higher octane ratings is yet to be determined for the Australian market. The perceived environmental benefits of biofuels could also be translated into commercial advantage.

- For the oil majors, the commercial benefits are not seen as justifying the commercial risks and there is little commercial incentive for them to develop a mainstream market for ethanol blend fuel. In the absence of improved confidence, and unless first mover risks are managed, there will be, at best, continuation of small, trial-based marketing of fuel ethanol by the oil majors. However, there could be attractive market segments for the independent fuel retailers if confidence is improved.

- There are a number of relatively low cost options that stakeholders have suggested the government could consider in this area without affecting current market structures. For example, small grants to offset infrastructure costs and so assist independent fuel retailers enter an embryonic E10 market, and/or consideration of biofuel use in the Australian Government fleet.

- RVP limits have the potential to be a barrier to the uptake of ethanol blends, and particularly for the use of ethanol as an oxygenate. The government could work with the states/territories to discuss approaches to RVP that are transparent, nationally consistent and take full account of the latest information on the impacts of ethanol blends on air quality.

- Lack of access to the existing fuel distribution network was identified as an impediment to the uptake of biofuels, eg petrol suppliers refusing to fill tankers preloaded with 10% ethanol. The Taskforce concludes that lack of access to infrastructure and to petroleum for blending are not artificial barriers to the uptake of biofuels.

- The Taskforce notes the potential for further damage to fragile levels of consumer confidence if consumers fail to understand the nature of octane claims made by some fuel retailers.

High levels of commercial risk

A key barrier to uptake of biofuels into the market, cited by both oil companies and biofuel producers, is the high level of commercial risk associated with market entry. This is a particularly important issue for ethanol. Commercial risks are present in a number of important aspects associated with market entry, including the following:

- From the oil company perspective, low levels of consumer confidence in fuel ethanol have resulted in little or no demand for the product. Consequently, the oil majors are reluctant to enter into long-term supply agreements with either current or prospective ethanol producers, as they are concerned that losses could occur if consumer confidence is not resolved. In turn, the lack of long-term supply agreements has been cited as a key barrier by ethanol producers, particularly for those prospective producers who require ‘bankable’ supply agreements with fuel retailers to underpin project financing.
  - The oil majors have noted that normal contractual arrangements in the fuel supply industry are for six month contracts, whereas ethanol producers are generally seeking longer term arrangements.
- First mover concerns. This relates to the higher risks taken by first movers into the market in terms of additional costs, brand exposure and potentially stranded infrastructure, lower profitability and reduced market share. Given the highly competitive nature of the downstream petroleum industry, there is potential for a first mover strategy into fuel ethanol to backfire if confidence issues are not resolved.
- Establishing an appropriate pricing regime for fuel ethanol is another clear commercial risk. Some biofuel producers are seeking fixed price contracts for their biofuels, in which prices do not fluctuate with oil price movements. Such a mechanism would provide certainty to biofuel producers but result in the fuel retailer bearing the pricing risk. Alternatively, a pricing regime reflecting some discount per litre against a terminal gate price for petroleum, transfers the pricing risk to the biofuel producers.
- Achieving an appropriate commercial return from the marketing of biofuels compared with conventional fuels is a barrier. Taskforce consultations with the oil majors and biofuels producers suggest that, despite high oil prices, commercial returns from ethanol blends to oil majors are currently insufficient to cover the risk.

- There are also significant costs associated with market entry.
  - Infrastructure costs such as for the installation of additional blending/fuel quality facilities as well as the potential need for additional tankage/bowsers at retail sites. Exxon Mobil noted in its submission[48]:

    > It will require investment in new facilities for us to be able to produce ethanol fuel blends. Investment would potentially be required at our Altona refinery and most certainly at our bulk fuel distribution terminals and across our service station network. The investment requirements at our major bulk fuel distribution terminals is expected to be in the range of A$5 to 10m at each terminal, while service station investment is estimated to average around A$15 to 20,000 at each service station where ethanol blend petrol is to be sold.

  - Costs associated with reliably and safely blending, distributing and marketing ethanol blend fuels. Again, Exxon Mobil noted that:

    > …changes will also be required to operating procedures in our distribution and retail operations to ensure precise blending and to eliminate the presence of water so that finished ethanol blend petrol quality is assured (ethanol will generally complement petrol qualities if blended correctly and uniformly through the blend; incomplete or inadequate blending processes may jeopardise the quality of the fuel). If we decide to market an ethanol blend petrol, we envisage a comprehensive and long-term customer communications programme will be required. While the cost of delivering this programme is likely to vary across markets we would expect it to be significant. We would also expect that the price of the ethanol blend may need to be discounted relative to normal petrol, at least in the early stages, to encourage greater uptake."

  Further to this, in discussions with the Taskforce, some independent fuel retailers also highlighted the additional costs of branding and advertising associated with introducing new fuels.

- There are also concerns about supply reliability. This relates to having a sufficient level of guaranteed supply from a small but emerging biofuels industry, particularly given the industry's current structure and agricultural base and during the period where new plants are being established. Given that there is an effective barrier to imports until 2011, the oil majors are concerned about their ability to reliably source sufficient supplies in order to enter the market in a meaningful way.

Along with these commercial risks, commercial benefits from marketing fuel ethanol need to be considered.

- A key benefit could be ethanol's role as an octane enhancer. The requirement that new petrol-fuelled vehicles sold in Australia meet Euro III vehicle emission standards from 2005 and expectations about the future introduction of Euro IV and Euro V compliant emissions technology suggest that there will be increasing demand for higher octane in Australian fuels. The octane rating of petrol can be increased by:
  - utilising higher octane crude oil

[48] Mobil Submission to the Australian Government Biofuels Taskforce, June 2005.

- additional refinery processing to convert low octane components into higher octane components, using a combination of isomerisation, alkylation and reforming
- through the use of chemical additives, of which ethanol is one option.

- The Australian Institute of Petroleum[49] noted in its submission that:

  > …each refinery in Australia has a different configuration and therefore the timing of the need for, and economics of, options to build octane in petrols is complex and difficult to estimate. The two most viable options for octane enhancement in Australian refineries are refinery solutions—capital investment, primarily in isomerisation capacity and/or the importation of selected crude oils or high octane blendstocks, such as reformate and the use of ethanol.

- Ethanol's potential use (and therefore value) as an octane enhancer to the oil majors is yet to be determined. Key issues likely to be considered by the major oil refiners in considering ethanol as an octane solution will include the economics and availability of ethanol. A third issue to be considered is regulatory constraints imposed on the use of ethanol in fuel through state-based RVP limits.
- Some independent retail petroleum suppliers, however, are already marketing ethanol blended fuels based on the octane advantages that can be derived, suggesting that at least to this segment of the petroleum industry, ethanol's role in increasing octane does have market value. For example, the Taskforce understands that several independent fuel retailers see market value in their ability to utilise the addition of ethanol to either a 91 RON or a 95 RON fuel so they can offer a higher octane and more profitable product than regular unleaded petrol.
- Another key benefit could flow from the role of biofuels in extending fuel supplies and in offsetting some of the requirement for additional imports. The perceived environmental benefits of biofuels could also be translated into commercial advantage.

For the oil majors, commercial benefits are not currently seen as justifying the risks. Some independent fuel retailers, however, may not perceive the same commercial risks as the oil majors and the commercial benefits may be more attractive.

Conclusion 44: *The Taskforce considers there are real and significant commercial risks, associated with market entry, facing both fuel suppliers and biofuel producers.*

For the oil majors, the Taskforce considers that, at present, there is little commercial incentive for them to develop a mainstream bulk market for ethanol blend fuel and, in the absence of improved confidence and unless first mover risks are managed, there will be, at best, continuation of small, trial-based marketing of fuel ethanol by the oil majors.

For the independent fuel retailers, the Taskforce considers fuel ethanol could represent an attractive market segment if confidence is restored.

There is a number of relatively low cost options that stakeholders have suggested the government could consider in this area without affecting current market structures. For example, stakeholders have suggested small grants to offset infrastructure costs

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[49] Australian Institute of Petroleum Submission to the Biofuels Taskforce, 24 June 2005.

and so assist independent fuel retailers enter the embryonic E10 market and/or consideration of biofuel use in the Australian Government fleet may be beneficial.

Access to infrastructure and claims of discrimination against biofuels

Access to the existing fuel distribution network was also identified as an impediment to the uptake of biofuels. The Independent Petroleum Group noted difficulties associated with the oil majors accepting trucks pre-loaded with ethanol for blending and many submissions also cited 'no ethanol' signs as evidence of discrimination against biofuels.

The Taskforce received advice from the Australian Institute of Petroleum that its member companies will not allow in-compartment blending of motor spirit and ethanol at their loading facilities to create E10. This is on the basis of unacceptable risks to people, the facility, and the environment. Unacceptable exposures can arise due to:

- vapour recovery systems being rated to handle vapour concentrations containing only 10% ethanol, whereas the addition of petrol on top of 10% ethanol results in 100% ethanol vapour concentrations
- ethanol having a very broad flammability range; consequently the risk of explosion is unacceptably higher as the vapour in the compartment being loaded will always be in the explosive range
- anti-detonation systems not being incorporated into the gantries, so fire could spread to all tankers
- ethanol being 100% miscible in water and, as a result, a spill of 100% ethanol will not be retained by the separator systems.

From a fuel quality perspective, the AIP noted that there are also problems with developing correct documentation for the end consumer when tankers come into the load rack partially filled with ethanol.

The AIP also notes, however, that some member companies are prepared to part load tankers to 90%. They can then be taken to other facilities to have ethanol added. In this case, the safety responsibilities are borne by the distributor/owner of the other facility, as is the guarantee of the blended fuel meeting the Australian fuel quality standards and being fit for purpose.

In relation to concerns raised about access to petroleum at 'reasonable' prices, the Taskforce notes that branded retail sites are more likely to be on term contracts for fuel supply and therefore are not purchasing at the prevailing terminal gate price. The Taskforce considers it is not anti-competitive for an oil company to sell fuel at a more competitive price to an aligned site operator on a term contract. There would be little value in an oil company selling fuel to a non-aligned site for the same prices as it supplies its own contracted network. This kind of behaviour is present in most markets. The Taskforce also notes that the proposed Oil Code will prevent a wholesale supplier from unreasonably refusing access to a declared product. (It is reasonable to refuse supply when there are insufficient supplies, among other things.)

Some of the oil majors have also identified access to infrastructure at retail petroleum sites as a barrier to the uptake of biofuels. From the oil companies' perspective, this issue relates to physical access to tanks and bowsers at service station sites. The major oil companies have noted that, in many service stations, there is typically sufficient infrastructure (in the absence of significant investment) to deliver two or possibly three grades of petroleum. Given the desire of the oil majors to provide consumers with choice, they argue that this has impeded their ability to market ethanol fuels for which there is little demand. On the other hand, some independents see the phase-out of lead replacement petrol, and the resulting freeing up of capacity, as an opportunity to market ethanol.

In light of the prevailing market conditions around 2002–03, the Taskforce considers the 'no ethanol' signs to have been an understandable response to consumer concerns about the quality of fuel containing ethanol (irrespective of whether these concerns were well grounded). Some fuel retailers (including some independents that are currently re-entering the fuel ethanol market) have, in the past, chosen to inform their customers that their fuel did not contain ethanol. Given the circumstances, this was a product differentiation strategy that was used aggressively. While the government and others have raised the need to encourage the removal of the 'no ethanol' signs, the key to their removal or ineffectiveness is greater clarity and effective communication around the suitability and performance of ethanol blend fuels and compliance with fuel quality standards.

As previously noted, some independent fuel retailers have cited barriers to access of premium unleaded petrols (95 RON PULP and 98 RON PULP) as a key reason for marketing ethanol. The oil companies have noted these products are expensive to produce and in short supply. Independent fuel retailers consider that the addition of ethanol to either a 91 RON or a 95 RON fuel allows them to offer a higher octane, higher performance product compared with regular unleaded petrol.

Conclusion 45: *The Taskforce concludes that lack of access to infrastructure and to petroleum for blending are not artificial barriers to the uptake of biofuels.*

The Taskforce considers there is some potential for consumer confusion arising from some current marketing practices associated with ethanol blends that are being marketed for their octane value.

The fuel standard defining premium unleaded petrol contains two variables in relation to octane levels. These are the research octane number (RON) and the motor octane number (MON). The FCAI has noted that RON is an indicator of the probability of uncontrolled detonation (known as 'knock' under low speed, high load conditions such as acceleration). MON refers to the probability of knock under high temperature, low load conditions such as cruise.

To be considered a premium unleaded fuel, RON must be a minimum of 95.0 and MON 85.0. The addition of 10% ethanol increases the RON by substantially more than it does the MON.

- Testing completed by Intertek for the Department of Environment and Heritage shows that:

- the addition of 10% ethanol to a 91 RON compliant fuel increased the RON to 95.6 (up 4 points) and the MON to 84.3 (up 2 points). The resulting MON meets the specification for unleaded petrol but not for premium unleaded petrol.
- The addition of 10% ethanol to a 95 RON fuel increases the RON to 98.5 (up 3.1 points) and the MON to 86.9 (up 1.3 points), which meets the requirements of premium unleaded petrol (because it started as premium unleaded petrol).
- Whilst Australian fuel standards do not set specifications for 98 RON premium unleaded petrol at this time, the World Wide Fuel Charter (an industry standard) suggests specifications for 98 RON fuel to contain a MON of 88. The addition of 10% ethanol to a 95 RON fuel does not meet the MON suggested by the World Wide Fuel Charter for a 98 RON fuel.

Conclusion 46: *The Taskforce notes the potential for further damage to fragile levels of consumer confidence if consumers fail to understand the nature of octane claims made by some fuel retailers.*

Reid vapour pressure

Adding ethanol to petrol increases its volatility. Volatility is measured as Reid vapour pressure (RVP). The peak RVP of ethanol blends occurs between 2% and 10% ethanol concentration, and is about 10% above the RVP of neat petrol. Hydrocarbon emissions from the volatilisation of fuel ('evaporative emissions') are a precursor to photochemical smog, which is measured by the presence of one of its constituents, ground level ozone.

Although most fuel parameters are regulated nationally under the *Fuel Quality Standards Act 2000*, RVP continues to be regulated by the states and territories, as the factors determining the presence of photochemical smog are airshed-specific. These factors include topography, climate, density of emission sources and the degree to which other ozone precursors are present in the atmosphere.

All states except Tasmania have a RVP limit. Typically, this will be set by a regulation under the relevant state Environment Protection Act. As photochemical smog is principally a summer problem, because the chemical reactions involved are driven by sunlight, RVP limits usually apply only in the summer, and only in urban areas. Where the use of ethanol blends has government approval, there will usually be a higher RVP limit for ethanol blends than for other fuel. Division 7 of the NSW Protection of the Environment Operations (Clean Air) Regulation is illustrative of this type of provision and sets an RVP limit of 64 kPa for petrol[50] or 71 kPa for E10.

RVP limits have the potential to be a barrier to the uptake of ethanol blends, and particularly for the use of ethanol as an oxygenate. Almost all ethanol blend petrol sold to date in Australia has been sold in NSW and Queensland. The governments of both of those jurisdictions have been supportive of E10 and have set a higher RVP limit for E10. Both undertook modelling before doing so, the results of which

[50] 62 kPa on a monthly average.

indicated that the impact of ethanol blend petrol on ozone formation was not a concern and there is no suggestion that air quality standards have been compromised. In NSW, the regulations have a statutory sunset date of 1 September 2007 and the Department of Environment and Conservation has commissioned data gathering that will help inform its 2007 review.

Other states have not yet made decisions on whether to increase RVP limits for E10, although Victoria has just received an application to do so. If a higher RVP limit is not set for E10, then given current limits, the only option available to a supplier would be to use a reduced volatility blend stock during the summer periods, known as a blend stock for oxygenated blends (BOB). While this practice is used in some parts of the USA, anecdotal evidence is that it adds 1 to 2c/L to the cost of the fuel. Also, the lighter fuel fraction that is removed to produce BOB (usually butane) will, in the absence of an adjacent petrochemical plant, have to be shipped elsewhere for use as a feedstock.

Should E5 be available as an invisible (unlabelled) blend as in Europe, suppliers would similarly have to modify their product with reduced volatility blend stock during summer, or reduce ethanol constituents during that time if there is no increase to RVP limits.

Conclusion 47: *The Australian Government is currently in dialogue with the states on how to regulate fuel parameters, including RVP, that are not part of the national fuel standards. The government could, as part of this dialogue, discuss approaches to RVP that are nationally consistent and take full account of the latest information on the impacts of ethanol blends on air quality. Given the lack of data and the fact that most states have yet to consider an RVP limit for E10, and to ensure that decision-making is based on the best available science, it may be necessary to commission further data gathering.*

High capital and transport costs

Several submissions raised high capital costs of biofuel plants in Australia compared with the US and Brazil, and one raised the monopoly of suitable coastal shipping as barriers to effective participation in the biofuels industry. The Taskforce was not able to investigate these issues in the time available but draws them to the attention of the government for possible further consideration.

Appendix 1 List of submissions

The Taskforce has received 64 submissions, of which 11 were ‘in confidence’.

Submissions received, other than those submitted in confidence, were as follows.

Reference no.	Organisation or individual
28	Australian Automobile Association (AAA)
50	Australian Cane Growers Council
46	Australian Conservation Foundation
26	Australian Dairy Farmers Limited
36	Australian Ethanol Limited
27	Australian Institute of Petroleum
5	Australian Liquefied Petroleum Gas Association (t/a LPG Australia)
63	Australian Medical Association
61	Australian Medical Association, New South Wales
48	Australian Sugar Milling Council
32	Australian Trucking Association
24	Axiom Energy Pty Ltd
64	B.D. & J.E. Batts Consulting Pty Ltd
22	Biodiesel Association of Australia
29	Biodiesel Industries Australia Pty Ltd
35	Bioenergy Australia
20	Bundaberg Sugar
58	Clean Up Australia
17	CSR
37	Dalby Bio Refinery
56	Davco Farming
11	Diesel Test Australia
1	Emission Traders International Pty Ltd
16	Enecon
33	ExxonMobil Australia
8	Federal Chamber of Automotive Industries (FCAI)
49	Grains Council of Australia
57	Independent Petroleum Group
12	Kearney, Associate Professor Ray; University of Sydney
45	Livestock Feedgrain Users Group
6	Lodge Farm
34	Manildra Group
60	MIEAust
52	Mr Marc Rowell MP, Member for Hinchinbrook (State Parliament, Qld)
3	Name withheld

Reference no.	Organisation or individual
47	Natural Fuels Australia Limited
40	New South Wales Farmers Association
62	Niven, Dr Robert
39	Ollie Clark, Noel Child and Simon Humphries
21	Orbital Corporation Ltd
9	Primary Sources
41	Public Health Association of Australia
2	Puritech Pty Ltd
43	Queensland Government
38	Renewable Fuels Australia
42	Richard Day
54	Senator Fiona Nash
13	Senator Ron Boswell
15	Stockfeed Manufacturers' Council of Australia
19	Sugar Research Institute
30	Tam Faragher & Associates
44	The Natural Gas Vehicles Group Pty Ltd
7	Warren Centre for Advanced Engineering

Appendix 2 Taskforce meetings

Venue	Date	Consultative group[1]
Canberra	29 June 2005	Australian Automobile Association
		Livestock Feedgrain Users Group
		Australian Conservation Foundation
Melbourne	30 June 2005	Australian Dairy Farmers
		Riverina Biofuels Pty Ltd
		Australian Ethanol Limited
		Gull Petroleum
		Australian Renewable Fuels
Melbourne	1 July 2005	Australian Institute of Petroleum
		Shell
		BP
		United Petroleum
		CSR
		ExxonMobil
Brisbane	4 July 2005	Lemon Tree Ethanol
		Queensland Government
		Senator Boswell
		Tam Faragher & Associates
Brisbane	5 July 2005	Independent Petroleum Group
		Australian Cane Growers Council
		Australian Sugar Milling
		Gull Petroleum
		Sugar Research Institute
		Dalby Bio Refinery
Sydney	6 July 2005	Manildra Group
		NRMA
		Davco
		Caltex
		Australian Trucking Association
		Primary Energy
		Australian Feedgrain Users Group
		Australian Biodiesel Consultancy
		Gardner Smith
		Renewable Fuels Australia
Melbourne	8 July 2005	Federal Chamber of Automotive Industries and car industry representatives

Appendix 3 ABARE analysis

Biofuels

an assessment of their viability

abare **report** 2005

ABARE report prepared for the Biofuels Taskforce

Christopher Short and Damien Riwoe

July 2005

abare

60 years of economic research

ISSN 1447-817X

Short, C. and Riwoe, D. 2005, *Biofuels: An Assessment of their Viability,* ABARE Report to the Biofuels Taskforce, Canberra, July.

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ABARE is a professionally independent government economic research agency.

ABARE project 3053

contents

tables

summary

On 30 May 2005 the Prime Minister announced the appointment of a taskforce to examine the latest scientific evidence on the impacts of ethanol and other biofuel use on human health, environmental outcomes and automotive operations.

One of the tasks is to reassess the findings of the December 2003 study examining the appropriateness of maintaining an objective that biofuels contribute at least 350 million litres (ML) to the total fuel supply by 2010 undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Bureau of Transport and Regional Economics (BTRE) and the Australian Bureau of Agricultural and Resource Economics (ABARE).

Since the 2003 study was undertaken, a number of factors have changed, including new fuel excise arrangements that bring biofuels into the fuel excise net and changes to the fuel tax credit system for the business use of vehicles with a gross vehicle mass of more that 4.5 tonnes. Finally, the short and medium term outlook for international oil prices has changed substantially, which may have an impact on an assessment of the viability of biofuels.

The Biofuels Taskforce has commissioned ABARE to review the economic and commercial viability of biofuel production in light of these changes.

Industry viability is assessed on the basis of whether or not biofuel production is considered likely to be cost competitive with traditional petroleum fuels over the medium to longer term. The transition period for biofuels to effectively pay fuel excise and the removal of certain subsidy arrangements will be completed by 2015-16.

To be cost competitive, an assessment is made of whether all revenue streams available to biofuel producers, including the prices received in the market into which the product is sold together with any direct subsidies, is sufficient to cover the costs of biofuel production, including achieving a rate of return on invested capital that is sufficient to attract capital relative to other investments.

Biofuels compete with petroleum based fuels in the transport fuel market. As such, the price at which biofuels can be sold is determined by the prices set in the petroleum fuel market. Traditional fuel prices at the wholesale level are principally determined by the world market price of oil, the exchange rate and any applicable fuel taxes.

While oil prices have been increasing over the past four years and averaged US$49/bbl in 2004-05 (in West Texas Intermediate terms), ABARE's current forecast is for a gradual easing in oil prices over the short and medium term. In this analysis, it is assumed that real prices will ease to US$32/bbl by 2009-10 and are held constant thereafter. The Australian dollar is also assumed to depreciate against the US dollar. ABARE currently assumes the Australian dollar will average around US74c in 2005-06 before returning to a trend level of US65c in the medium term.

From 2015-16, biofuels will receive a 50 per cent discount on fuel taxes for fuels sold in the private vehicle fuel market. This effectively increases the price at which biofuels can be sold by creating an implicit subsidy. After accounting for the different energy contents of biofuels relative to traditional fuels, and any net difference in fuel tax arrangements, together with the subsidies available under the Biofuels Capital Grants program, it is estimated that the threshold prices available to biofuel producers are 38c/L for ethanol and 52c/L for biodiesel sourced from used cooking oil in 2015-16 (and 55c/L for biodiesel sourced from tallow).

Biofuels remain effectively excise free until 1 July 2011. From 2011-12 to 2015-16, the effective excise payable increases in equal instalments until the effective excise rates of 50 per cent of the fuel excise is reached in 2015-16. As a result, the relevant threshold prices against which the cost of biofuel production should be assessed will be higher in the short to medium term.

Feedstock is the major cost in producing ethanol and biodiesel — as a share of the required revenue from biofuel production, other operating and capital costs are estimated to account for around 45 per cent for ethanol and 20 per cent for biodiesel in the medium term.

Reflecting previous advice on the viability of certain feedstocks, together with the proposed feedstocks that successful applicants under the Biofuels Capital Grants programs intend to use, only feedgrains and

C molasses for ethanol production, together with used cooking oil and tallow for biodiesel production, are assessed.

Ethanol produced from whole cereal grains generates crushed grain meal, a valuable by-product for use as livestock feed. Taking this into account, the long term net required revenue for fuel ethanol production is estimated to be 36c/L. For C molasses, the long term net required revenue is estimated to be 33c/L. When compared with the threshold price of ethanol of 38c/L, fuel ethanol production is assessed as being able to compete against petroleum based fuels in the medium to long term given current policy arrangements. A C molasses based plant is estimated to generate 12 per cent return on invested capital in 2015-16, whilst a sorghum based plant is estimated to generate a 10 per cent return.

With significantly lower effective excise rates payable in the short to medium term and assumed higher oil prices, the ethanol production is estimated to be able to earn an annual return on invested capital in excess of 30 per cent in the period to 2010-11.

The net required revenue for biodiesel in 2015-16 is estimated to be 56c/L for used cooking oil based production and 66c/L for tallow based production. With an estimated threshold price of 55c/L, tallow based biodiesel production is not viable in the long term. For used cooking oil, although operating costs would be covered, the returns available would be insufficient to warrant new investment in the long term.

Despite the limited, or lack of, viability in the long term, biodiesel producers may still seek to invest in the industry as there are substantial returns to capital that can be achieved in the short term. For a biodiesel plant using tallow that commenced full production in 2006-07, the average annual return to capital between 2006-07 and 2015-16 is estimated to be 19 per cent, despite significant losses occurring late in the period.

Heavy vehicle fuel market

The Government's intention is that the full excise payable on fuels be limited to private vehicles (or other private purposes except the generation of electricity and in burner applications) or in business use of vehicles with a gross vehicle mass of less than 4.5 tonnes.

For the business use of vehicles with a gross vehicle mass of 4.5 tonnes or more, the effective fuel tax rate is intended to be at the level of the road user charge. It is expected that the road user charge will be set at a level lower than the fuel excise rate of 38.1c/L. No decision has yet been made on the level of the road user charge that will apply from 1 July 2006. For this analysis, it has been assumed that the charge is set at 22c/L.

As a result, the subsidy available to biofuel producers targeting this market is reduced relative to the private vehicle market. In the case of 100 per cent biodiesel, known as B100, the relative tax advantage to diesel is 22c/L in 2006-07. By 2015-16, the effective subsidy falls to 0.6c/L.

As a result of the effective subsidy falling and assumed falling oil prices, the estimated rates of return on invested capital in biodiesel production for use in the B100 market become negative early in the next decade. This would also apply to biodiesel blends that do not meet the diesel fuel standard (such as B20) as both the excise payable and any fuel credit relative to the road-user charge will be proportional to the diesel content. In all these cases, it would appear that biodiesel blends (that do not meet the diesel fuel standard) targeting the heavy vehicle market would not be considered commercially viable, even in the short term, given the assumptions used in this analysis.

Some biodiesel blends, such as B5 — where biodiesel comprises 5 per cent of the diesel fuel — are able to meet the diesel fuel standard. As a result, these blends will be treated by the Government as diesel. This entitles end-users to claim the full credit between the diesel excise rate and the road user charge. However, the actual excise payable on a biodiesel blend will be based on the proportions of diesel, biodiesel and the relevant excise rates applicable at the time. This effectively recreates the fuel tax advantage of biodiesel relative to diesel that occurs in the private vehicle market. As such, the returns available are the same as those available in the private vehicle market.

Economic implications of the 350 ML target

The analysis conducted here (where market penetration of biofuels has been ignored) suggests that ethanol production is commercially viable in both the short and long term. However, the picture is less clear for biodiesel production. Given the limited time available for analysis, it has not been possible to provide an assessment of whether the current policy framework provides assistance sufficient to generate the commercial returns to ensure the 350 ML target will be met by 2010.

Despite the uncertainty of whether the 350 ML target would be met, the Biofuels Taskforce requested an assessment of the economic costs of meeting the target by 2010 under the assumptions used in this study. For the purposes of this exercise, it is assumed that all recipients of the Capital Grants provided to biofuel producers in 2004 will commence production between 2005-06 and 2009-10.This would increase biofuel capacity to 364 ML, sufficient to achieve the 350 ML target.

Biofuel production is only commercially viable through the provision of large and ongoing industry support. This support causes an economic loss through both the reduced efficiency (of using more costly transport fuels and the need to bid resources away from productive activities elsewhere in the economy, thus lowering economic output) as well as the impact of increased taxes or reduced government expenditure on services, which is required to fund the subsidy.

Taking into account the production buildup that would be necessary to meet a 350 ML target in 2010, it is estimated that gross domestic product would be $90 million lower in 2010 than it otherwise would be.

introduction

On 30 May 2005, the Prime Minister announced the appointment of a Biofeuls Taskforce to examine the latest scientific evidence on the impacts of ethanol and other biofuel use on human health, environmental outcomes and automotive operations. Taking into account the most recent economic analyses of fuel supply in Australia, the taskforce will assess the costs and benefits of biofuel production.

Among other tasks, the taskforce will examine the findings of the December 2003 CSIRO/ ABARE/BTRE desktop study (hereafter referred to as 'the 2003 study') into the appropriateness of a 350 million litre biofuels target. In that study, ABARE provided a detailed assessment of the economic viability of the Australian biofuels industry. The main conclusions of that report were:

- The costs of implementing a policy of assisting the Australian biofuels industry to meet a 350 ML biofuels target were estimated to significantly exceed the benefits.
- Ethanol produced from waste starch and biodiesel produced from used cooking oil both appeared to be (or were close to being) economically viable without government assistance and should be able to compete effectively in an environment where they are taxed on a comparable basis with other fuels. However, in both cases, future growth in production was expected to be modest due to the limited availability of feedstock supplies.
- Ethanol produced from molasses and cereal grains and biodiesel produced from tallow or oilseeds would require substantial and ongoing government assistance to be viable.
- Assistance to the biofuel industry would generate some benefits in terms of health (via improvements in air quality), reductions in greenhouse gas emissions and regional employment opportunities. However, in all cases, these benefits were found to be small and varied with the biofuel source, production practices and utilisation circumstances.

Since the 2003 study was undertaken, a number of factors have changed.

- New fuel excise arrangements, including biofuels, were announced in December 2003 (where the 2003 study assumed that, after 2012, the excise rates for ethanol and biodiesel would be the same as those for petrol and diesel). In particular, a banded excise system was adopted, with differing rates for high, medium and low energy fuels. Alternative fuels, including biodiesel and ethanol, will receive a discount of 50 per cent on the full energy content rate, making the final excise rate for biodiesel and ethanol 19.1c/L and 12.5c/L respectively (compared with 38.143c/L for petrol and diesel). Further, the excise for these fuels is to be phased in over a five year period commencing 1 July 2011. In the 2003 study, the phase-in period was assumed to commence in 2008.

- Changes to the fuel tax credit system have been announced. The Australian Treasury released a discussion paper in May 2005 outlining a number of key components in the proposed fuel tax credit system. Among the proposed arrangements are that fuel tax will only be effectively collected from fuel consumed:
  - in the private use of motor vehicles;
  - for any other private purpose (except for the generation of electricity and use in burner applications);
  - in the business use of vehicles with a gross vehicle mass of less than 4.5 tonnes; and
  - in the business use of vehicles with a gross vehicle mass of 4.5 tonnes or more but only to the extent of the applicable road user charge (which is expected to be lower than the current fuel excise rate).

Finally, the short and medium term outlook for international oil prices has changed substantially which may have an impact on an assessment of the viability of biofuels.

Given changes in both Australian Government policy and market conditions, the Biofuels Taskforce has asked ABARE to reassess the economic viability of the Australian biofuel industry (ethanol and biodiesel) to take account of these factors. The results of this reassessment are presented in the remainder of this report.

With regard to feedstocks, only feedgrains and C molasses for ethanol production are considered, together with used cooking oil and tallow for biodiesel production. This reflects previous advice on the viability of those feedstocks and that these are the feedstocks that have been proposed by successful applicants under the Biofuels Capital Grants program.

The remainder of this report is organised as follows. In the following chapter the viability of future expansion of the biofuel industry is considered by assessing the cost competitiveness of biofuels against price benchmarks of traditional fuels in the general transport fuel market. Assumptions about both short and medium term feedstock costs, as well as oil prices and exchange rates have been updated to reflect ABARE's most recent long term commodity price projections released earlier this year. In chapter 3, the analysis of the viability of biodiesel for the heavy vehicle fuel market is considered in light of the proposed changes to the fuel tax credit arrangements. Chapter 4 considers the economic implications for Australia of meeting the 350 ML target under current industry assistance arrangements. In the final chapter, the sensitivity of the results to a range of input assumptions is assessed. This includes oil prices, exchange rates.

analysis

Methodology

In this report, as in the 2003 study, the viability of the biofuel industry is assessed on the basis of whether the costs of producing a given biofuel are covered by the price received in the market into which the product is being sold. The relevant market is considered to be the traditional petroleum fuel market. That is, viability is assessed on the basis of whether or not the production of biofuels in Australia is likely to be cost competitive with traditional fuels, taking account of both changes to the fuel tax arrangements and government assistance to the biofuel industry.

Biofuels compete with traditional fuels (petrol and diesel) in the transport fuel market. In this analysis, biofuels are considered as ‘fuel extenders’. As such, the price at which biofuels can be sold (with or without an excise) is the excise inclusive price of traditional fuels.

In assessing viability, given that investment is required to meet the 350 ML target, the most important consideration is the expected rate of return for investment in new capacity and whether that rate of return is sufficient to attract capital relative to other investments.

In the short to medium term, the returns to investors in biofuels capacity are strongly influenced by the current effective excise free arrangements, the transition path for biofuels becoming subject to fuel tax, oil prices and production costs. After 2015, when biofuels have been effectively brought fully within the excise net, long term viability is defined to be the ability to earn a rate of return on invested capital commensurate with other long term investments in Australia.

In considering the viability of the fuel ethanol industry, two important issues are worth considering. The first is the extent to which the use of ethanol will be associated with and overlap the anticipated future demand for high octane rated fuels. Second, recent adverse comment over potential engine damage associated with ethanol blended fuels may have significantly reduced the demand for biofuels, at least in the short term.

With regard to the use of ethanol as an octane enhancer (and as discussed in the 2003 study), more stringent future vehicle emissions standards and fuel quality standards are likely to increase the future demand for higher octane fuels. For refiners, meeting the demand for higher octane fuel may require additional capital investment (and/or the importing of selected feedstocks or high octane blends) or the use of octane enhancing additives, one of which is ethanol.

The Australian Institute of Petroleum noted in its submission to the Biofuels Taskforce that 'each refinery in Australia has a different configuration and therefore the timing of the need for, and economics of, options to build octane in petrols is complex and difficult to estimate. The two most viable options for octane enhancement in Australian refineries are refinery solutions — capital investment, primarily in isomerisation capacity and/or the importation of selected crude oils or high octane blendstocks, such as reformate and the use of ethanol' (Australian Institute of Petroleum 2005).

As these issues are still to be resolved, ethanol's potential use (and therefore value) as an octane enhancer to the oil industry is yet to be determined. Key issues likely to be assessed by the major oil refiners in considering ethanol as an octane solution will include the cost and availability of ethanol. A third issue to be considered includes regulatory constraints imposed on the use of ethanol in fuel through state based petrol volatility (Reid Vapor Pressure) limits. In addition, Caltex stated that 'in the future, Australian refiners may consider the use of ethanol to increase their ability to produce higher octane petrol. However, it seems more likely ethanol will be added to petrol as a volume extender and a means of including a renewable content in the fuel' (Reeves 2004).

For the analysis presented here (and presented in the 2003 study), it has been assumed that any additional ethanol use in transport fuels is purely as a fuel extender, and not for the purposes of meeting the future demand for higher octane rated fuels.

The issue of consumer confidence is also discussed in appendix III of the 2003 study. Prior to 1 July 2003, fuel retailers did not have to reveal the ethanol content of fuel sold to motorists. However, the Fuel Standard (Petrol) Amendment Determination 2003 (No 1) now caps the volume of ethanol that may be blended with petrol to 10 per cent. In addition, the Minster for the Environment and Heritage made the Fuel Quality Information Standard (Ethanol) Determination 2003 that requires the labelling of petrol containing ethanol from 1 March 2004. Until the introduction of these legislative instruments, the ethanol content of ethanol blend fuels was not limited and consumers knew little about the ethanol content of the fuel when refuelling their vehicles.

As reported in appendix III of the 2003 study, public confidence in ethanol had been adversely affected by reports of engine damage from the use of ethanol blends exceeding 10 per cent. The mandatory labelling of ethanol blended fuel and the 10 per cent cap on ethanol in petrol, will give consumers more reliable information about the price/quality mix of fuel purchases and this is expected to allay consumer concerns about ethanol blend fuels. The analysis presented here assumes that consumer confidence in ethanol blends of 10 per cent or less will recover and not act to restrain growth in the industry. Therefore, in assessing the future viability of ethanol producers, it is assumed that a lack of consumer confidence will not be one of the factors limiting demand for ethanol.

Determining the price at which biofuels can be sold

An important component of assessing the viability of biofuels is to determine the price at which they can be sold — and this is determined by the prices of fuels set in the traditional petroleum fuel markets. That is, by the prices of the fuels that biofuels could substitute for.

Both consumption and production of oil in Australia are small relative to world consumption and production levels. As a result, Australian producers and consumers of oil are considered to be price takers in the global oil market. Reflecting this, changes in the price of petroleum products in Australia (ex refinery) mainly reflect changes in the world price of crude oil and exchange rates.

Singapore is the third largest refining and marketing centre in the world and is the closest major market to Australia. It is the most likely source of refined petroleum products for import into Australia. Singapore's refineries are widely regarded as operating close to international best practice in terms of efficiency and cost. Reflecting the open nature of the Australian economy, agencies that seek to benchmark Australian fuel prices, such as the Australian Competition and Consumer Commission (and the West Australian Department of Consumer and Employment Protection), do so against movements in the prices of refined petroleum products sourced from Singapore.

In the case of unleaded petrol, Australian petrol prices are linked to the spot price of Singapore Mogas 95 unleaded. In the case of diesel, Australian product prices are linked to a combination of the spot prices of Singapore gasoil (80 per cent) and Singapore kerosene (20 per cent) (ACCC 2002). These refined product prices are also highly correlated with world oil prices. In particular, Mogas 95 usually trades within a US$3.10 band above the West Texas Intermediate Index.

International oil prices and Australian fuel prices

The price of crude oil has more than doubled over the past four years, with prices averaging US$49 a barrel in 2004-05 in West Texas Intermediate terms. However, the price of crude oil fluctuates regularly reflecting the interaction of global business cycles and ad hoc global developments. ABARE's current forecast is for a gradual easing in oil prices over the short and medium term.

The second factor influencing domestic product prices is the exchange rate. The Australian – United States exchange rate depreciated significantly from 1996-97 through to 2001-02 before recovering. ABARE currently assumes the Australian dollar will average around US74c in 2005-06 before returning to a trend level of US65c in the medium to long term (Penm and Fisher 2005).

The assumed international oil prices and exchange rates used in this analysis are presented in table 1, and are derived from ABARE's current medium term forecasts (Burg, Haine and Maurer 2005; Bailey, Hanna and Pemn 2005).

1 Assumed oil prices and exchange rates

		2004-05	2005-06	2006-07	2007-08	2008-09	2009-10 to 2015-16
West Texas Intermediate **a**	US$/bbl	49.01	47.40	43.16	37.91	34.21	32.24
Exchange rate	US$/A$	0.75	0.74	0.70	0.68	0.66	0.65

a In 2004-05 terms.

To determine gasoline prices in Australia, the usual approach is to estimate the Mogas 95 price, add a transport cost and convert this sum to Australian dollars. In this analysis, estimates of the Mogas 95 prices over the medium term were constructed by adding an assumed Singapore refining cost of US$3.10 to the West Texas Intermediate price assumptions in table 1. The transport cost to Australia from Singapore is assumed to be US1c/L. This approach is similar to that used by the ACCC to monitor petrol pricing in Australia (ACCC 2002).

2 Timetable for the introduction of vehicle fuel standards

	Diesel vehicles	Petrol vehicles
Euro 3	2006	2005 (150ppm)
Euro 4	2006 (50ppm, sulfur only)	2008 (50ppm, sulfur only)
Euro 5	2009 (10ppm, sulfur only)	10ppm – yet to be specified

Source: Department of Environment and Heritage (2005).

Over the projection period of this analysis, Australian fuel standards will change. The changes are intended to improve air quality — through reductions in the amount of substances such as benzene, sulfur and particulates — and improve operability standards of the fuels. The timetable for the introduction of these standards is presented in table 2.

For this analysis, the assumed increased petrol refining costs associated with moving to Euro 4 is 1.1c/L from 2008-09 onwards, and 2c/L for Euro 5 from 2010-11 onwards. For diesel, the assumed increase in diesel refining costs in moving to Euro 5 standards is 1c/L from 2009-10 onwards (Costello and Kemp 2003).

Including the associated production costs along with the import parity price of Mogas 95 will provide a petrol price benchmark in Australian dollar terms. For example, with the West Texas Intermediate assumed to average around US$32/bbl from 2009-10 onwards in this analysis (in 2004-05 terms), and at an assumed exchange rate of US65c, the benchmark for the ex refinery price of unleaded petrol would be A39c/L (in 2004-05 dollars). Similarly, the benchmark price for diesel in that period is estimated to be A41c/L.

Threshold prices for biofuels

As in the 2003 study, this analysis defines the threshold price of a biofuel as the sum of all the revenue streams available to the producer of a biofuel. This includes: the price at which each biofuel can be sold for (which is determined by the excise inclusive price of traditional fuels); and any subsidies payable to the biofuel producer, such as the Capital Grant subsidy, or the Alternative Fuel Grant available to biofuel sold in certain markets, such as the heavy transport fuel market; less any excise payable on the biofuel itself.

In comparing the estimated cost of ethanol and biodiesel with the prices of petrol and diesel it is important to ensure that the terms are expressed in equivalent energy units. For this analysis, the energy content of fuel ethanol is assumed to be 68 per cent that of petrol for an equivalent volume.

In the 2003 study, it was noted that the energy content of biodiesel varies depending on the feedstock and the esterification process. Table 3 presents information on the calorific value of biodiesel produced from a variety of feedstocks and the energy density relative to diesel produced in Australia. Due to this variability in energy content and the requirement to make a general assessment about biodiesel, the 2003 study assumed a relative energy density of 90 per cent on the basis of advice from CSIRO.

However, in this analysis, the only feedstocks considered for biodiesel production are used cooking oil and tallow, each with a relative energy density of 94 per cent and 98 per cent respectively. These are the energy densities used when considering those specific feedstocks in this analysis.

3 Energy content of diesel and biodiesel

	Energy content	Energy density relative to Australian diesel
	MJ/L	%
Diesel in Australia	38.60	1.00
Rapeseed methyl ester	34.04	0.88
Rapeseed ethyl ester	36.60	0.95
Canola methyl ester	34.71	0.90
Palm oil methyl ester	34.17	0.89
Tallow methyl ester	37.80	0.98
Soy methyl ester	36.08	0.93
Soy ethyl ester	38.10	0.99
Frying oil ethyl ester	36.28	0.94

Source: CSIRO, BTRE, ABARE (2003).

As the price to be paid for biofuels is assumed to be set in the traditional fuel market, the excise inclusive price of traditional fuels is the relevant price to consider. As such, any applicable excise to biofuels also needs to be considered. On 16 December 2003 the final excise rates to be applied to ethanol, biodiesel and other fuels were announced. A banded excise system was adopted, with differing nominal rates for high (38.143c/L), medium (25c/L) and low energy fuels (17c/L) (table 4).

4 Selected fuel excise rates

Fuel type	Energy content	Standard excise rate		Alternative fuels excise rate	
	MJ/L	c/L		c/L	
High-energy content fuels	Above 30	38.14	(petrol, diesel)	19.1	(biodiesel)
Mid-energy content fuels	Between 20 – 30	25		12.5	(LPG, ethanol, LNG)
Low-energy content fuels	Below 20	17		8.5	(methanol)

5 Excise transition path for fuels entering the excise net

Fuel type			July 2003 to July 2010	July 2011	July 2012	July 2013	July 2014	July 2015
High-energy content	nominal	c/L	0	3.8	7.6	11.4	15.3	19.1
Biodiesel	real **a**	c/L	0	3.1	6.2	9.1	11.9	14.5
Mid-energy content	nominal	c/L	0	2.5	5.0	7.5	10.0	12.5
LPG, LNG, ethanol	real **a**	c/L	0	2.1	4.1	6.0	7.8	9.5

a In 2004-05 terms.
Source: Energy Grants (Cleaner Fuels) Scheme Bill 2003; Energy Grants (Cleaner Fuels) Scheme (Consequential Amendments) Bill 2003.

Alternative fuels will receive a discount of 50 per cent on the full energy content rate, making the final excise rate for biodiesel 19.1c/L and ethanol 12.5c/L. At the time of introduction, excise for these fuels was to be phased in over a five year period commencing 1 July 2008. Subsequently the excise-free period for alternative fuels was extended to 2011 (table 5).

Estimates of the threshold ethanol and biodiesel prices — in energy equivalent and real 2004-05 dollar terms — expected to prevail *after* 2015 are presented in table 6.

6 Long term threshold ethanol and biodiesel prices

		Ethanol	Biodiesel	
			UCO	Tallow
Estimated medium term ex refinery prices	c/L	39 (petrol)	41 (diesel)	
Relative energy density	%	68	94	98
Threshold fuel prices in absences of assistance	c/L	26	38	40
Excise relief **a**	c/L	10.2	12.8	13.9
Capital subsidy **b**	c/L	1	1	1
Threshold fuel prices (including excise relief and capital subsidy)	c/L	38	52	55

a Excise relief is calculated by considering the energy equivalent level of excise applied to petrol (or diesel) less the excise applied to ethanol (or biodiesel). **b** A one-off capital subsidy of 16c/L for a 40 ML plant amortised over the life of the plant reduces the fixed costs by approximately 1c/L.

These estimates are based on the oil price, exchange rate and other cost assumptions described above. It is estimated that, in the absence of any assistance arrangements, the threshold price for ethanol would be 26c/L. That is, in the absence of assistance, only in those cases where the long run average cost of production (including an appropriate return on capital which is assumed to be 7 per cent in real terms) is at or below 26c/L, is it likely that ethanol would compete with petrol and hence be assessed as viable. Similarly the long term threshold price for biodiesel in the absence of assistance is estimated to be 38c/L.

As noted earlier, the excise arrangements announced in December 2003 do not come fully into effect until July 1 2015 and will be phased in over a five year period commencing 1 July 2011 (table 5). As a result, the relevant threshold fuel prices against which the costs of biofuel production should be assessed will be higher in the short to medium term. This issue is discussed further below when considering the expected rate of return on investment in new biofuel capacity.

Biofuel production costs

The cost of producing ethanol and biodiesel consists of three main components: fixed capital costs (reflecting the rate of return on invested capital); operating costs excluding feedstocks (such as labor, energy, maintenance, and other input costs); and feedstock costs.

Fixed and operating costs

The capital costs to construct biofuel plants used in the 2003 study were based on information provided by several proponents of new facilities. For example, it was assumed that the cost of constructing a 40 ML plant for ethanol production using either grain based feedstocks or molasses was approximately $40 million, and that the life of the plant was 30 years. A

40 ML biodiesel plant was assumed to cost $25 million. The assumption of a real rate of return to capital of 7 per cent is consistent with the long run return from investments sourced in the Australian stock market. Further it is within the range of the appropriate cost of capital provided in various pricing decisions on infrastructure investments by Australian regulatory agencies. Discussions with proponents and current operators do not suggest there is any information available that would result in a revision to these assumptions.

7 Fixed capital and operating cost estimates

	Operating cost excluding feedstocks		Fixed capital costs	
	Low	High	Low	High
	c/L	c/L	c/L	c/L
Ethanol	5	10	7	9
Biodiesel	5	10	4	5

Similarly, information about operating costs, such as labor and energy, were derived from information from biofuel proponents and other Australian studies of biofuel production at the time of the 2003 study. The estimated ranges for fixed capital and operating costs (excluding feedstock costs) for ethanol and biodiesel reported in the 2003 study are reproduced in table 7. For both the 2003 study and this analysis, an average of 7.5c/L is assumed for operating costs.

Feedstock costs

Feedstock costs account for the largest proportion of total costs of producing ethanol and biodiesel. In some cases, there are other revenue streams associated with the production of biofuels that can contribute to cover total costs. For example, in the case of both ethanol and biodiesel produced from whole grains, crushed grain meal (also called distillers grain) is a valuable byproduct for use as a livestock feed. In table 8, a summary of the medium term assumptions for feedstock costs and byproduct revenues for the production of ethanol and biodiesel assumed is provided. In addition, the 'net revenue required' column provides

8 Biofuel feedstock costs and byproduct revenues

	Feedstock			Chemicals **bc**	Glycerol revenue **d**	Meal revenue			Net required revenue **e**
	Yield **a**	Price	Cost			Yield	Price	Revenue	
	L/t	$/t	c/L	c/L	c/L	kg/L	$/t	c/L	c/L
Ethanol – new capacity									
C Molasses	280	50	18	–	–	–	–	–	33
Sorghum	380	152	40	–	–	0.9	220	20	36
Biodiesel									
Used cooking oil	870 **f**	350	40	9	6	–	–	–	56
Tallow	894 **g**	450	50	9	6	–	–	–	66

a The yield of biodiesel per litre of oil is 0.8 litres. **b** Methanol costs of $800/t at a specific density of 0.791 with 125mL/L of biodiesel required gives 8c/L input cost. **c** Catalyst cost of $200/t at a ratio of 0.5 per cent by weight equates to a 1c/L input cost. **d** Glycerine yield of 8 per cent per litre of biodiesel sold at $850/t with a specific density of 1.112. **e** With production costs of 8c/L for both ethanol and biodiesel and capital costs of 8c/L for ethanol and 5c/L for biodiesel. **f** At a specific density of 0.92. **g** At a specific density of 0.895.

the total cost per litre that must be recovered from revenues obtained in the transport fuel market.

The ‘net required revenue’ is 33c/L for C molasses plants and 36c/L for sorghum plants. Likewise, for used cooking oil and tallow, the revenues are 56c/L and 66c/L respectively. This is the sum of the various production costs and byproduct revenues from production of the given feedstock.

As a result of the revenue from meal byproducts, a sorghum plant has a net required revenue lower than the cost of its feedstock.

Rates of return

Threshold prices, defined earlier to be the sum of the price at which the biofuel can be sold and any explicit subsidy available to biofuel production, for both ethanol and biodiesel are estimated to fall over the short to medium term. This is due to a combination of the assumed easing in oil prices, the phasing in of effective excises for alternative fuels, and the switch to paying fuel tax on an energy content basis in 2011-12. In real terms, the maximum excise on ethanol is 9.5c/L in 2015-16 (table 9), while for biodiesel this is 14.5c/L (table 10). This reflects the difference in energy content of the respective fuels.

The effective excise relief column in tables 9 and 10 defines the fuel tax advantage (or implicit subsidy) that each alternative fuel has relative to the traditional fossil fuel with which they compete. It is the difference between the excise applied to the traditional competing fuel and that applied to the alternative fuel. In real terms, both alternative fuels have falling effective excise relief; and the rate of decrease increases with biofuels beginning to pay effective excise from 2011.

9 Ethanol excise rates and threshold prices

	Oil price	Exchange rate	Relevant excise baseline a,b		Ethanol excise a		Effective excise relief a		Threshold price
	$/bbl	US$/A$	c/L		c/L		c/L		c/L
2005-06	47.40	0.74	37.1	*(38.1)*	0.0		37.1	*(38.1)*	68
2006-07	43.16	0.70	36.2	*(38.1)*	0.0		36.2	*(38.1)*	66
2007-08	37.91	0.68	35.3	*(38.1)*	0.0		35.3	*(38.1)*	63
2008-09	34.21	0.66	34.5	*(38.1)*	0.0		34.5	*(38.1)*	61
2009-10	32.24	0.65	33.6	*(38.1)*	0.0		33.6	*(38.1)*	60
2010-11	32.24	0.65	32.8	*(38.1)*	0.0		32.8	*(38.1)*	60
2011-12	32.24	0.65	21.8	*(25.9)*	2.1	*(2.5)*	19.7	*(23.4)*	47
2012-13	32.24	0.65	21.2	*(25.9)*	4.1	*(5)*	17.1	*(20.9)*	45
2013-14	32.24	0.65	20.7	*(25.9)*	6.0	*(7.5)*	14.7	*(18.4)*	42
2014-15	32.24	0.65	20.2	*(25.9)*	7.8	*(10)*	12.4	*(15.9)*	40
2015-16	32.24	0.65	19.7	*(25.9)*	9.5	*(12.5)*	10.2	*(13.4)*	38

a Numbers in brackets are excise rates in nominal terms. **b** In 2011-12, excise is applied on an energy content basis rather than volume basis; as such, the ethanol equivalent excise rate changes in 2011-12. This assumes ethanol has an energy content of 0.68 relative to petrol.

10 Biodiesel excise rates and threshold prices a

	Oil price	Exchange rate	Relevant excise baseline a,b,c		Ethanol excise b		Effective excise relief b		Threshold price a
	$/bbl	US$/A$	c/L		c/L		c/L		c/L
2005-06	47.40	0.74	37.1	*(38.1)*	0.0		37.1	*(38.1)*	83
2006-07	43.16	0.70	36.2	*(38.1)*	0.0		36.2	*(38.1)*	80
2007-08	37.91	0.68	35.3	*(38.1)*	0.0		35.3	*(38.1)*	77
2008-09	34.21	0.66	34.5	*(38.1)*	0.0		34.5	*(38.1)*	74
2009-10	32.24	0.65	33.6	*(38.1)*	0.0		33.6	*(38.1)*	73
2010-11	32.24	0.65	32.8	*(38.1)*	0.0		32.8	*(38.1)*	72
2011-12	32.24	0.65	28.8	*(35.8)*	3.2	*(3.8)*	25.6	*(32.1)*	66
2012-13	32.24	0.65	28.1	*(35.8)*	6.2	*(7.6)*	21.9	*(28.3)*	62
2013-14	32.24	0.65	27.4	*(35.8)*	9.1	*(11.4)*	18.3	*(24.5)*	59
2014-15	32.24	0.65	26.8	*(35.8)*	11.9	*(15.3)*	14.8	*(20.6)*	55
2015-16	32.24	0.65	26.1	*(35.8)*	14.5	*(19.1)*	11.6	*(16.8)*	52

a For a relative energy content of 94 per cent – that is, used cooking oil. **b** Numbers in brackets are excise rates in nominal terms. **c** In 2011-12, excise is applied on an energy content basis rather than volume basis. As a result the biodiesel equivalent excise rate changes in 2011-12.

By assessing the threshold price (that is, all the revenue streams available to a biofuel producer) against all assumed biofuel operating costs over time, it is possible to estimate the annual rates of return on invested capital that producers of biofuels can expect over the medium to long term (given the various assumptions about commodity prices, alcohol and oil yields, etc).

On the basis of the assumptions used in this analysis, fuel ethanol production is assessed as being able to compete against petroleum based fuels in the medium to long term, given current policy arrangements. A C molasses based plant is estimated to generate a 12 per cent return on invested capital in 2015-16, whilst a sorghum based plant is estimated to generate a 10 per cent return (table 11).

11 Ethanol feedstock rates of return

	C molasses price	Sorghum price	Annual rate of return			
			C molasses		Sorghum	
	A$/t	A$/t	c/L	%	c/L	%
2005-06	90	203	32	32	38	38
2006-07	80	161	34	34	37	37
2007-08	70	157	34	34	34	34
2008-09	60	156	36	36	34	34
2009-10	50	152	34	34	32	32
2010-11	50	152	35	35	33	33
2011-12	50	152	22	22	19	19
2012-13	50	152	19	19	17	17
2013-14	50	152	17	17	14	14
2014-15	50	152	14	14	12	12
2015-16	50	152	12	12	10	10

An ethanol plant employing either of these feedstocks that commenced full operation in 2005-06 or 2006-07 would recoup all or nearly all of the initial capital outlay in the first three years of operation under these assumptions (including no consumer resistance to fuel ethanol).

Further, under these assumptions, invested capital would be returned to owners nearly three times over in the period to 2015-16, assuming the plant is up and running in 2005-06.

The estimated annual rates of return for biodiesel produced from used cooking oil and tallow are presented in table 12. With regard to used cooking oil, biodiesel producers are estimated to be just covering their operating costs in the medium to long term and are expected to receive a return on capital of 2 per cent. For tallow based biodiesel production, the estimated negative returns to capital in the medium term indicate that the plants would be considered unprofitable and would be closed down as there would be insufficient revenue to cover the operating costs.

Despite the limited, or lack of, viability in the long term, biodiesel producers may still seek to invest in the industry as there are substantial returns to capital that can be achieved in the short term. The average rate of return on invested capital over time, between the commencement year of production and 2015-16 is presented in table 13.

For example, a C molasses based ethanol plant that commenced production in 2006-07 is estimated to average 25 per cent annual return on invested capital between 2006-07 and 2015-16.

Similarly for a biodiesel plant using tallow that commenced operation in 2006-07, the average annual return to capital is estimated to be 19 per cent between 2006-07 and 2015-16 despite the significant losses occurring late in the period.

12 Biodiesel feedstock rates of return

	Used cooking oil price	Tallow price	Annual rate of return			
			Used cooking oil a		Tallow b	
	A$/t	A$/t	c/L	%	c/L	%
2005-06	375	490	33	52	24	39
2006-07	365	480	30	47	21	34
2007-08	360	470	26	42	18	28
2008-09	350	460	23	38	15	24
2009-10	350	450	22	36	14	22
2010-11	350	450	21	34	13	21
2011-12	350	450	16	25	8	13
2012-13	350	450	12	19	5	7
2013-14	350	450	8	13	1	2
2014-15	350	450	5	7	-3	-4
2015-16	350	450	1	2	-6	-9

a Assumes a relative energy density of 94 per cent. **b** Assumes a relative energy density of 98 per cent.

13 Capital returned over time

		Ethanol				Biodiesel c			
		C molasses		Sorghum		Used cooking oil a		Tallow b	
Start	Years earned	Annual	Over time	Annual	Over time	Annual	Over time	Annual	Over time
		%	%	%	%	%	%	%	%
2005-06	11	26	283	25	273	29	315	21	191
2006-07	10	25	250	24	235	26	263	19	152
2007-08	9	24	216	22	198	24	216	17	117
2008-09	8	23	182	20	164	22	174	15	89
2009-10	7	21	146	19	130	20	137	13	65

a Assumes a relative energy density of 94 per cent. **b** Assumes a relative energy density of 98 per cent. **c** Assumes production ceases when operating costs are not covered.

Biodiesel assessment changes since the 2003 study

In general, the results of the 2003 study remain generally valid, despite revisions to assumptions regarding oil prices, exchange rates and input costs. The 2003 study concluded:

- that biofuel production was not economic in the medium to long term.
- further, that commercial production of biofuels could only be expected to expand to meet the 350 ML target with significant ongoing industry assistance equivalent to around 60 per cent of the production costs of ethanol, and nearly 20 per cent of the production costs of biodiesel.

However, the results for biodiesel based on used cooking oil feedstock in this analysis differ significantly from the results in the 2003 study. This is predominantly due to the revision of used cooking oil price assumptions. Previously, the long run price of used cooking oil was assumed to be $170 per tonne, but recent information from industry participants suggests that this is more reflective of the costs of collecting used cooking oil, and does not include the costs of processing and reselling it. In this analysis, the used cooking oil feedstock cost has been increased to $350 per tonne in the long run.

In the 2003 analysis, the long run threshold price of biodiesel was projected to be 30c/L. This compared with net required revenue of 35c/L for used cooking oil and 66c/L for tallow.

With the revision to the cost of using used cooking oil feedstocks in biodiesel production, the long run viability of biodiesel production is much less certain with required revenue for used cooking oil biodiesel of 56c/L and tallow based biodiesel of 66c/L, compared with an estimated threshold price of 52c/L and 55c/L respectively.

The Biofuels Taskforce requested that consideration be given to the question — ‘what level of excise in 2015-16, given the assumptions used in this analysis, would provide a real rate of return of 7 per cent to biodiesel producers?’

If the biodiesel was sourced from used cooking oil, fuel excise levied on biodiesel at 11.5c/L in 2015-16 (in 2004-05 terms — or 15.2c/L in nominal terms) would provide an estimated return on capital of 7 per cent. This contrasts with the current policy of 14.5c/L (or 19.1c/L in nominal terms) shown in table 5. A biodiesel excise of 11.5c/L would amount to an implicit subsidy of 16c/L (or 21c/L in nominal terms), equal to 28 per cent of the required revenue for biodiesel production.

To earn a 7 per cent return on capital from tallow based biodiesel production, fuel excise levied in 2015-16 is estimated to be 4.2c/L (in 2004-05 terms or 5.6c/L in nominal terms). This would amount to an implicit subsidy of 24c/L (or 32c/L in nominal terms), equal to more than 40 per cent of the net required revenue for biodiesel production.

To the extent that actual biofuel plants are more efficient than the generic biodiesel plant assumptions used in this analysis (table 8), the level of subsidy required to achieve a 7 per cent rate of return would be lower.

heavy vehicle fuel market

This chapter considers the effect of the fuel taxation arrangements that apply to the business use of fuel used in on-road applications for vehicles with a gross vehicle mass of more than 4.5 tonnes. As the effective excise applied to such vehicles is different from that considered in chapter 2, the implicit subsidy available to biofuel producers through differential fuel tax treatment will be different — and so will the potential rates of return available for fuel that targets this market.

Fuel tax credit reform

In June 2004 the Energy White Paper outlined further fuel tax credit reform measures, including the application of a road user charge to all fuels. Ultimately, the Government's intention is for excise to be limited to:

- in the private use of motor vehicles;
- for any other private purpose (except for the generation of electricity and use in burner applications);
- in the business use of vehicles with a gross vehicle mass of less than 4.5 tonnes; and
- in the business use of vehicles with a gross vehicle mass of 4.5 tonnes or more but only to the extent of the applicable road user charge (which is expected to be lower than current fuel excise arrangements).

The fuel tax credit reform measures announced by the Government change the level of Government support to biodiesel competing in the on-road heavy transport market (in either a 100 per cent biodiesel form or a blend mixed with diesel such as B5 or B20). The main features of the government's policy relevant for this analysis are:

- all business use of fuel in on-road transport activities in vehicles weighing 4.5 tonnes gross vehicle mass or over will incur a road user charge collected via the fuel tax system;
- the fuel tax credit for such use of fuel will be the relevant excise rate payable on the fuel minus the road user charge set in accordance with the National Transport Commission's heavy vehicle charges determination; and
- the Alternative Fuel Grants that currently apply under the Energy Grants (Credits) Scheme will be phased out between 2006 and 2010.

ABARE understands that three of the four biodiesel producers that have been awarded grants under the Biofuels Capital Grants Program intend to use tallow as their predominant feedstock. Further, the majority of this biodiesel production is proposed to be sold as a B5 or a B20 biodiesel blend and marketed for the heavy vehicle market (for example truck fleets), local council operations and other niche markets such as mining and marine applications.

As these changes relate to biodiesel production, the key differences to the analysis presented in chapter 2 are:

- business use of fuels on-road in heavy vehicles will receive a partial credit from fuel excise, equal to the fuel tax rate minus a road user charge;
- the road user charge to be paid will be less than the current fuel tax excise; and
- Alternative Fuel Grants under the Energy Grants (Credit) Scheme for the use of alternative fuels will be phased out in five equal steps, starting from 1 July 2006.
  - There is no Alternative Fuel Grant available to biofuels used in the private vehicle market.

Analysis

As before, the approach used is to derive the 'threshold price' in the heavy transport fuel market. That is, to assess all the revenue streams available to producers of biofuels and contrast this with the net required revenue for biofuel production.

The 'threshold price' consists of three components:

- the ex refinery price of diesel;
- the implicit subsidy associated with the difference between the effective excise rate paid by diesel and the effective excise rate paid by biodiesel;
  - No decision has yet been made of the road user charge that will apply from 1 July 2006. A recent study by the National Transport Commission considered 5 alternative scenarios with the road user charge varying from 19c/L to 23.3c/L. The analysis here will assume that the charge is set at 22c/L (National Transport Commission, 2005); and
- explicit subsidy arrangements such as the Capital Grants subsidy or the Alternative Fuel Grants supporting the use of biofuels in certain markets, such as the heavy transport fuel market.

In the analysis conducted in chapter 2, the implicit subsidy was the difference between the diesel excise rate (adjusted for energy content after 2011-12) and the biodiesel excise rate. In the heavy transport fuel market, the rebate available to end-users of diesel effectively reduces the implicit subsidy available to biodiesel producers. In such a case, it would be expected that the viability of biofuels in the heavy transport market would be reduced relative to the private vehicle fuel market. However, as some blends of biodiesel meet the diesel fuel standard, this recreates the tax treatment differential between biodiesel and diesel because of the manner in which the Australian Taxation Office will assess eligibility for the fuel tax credit.

Biodiesel produced for use in B100

In the case of 100 per cent biodiesel, in 2006-07, the implicit subsidy arising from the tax advantage of biodiesel relative to diesel is 22c/L. By 2015-16, the relative tax advantage has fallen to 0.6c/L due to the payment of excise on biodiesel (table 14).

Biodiesel production that is intended to be sold as B100 is currently entitled to the full Alternative Fuel Grant. Under the Fuel Tax reforms, this grant will be phased out in equal steps between 2006-07 and 2010-11. In 2006-07, the Alternative Fuel Grant is 14.8c/L in nominal terms, which, when combined with the relative tax advantage, provides an effective subsidy of 37.8c/L in nominal terms. By 2015-16, this effective subsidy has been reduced to zero.

As a result of the effective subsidy falling, the estimated rates of return on invested capital in biodiesel production for use in the B100 market become negative early in the next decade. Although the estimated annual rate of return is high over the next few years, it is unlikely that sufficient return on capital can be generated to warrant investment for B100 being targeted at this market. This would also apply to biodiesel blends that do not meet the diesel fuel standard as both the excise payable and fuel credit will be proportional to the diesel content — effectively rendering the analysis identical.

For biodiesel used in off-road applications under the proposed fuel tax regime in 2015-16, no large pricing advantage is provided through either fuel tax relief or energy grants as the fuel tax payable on diesel is effectively zero. Neither used cooking oil nor tallow will

14 B100 viability in the heavy transport fuel market a

	REB b	Diesel on-road credit relative to B100 c	Effective bio-diesel excise	Biodiesel relative tax advantage	Altern-ative fuel grant	Effective bio-diesel subsidy d	Threshold price		Annual rates of return	
	B	C	D	E = B – C – D	F	G = E + F	UCOe	Tallow f	UCOe	Tallow f
	c/L	c/L	c/L	c/L	c/L	c/L	c/L	c/L	%	%
2006-07	38.1	16.1	0	22	14.8	37.8	80	82	47	34
2007-08	38.1	16.1	0	22	11.1	34.1	72	74	35	21
2008-09	38.1	16.1	0	22	7.4	30.4	66	68	25	11
2009-10	38.1	16.1	0	22	3.7	26.7	62	63	18	4
2010-11	38.1	16.1	0	22	0	23.0	58	60	12	–2
2011-12	35.9	16.1	3.8	15.9	0	16.9	52	55	3	–9
2012-13	35.9	16.1	7.6	12.1	0	13.1	49	52	–3	–14
2013-14	35.9	16.1	11.4	8.3	0	9.3	46	49	–8	–19
2014-15	35.9	16.1	15.3	4.4	0	5.4	43	45	–13	–25
2015-16	35.9	16.1	19.07	0.6	0	1.6	40	42	–18	–29

a For ease of exposition, the excise and grants are presented in nominal terms, however, the threshold prices and rates of return are in 2004-05 terms. **b** Relevant excise baseline. **c** The road-user charge is assumed to be 22c/L. **d** Includes the Capital Grant subsidy equal to 1c/L. **e** Assumes energy density of 94 per cent. **f** Assumes energy density of 98 per cent.

be cost competitive feedstocks to produce biodiesel that targets the off-road market when compared with traditional diesel.

The analysis conducted in table 14 employed a constant nominal road user charge. The National Transport Commission considered a range of options for an annual adjustment to the road user charge to fund potential changes to increasing road-user charges over time (National Transport Commission 2005). The options included:

- an updated annual adjustment formula measuring changes in road expenditure and reflecting expected changes in road us;
- a more complex formula measuring changes in road expenditure and changes in road use;
- annual recalculation of charges (without review of cost allocation rules or methods of calculation);
- indexation using changes in the CPI or Rad Construction and Maintenance Index; or
- biannual recalculation of charges with indexation every second year.

The Biofuels Taskforce has expressed interest in the effects of indexing the road user charge. In response, the above analysis has been repeated with the road user charge indexed at the assumed CPI rate (2.5 per cent from 2006-07 onwards).

15 B100 viability with indexing of the road-user charge a

	REB b	Diesel on-road credit relative to B100 c	Effective bio-diesel excise	Biodiesel relative tax advantage	Altern-ative fuel grant	Effective bio-diesel subsidy d	Threshold price		Annual rates of return	
	B	C	D	E = B – C – D	F	G = E + F	UCOe	Tallow f	UCOe	Tallow f
	c/L	c/L	c/L	c/L	c/L	c/L	c/L	c/L	%	%
2006-07	38.1	15.6	0	22.6	14.8	36.5	81	83	48	35
2007-08	38.1	15.0	0	23.1	11.1	32.7	73	75	37	23
2008-09	38.1	14.5	0	23.7	7.4	29.1	68	69	27	14
2009-10	38.1	13.9	0	24.3	3.7	25.7	64	66	21	8
2010-11	38.1	13.3	0	24.9	0	22.4	61	62	16	3
2011-12	35.9	12.6	3.8	21.0	0	18.6	56	59	8	–4
2012-13	35.9	12.0	7.6	17.8	0	15.6	53	55	3	–8
2013-14	35.9	11.3	11.4	14.6	0	12.7	50	53	–1	–13
2014-15	35.9	10.7	15.3	11.4	0	9.9	47	50	–6	–17
2015-16	35.9	10.0	19.07	8.3	0	7.3	44	47	–10	–22

a For ease of exposition, the excise and grants are presented in nominal terms, however, the threshold prices and rates of return are in 2004-05 terms. **b** Relevant excise baseline. **c** The road-user charge is assumed to be 22c/L in 2005-06 and indexed at 2.5 % each year afterwards. **d** Includes the Capital Grant subsidy equal to 1c/L. **e** Assumes energy density of 94 per cent. **f** Assumes energy density of 98 per cent.

The effect of annual increases in the road user charge is to increase biodiesel's relative tax advantage, and hence the threshold price to biodiesel producers (table 15). However, the increase in returns to biodiesel producers relative to no indexing is not sufficient to warrant investment in biodiesel for sale as B100 in the heavy vehicle fuel market as the medium to long term return to capital is estimated to be negative.

Biodiesel blends that meet the diesel fuel standard

Where biodiesel blends such as B5 — where biodiesel comprises 5 per cent of the diesel fuel — are able to meet the diesel fuel standard, these blends will be treated by the Government as diesel. This entitles end-users to claim the full credit between the diesel excise rate and the road user charge. However, the actual excise payable on a biodiesel blend will be based on the proportions of diesel, biodiesel and the relevant excise rates applicable at the time. For example, in nominal terms, a litre of B5 in 2006-07 would be liable for 36.2c/L fuel excise (95 per cent of 38.1c/L and 5 per cent at 0c/L) and end-users would be able to reclaim the full on-road credit of 16.1c/L. This creates a 1.9c/L credit that, in effect, flows back to the price that the biodiesel producer can receive.

If a blend is only partially entitled to the on-road credit (in proportion to the content of diesel in the blend), then the price to the end-user of the blend would have to be reduced relative to diesel in order for end-user to be indifferent between purchasing diesel or the biodiesel blend. Otherwise, the price to the end-user would be lower for the purchase of diesel — where the on-road credit is higher. This difference in retail prices would flow

16 Viability of biodiesel blends that meet the diesel fuel standard a

	REB b	Diesel on-road credit relative to B100 c	Effective bio-diesel excise	Biodiesel relative tax advantage	Altern-ative fuel grant	Effective bio-diesel subsidy d	Threshold price		Annual rates of return	
	B	C	D	E = B – C – D	F	G = E + F	UCOe	Tallow f	UCOe	Tallow f
	c/L	c/L	c/L	c/L	c/L	c/L	c/L	c/L	%	%
2006-07	38.1	0	0	38	0	39	81	83	49	34
2007-08	38.1	0	0	38	0	39	77	79	42	28
2008-09	38.1	0	0	38	0	39	74	76	37	24
2009-10	38.1	0	0	38	0	39	73	74	35	22
2010-11	38.1	0	0	38	0	39	72	74	34	21
2011-12	35.9	0	3.8	32	0	33	66	69	25	13
2012-13	35.9	0	7.6	28	0	29	62	65	19	7
2013-14	35.9	0	11.4	24	0	25	59	61	13	2
2014-15	35.9	0	15.3	21	0	22	55	58	7	–4
2015-16	35.9	0	19.07	17	0	18	52	55	2	–9

a For ease of exposition, the excise and grants are presented in nominal terms, however, the threshold prices and rates of return are in 2004-05 terms. **b** Relevant excise baseline. **c** The road-user charge is assumed to be 22c/L in 2005-06. **d** Includes the Capital Grant subsidy equal to 1c/L. **e** Assumes energy density of 94 per cent. **f** Assumes energy density of 98 per cent.

back to the price at which biodiesel could be purchased, resulting in a lower price that the biodiesel producer could receive.

Although this treatment of blends such as B5 improves the implicit subsidy available to biodiesel producers in contrast to B100, it is offset by the removal of the Alternative Fuel Grant. The net effect of these arrangements is to make the return to biodiesel producers for biodiesel used in blends that meet the diesel fuel standard, such as B5, identical to the returns available to biodiesel used in the private vehicle market (discussed in chapter 2).

The estimated threshold prices and rates of return for biodiesel used in the B5 market are presented in table 16.

economic implications of the 350 ML target

In the 2003 study, it was concluded that with sufficient support, the 350 ML target could be achieved. The long term excise arrangements announced in December 2003, were broadly consistent with the levels of support identified in the 2003 study.

Since that time, a number of commercial proposals for investments in biofuel production have been announced. Some of the proponents of these ventures have been successful applicants in the Capital Grants program. Many of the proponents are still seeking opportunities to raise sufficient capital in order to proceed. The Biofuels Taskforce has provided ABARE with a list of known project proposals, and these are presented in table 17.

As discussed in the 2003 study, it is very difficult to fully identify current capacity, in part because of the ability to switch between industrial and fuel-grade ethanol production. Currently available information suggests that total biofuel capacity by the end of 2005-06 is likely to be around180 ML (table 17).

17 Biofuel capacity ML

	2005-06	2009-10	
		Capital grant recipient	Proposed
	ML	ML	ML
Ethanol			
Manildra	70		109
CSR	4	26	32
Rocky Point	1.2	15	16.2
Lemon Tree (Milmerran)		36.6	67
Primary Energy (Gunnedah)			120
Australian Ethanol (Swan Hill)			90
Australian Ethanol (Colleambally)			100
Australian Ethanol (Lake Grace)			100
Dalby Biorefinery			80
Austcane			100
SymGrain, Quirindi			100
Symgrain, Western Victoria			100
Ethanol total	75.2	77.6	1005.2
Biodiesel			
Biodiesel Industries Australia, Rutherford	20	8	20
Australian Biodiesel Group, Berkeley Vale	40		45
Biodiesel Producers Australia		60	60.2
Australian Renewable Fuels, Adelaide South Australia	44.7	44.7	44.7
Riverina Biofuels		44.7	44.7
Australian Renewable Fuels, Picton WA			44.5
AJ Bush			60
Australian Biodiesel Group Queensland			40
Natural Fuels			150
South Australian Farmers Fuel			15
Biodiesel total	104.7	157.4	524.1
Total	179.9	235	1 529.3

With regard to the viability of achieving the 350 ML target, it has not been possible to undertake a comprehensive assessment of the current proposals for biofuel plant construction, especially in the absence of detailed cost and plant specific information. The analysis conducted in chapters 2 and 3 suggest that ethanol production is commercially viable in the long run (under the assumption of no consumer resistance) but biodiesel production is not. However, the picture is less clear for biodiesel production in the short term. Under the assumptions for a generic biodiesel plant used in this analysis, a plant (using either used cooking oil or tallow) would earn substantial returns if it were constructed and able to produce at capacity by 2005-06, and slightly less so for commencement in 2006-07 (table 13). As a result, the long term production of biodiesel, given current assistance arrangements, is less certain. For example, under the assumptions used in this analysis, tallow based biodiesel production would cease sometime early next decade, but an established used cooking oil plant could continue to operate as long as all operating costs were covered.

The analysis conducted here has only considered the cost of production of biofuels relative to traditional fuels and has explicitly ignored issues associated with market penetration of biofuels in the longer term. Further, no consideration was given to the possible impact of biofuel import competition from 2011 onwards.

Given the limited time available for analysis, it is not possible to provide an assessment as to whether the current policy framework provides assistance sufficient to generate the commercial returns to ensure the 350 ML target will be met by 2010.

Economic impacts of achieving the 350 ML target

In the 2003 study, it was estimated that as a result of the need to subsidise the biofuels industry to reach the target, annual gross domestic product (GDP) for the Australian economy in 2010 was estimated to be $78 million lower (in 2004-05 dollars — which is equivalent to the $74.3 million in 2003 dollars in the 2003 report).

Despite the uncertainty of whether the 350 ML target would be met, the Biofuels Taskforce has requested an assessment of the economic costs of meeting the target under the assumptions used in this study.

In order to consider the economic costs, it is necessary to consider the composition of biofuels that might occur in 2010 should sufficient production occur. For the purposes of this exercise, it is assumed that all recipients of the Capital Grant will commence production between 2005-06 and 2009-10. This would increase biofuel production to 357 ML by 2009-10.

Under that scenario, the composition of biofuel production in 2009-10 would consist of 148 ML of ethanol and 202 ML of biodiesel.

Due to time restrictions, it has not been possible to revise the comprehensive analysis of the economic costs associated with meeting the target in this study. However, as the biofuel industry is small relative to total production in the Australia, estimates of the economic costs of meeting the target can be derived from the 2003 estimates.

The economic loss associated with biofuel production arises from three main sources. First, using transport fuels that are more costly to produce (such as ethanol and biodiesel) reduces economic efficiency. Second, increasing output in the biofuels industry requires resources (such as labor and capital) to be attracted away from other economically productive activities, thus reducing the total value of output in other sectors of the economy. Finally, there is a need to fund the subsidy (via increased taxes or reduced government expenditure on services), which further decreases economic efficiency within the economy.

The loss in economic efficiency (often referred to as the deadweight loss) within the fuel transport sector of using biofuels instead of oil based transport fuels was estimated in the 2003 study to be approximately $16 million (in 2004-05 dollars). In that study, the long run oil price was assumed to be US$23/bbl (in 2004-05 dollars — which is equivalent to the US$21/bbl in 2003 dollars discussed in the 2003 study). In contrast, in the current study, the long run oil price is assumed to be around US$32/bbl. Similarly, in the 2003 study, the long run exchange rate was assumed to be US60c, compared to US65c in this analysis.

Despite the increase in the exchange rates assumptions, the increase in long term oil price assumptions will result in a reduction in the loss in economic efficiency of using more costly biofuels to displace traditional fuels in the transport fuel market. The combined effect of increased oil prices and exchange rates results in an increase in the threshold price of approximately 36 per cent relative to the 2003 study (in energy equivalent terms). As such, the economic losses within the fuel transport sector are reduced by an approximately similar amount. It is estimated that this loss in efficiency in the transport sector will be reduced by approximately $6 million to $10 million (in 2004-05 dollars) in 2009-10.

The remaining $62 million loss estimated in the 2003 study resulted from the reduced economic activity elsewhere in the economy arising from both the diversion of factor resources away from other productive activities in the economy and the impact of funding the subsidy through raising additional taxation revenue. Additional revenue is required to offset the loss in revenue from the displaced petrol and diesel sales, as well as to fund the required subsidies to the biofuels manufacturers.

As the target remains unchanged, the economic losses associated with diverting factor resources away from other productive activities in the economy is likely to be similar. In addition, under the current policy settings, and based on the identified composition of the 350 ML target, the government expenditure is estimated to be $118 million in 2009-10. This exceeds the estimated $46 million (in 2004-05 dollars) government expenditure identified in the 2003 study by $72 million. As such, the economic costs in 2009-10 associated with reduced economic activity elswhere and the impact of raising additional tax revenue is estimated to increase to $80 million.

In total, meeting the 350 ML in 2010 is estimated to lead to Australian GDP in 2010 being approximately $90 million (in 2004-05 dollars) lower than otherwise. This is contrasted with the estimate of a $78 million reduction in GDP in the 2003 study.

In order to obtain a measure of the full economic impact (or cost) of achieving the 350 ML target, it is also necessary to account for other possible economic costs or benefits that are not included in the above analysis, such as reductions in emissions from burning fossil fuels. The benefits from reducing emissions can be grouped into two categories: local health and environmental benefits, and the global benefits of avoiding the damage associated with climate change.

In the case of avoided health costs, epidemiological studies have shown a link between concentrations of toxic substances in urban air sheds and morbidity and mortality rates amongst residents. Hence, benefits in the form of avoided health costs result from lower emissions of pollutants both at the tailpipe (that is, directly associated with vehicle use) and further upstream (that is, associated with fuel production and refining).

In the 2003 study, it was estimated that, given the composition of the additional 235 ML required to meet the target (relative to anticipated production that would occur in the absence of assistance) would consist of 205 ML of additional ethanol production and 30 ML of biodiesel. Under that scenario, annual avoided health costs were estimated at $3.3 million in 2010 (in 2003 dollars).

In this analysis, the assumption of the composition of the additional biofuel production required to meet the 350 ML target is different — consequently it is expected that the avoided health costs would also be different. ABARE was not directly involved in assessing the health benefits in the 2003 study.

In the 2003 study, the economic costs were an order of magnitude larger than the associated health benefits. In this analysis, the economic costs of supporting the biofuel industry in 2010 have been estimated to be larger due to the higher level of subsidies that will actually be in place in 2010. However, the economic benefits associated with avoided health costs, given the composition of the target, have not been re-estimated. For the benefits to exceed the costs, the health benefits would have to increase almost thirty-fold compared to the 2003 study.

Feedstock requirements to meet the target

On the basis of the ethanol and biodiesel yields presented in table 18 it is possible to derive the consumption of feedstock under the assumed composition of biofuels presented above. On that basis, approximately 149 000 tonnes of feedgrains and 172 000 tonnes of C molasses is required (table 18). This contrasts with recent annual exports of approximately 500 000 tonnes of sorghum (in non-drought years) and 1 million tonnes of C molasses.

For biodiesel, approximately 46 000 tonnes of used cooking oil and 156 tonnes of tallow would be required. Over the past three years, exports of tallow have been around 350–400 000 tonnes. As discussed in the 2003 study, the used cooking oil market is still in the early stages of development and no transparent market exists. Some businesses incur costs associated with the disposal of the used cooking oil while others are able to sell their used oil. Estimating availability of used cooking oil is difficult, but on the basis that waste cooking oil is produced at a rate of between 10–12 litres per person a year, total availability could be as high as 242 million tones (CSIRO, BTRE, ABARE 2003). Of course, it is more likely that less than 50 per cent of that could be realistically collected, but this would still exceed biofuel requirements by a significant margin.

This preliminary overview of feedstock availability to meet a 350 ML target suggests that there are sufficient feedstocks supplies available such that additional domestic consumption of feedstocks would most likely result in reduced exports of the those feedstocks. As a result, the prices of these feedstocks to other domestic consumers, such as feedgrain for domestic feedlots, are unlikely to change as the domestic prices remain linked to export prices — at least in years of average seasonal conditions.

However, the subsidies available to biofuel production are available to all biofuel producers. It is conceivable that, should a rapid uptake of biofuels by the community occur in the short term, production in 2010 could exceed 350 ML. On the basis of known ethanol project proposals presented in table 18, fuel ethanol production could increase to over 1000 ML, consisting of 148 ML consuming 500 000 tonnes of C molasses and 820 ML consuming 2.15 million tonnes of grain (with the remaining 50 ML sourced from existing waste starch capacity).

18 Estimated feedstock consumption – ethanol and biodiesel

	Production	Grain	C molasses
	ML	kt	kt
Ethanol			
Manildra (20 ML)	20	53	
CSR (Sarina, Queensland)	32		114
Rocky Point (Woongoolba, Queensland)	16		58
Lemon Tree (Millmerran, Queensland)	37	96	
Total	155	149	172
		UCO	**Tallow**
	ML	kt	kt
Biodiesel			
Biodiesel Industries Australia (Rutherford, New South Wales)	20	23	
Australian Biodiesel Group (Berkeley Vale, New South Wales)	40	23	22
Biodiesel Producers Australia (Victoria)	60		34
Australian Renewable Fuels (Adelaide, South Australia)	45		50
Riverina Biofuels (New South Wales)	45		50
Total	209	46	156

In the event that all current grain based ethanol proposals were to be established, it may be difficult to meet the increased domestic grain demand for sorghum and feed wheat through subsitution away from the export market. In addition to the 500 000 tonnes of sorghum exports, exports of feed quality wheat are approximately 200–500 000 tonnes. Other potential grains are maize or barley. Exports of maize are small at around 50 000 tonnes, whilst barley exported for feed is around 3 million tonnes in a year with average seasonal conditions. However, barley is less suited for ethanol production as it has an abrasive hull and relatively lower starch content. Where insufficient quantities of grains are unable to be switched away from export markets, there

19 Government and economic costs per direct job

		2009-10	2015-16
Biofuel production	ML	350	350
Number of plants		6	6
Direct jobs per plant		36	36
Total direct jobs		216	216
Government expenditure	$m	118	44
Government expenditure per direct job	$'000	545	205
Economic costs in 2010	$m	90	72
Economic costs per direct job	$'000	417	333

could be financial implications for other feedgrain consumers, such as feedlots, as increased domestic consumption bids up domestic grain prices. Further analysis of this is required, but is beyond the scope of this biofuel viability assessment.

Economic costs per job created

The 2003 study identified both the economic costs per job and the government expenditure per job created by the production of the 350 ML biofuels target in 2010. The Biofuels Taskforce has requested that the same approach be used in this study to provide approximate estimates of those same figures. In particular, it has again been assumed that each construction and operation of a biofuel plant generates 36 direct jobs.

The jobs created would most likely be located in a mix of regional and urban areas depending on the expected location of ethanol and biodiesel production, respectively. As a result, it is estimated that the economic costs of each direct biofuel related job (in 2009-10) is approximately $417 000. The cost in government expenditure for creating each of these jobs is estimated to be $545 000 (table 19).

sensitivity analysis

The estimates presented in the earlier sections are based on ABARE's medium to long term assessment of the relevant commodity markets. However, the estimates are also likely to be sensitive to the underlying assumptions. Of most importance for threshold prices and returns to capital for ethanol and biodiesel are the possible oil prices and exchange rates that may prevail in the future.

A higher exchange rate in the long run would mean that the threshold price would be lower. As for oil prices, if these were to be higher (lower) than expected, this would suggest greater (less) opportunity for the biofuel industry through higher threshold prices. Estimates for both ethanol and biodiesel given a range of different oil prices and exchange rates are investigated in this section.

Sensitivity analysis with effective excise exemptions

The energy adjusted ethanol threshold prices and returns to capital under different oil price and exchange rate assumptions are presented in table 20 and table 21. Higher oil prices and lower exchange rates push the threshold price and returns to capital up. As a point of reference, the net revenue requirement for a sorghum feedstock ethanol plant to cover is around 36c/L (table 8).

The different combination of oil price and exchange rates presented in table 20 yield possible threshold prices between 27c/L and 59c/L. With an assumed exchange rate of

20 Threshold ethanol prices with excise exemption a,b

Oil price	**Exchange rates** (US$/A$)			
($/bbl)	**0.60**	**0.65**	**0.70**	**0.75**
20	31	30	28	27
30	38	36	35	33
40	45	43	41	39
50	52	49	47	44
60	59	56	53	50

a Estimates based upon a real return to capital of 7 per cent. **b** Assumes an effective excise relief of 10.2c/L.

21 Return to capital for a sorghum feedstock ethanol plant a,b

Oil price	**Exchange rates** (US$/A$)			
($/bbl)	**0.60**	**0.65**	**0.70**	**0.75**
20	3	2	1	0
30	10	8	7	5
40	17	15	13	11
50	25	22	19	17
60	32	28	25	22

a Estimates based upon a real return to capital of 7 per cent. **b** Assumes an effective excise relief of 10.2c/L.

22 Threshold biodiesel prices with excise exemption a,b,c

Oil price	**Exchange rates** (US$/A$)			
($/bbl)	**0.60**	**0.65**	**0.70**	**0.75**
20	44	42	40	39
30	54	51	49	47
40	65	61	58	55
50	75	70	67	64
60	85	80	76	72

a Estimates based upon a real return to capital of 7 per cent. **b** Assumes an effective excise relief of 12.7c/L. **c** Assumes energy density of 98 per cent.

US65c, oil prices would have to be exceed $30/bbl for a sorghum plant to meet the net revenue requirement to be viable.

The threshold biodiesel prices and rates of return to capital are found in table 22 and table 23. The assumed effective excise relief used in these tables is 12.7c/L.

Some additional sensitivity tests were conducted for biodiesel to include an oil price / exchange rate combination that yielded a threshold price above the required revenue for a used cooking oil biodiesel plant of 56c/L.

23 Return to capital for used cooking oil feedstock biodiesel plant a,b,c

Oil price	**Exchange rates** (US$/A$)			
($/bbl)	**0.60**	**0.65**	**0.70**	**0.75**
20	–11	–14	–16	–19
30	6	1	-2	-6
40	22	17	12	8
50	39	32	26	21
60	55	47	40	34

a Estimates based upon a real return to capital of 7 per cent. **b** Assumes an effective excise rate of 11.6c/L. **c** Assumes energy density of 98%.

Sensitivity analysis with no effective excise exemptions

The final set of sensitivity tests looked at the effect of different oil prices and exchange rate assumptions on the threshold prices for ethanol and biodiesel *with no excise relief* (table 24). For example, with an assumed exchange rate of US65c, oil prices must be $50/bbl or higher for a sorghum ethanol plant to be viable. It is at this point that the threshold price is equal or higher than the net revenue required to make it financially viable.

For a biodiesel plant employing used cooking oil as a feedstock to be viable, the net required revenue is 56c/L (table 25). This revenue requirement is met when oil prices exceed US60/bbl for all considered exchange rates.

24 Threshold ethanol prices without excise exemption

Oil price	**Exchange rates** (US$/A$)			
($/bbl)	**0.60**	**0.65**	**0.70**	**0.75**
40	34	32	29	28
50	41	38	36	33
60	48	45	42	39

25 Return to capital for used cooking oil feedstock biodiesel plant a,b,c

Oil price	**Exchange rates** (US$/A$)			
($/bbl)	**0.60**	**0.65**	**0.70**	**0.75**
40	49	45	42	40
50	59	54	51	48
60	68	64	59	56

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Research funding. ABARE relies on financial support from external organisations to complete its research program. As at the date of this publication, the following organisations had provided financial support for ABARE's research program in 2004-05 and 2005-06. We gratefully acknowledge this assistance.

Agricultural Production Systems Research Unit
Asia Pacific Economic Cooperation Secretariat
AusAid
Australian Centre for International Agricultural Research
Australian Gas Association
Australian Greenhouse Office
Australian Quarantine and Inspection Service
Australian Wool Innovation Limited
Batelle Pacific NW
Canegrowers
Chevron Texaco
Commonwealth Grants Commission
Commonwealth Secretariat, London
CSIRO (Commonwealth Scientific and Industrial Research Organisation)
Dairy Australia
Department of Agriculture, Fisheries and Forestry
Department of Business, Industry and Resource Development, Northern Territory
Department of Environment and Heritage
Department of Foreign Affairs and Trade
Department of Health and Ageing
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Pratt Water
Primary Industries, Victoria
Rio Tinto
Rural Industries Research and Development Corporation
Snowy Mountains Engineering Corporation
Terrapin Australia
University of Queensland
US Environmental Protection Agency
WA Global Ocean Observing System
Woodside Energy
Woolmark Company

Appendix 4 ACIL Tasman review of 2003 *350 ML Target Report*

Confidential

Appropriateness of a 350 Million Litre Biofuels Target

Review of an ABARE, BTE and CSIRO Report to the Department of Industry, Tourism and Resources

Prepared for Department of Prime Minister and Cabinet

19 July 2005

ACIL Tasman

Economics Policy Strategy

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Contents

Figures and tables

Executive summary

Introduction and general conclusions

On 28 June 2005, the Task Force on Biofuels commissioned ACIL Tasman to undertake an independent review of the specific values to be used as the key inputs in a re-run of the industry viability analysis undertaken in the December 2003 report "Appropriateness of a 350 Million Litre Biofuels Target" (the Report), as well as an independent review of the methodologies used in Chapters 7, 14 and 15.

Specifically, the Task Force requested ACIL Consulting to advise on the following questions:

- Are the methodologies used in chapters 7, 14 and 15 of the December 2003 study the standard economic methodologies for addressing the analytical questions explored in these chapters, or are there other, more appropriate methodologies?
  - ACIL Tasman concludes that the methodologies used are standard economic methodologies appropriate for analysing the questions posed in the terms of reference.
  - ACIL Tasman suggests that the methodologies could be improved with the use of scenarios and sensitivity tests, and with more explanation about some of the assumptions used.
- In the consultant's professional opinion, are the new assumed input values for the re-run of the viability analysis reasonable (i.e. lie in about in the middle of what might be considered a reasonable consensus range), or are they noticeably higher or lower?
  - ACIL Tasman comments on the new assumed input values suggested by ABARE for a re-run of the analysis are as follows:
    - for crude oil prices at US$30/barrel (at 2005 prices), this assumption is toward the lower end of ACIL Tasman's suggested range for scenarios of between US$25-45/barrel (at 2005 prices) with exchange rates of A$0.71 and A$0.73, respectively. ACIL Tasman's range is slightly higher than that of the US Department of Energy and straddles the recently reported view of BP. BP expects prices to settle back to US$40/barrel in nominal terms (about US$35/barrel in real terms) by 2010. ACIL Tasman's single scenario projection from the Oxford Economic Forecasting model is US$32/barrel with an exchange rate of A$0.725
    - for the exchange rate at A$0.65, this assumption is at the lower end of ACIL Tasman's suggested range for sensitivity tests of A$0.60-0.80

    - for the return on capital at 6-8%, this assumption is significantly below ACIL Tasman's suggested range for return on capital of 10-15%
    - for capital costs of ethanol from molasses at $0.08/L for a 60ML plant, ACIL Tasman would recommend using Mark Ellis & Associates' estimate of $0.10/L
    - for the operating costs of ethanol from molasses at $0.26/L for a 60ML plant, this is at the lower end of the range estimated by Mark Ellis & Associates of $0.26/L for a 100ML plant and $0.44/L for a 10ML plant, suggesting around $0.36/L for a 60ML plant
    - for the operating costs of biodiesel, this is in the range estimated by Mark Ellis & Associates;
    - for capital and operating costs, there is some new data provided in submissions to the Task Force which could be useful to ABARE; and
- If they are noticeably higher or lower, what values, in the consultant's professional opinion, would represent better consensus range values, and why?
  – ACIL Tasman's suggestions are set out above.

Chapter 7

ACIL Tasman's review of Chapter 7 has resulted in the following comments and recommendations:

- There may be an inconsistency in the Report between the general assumption about existing and intended government policy on fuel standards and the threshold competitive prices for petrol and diesel used in the analysis
  – ABARE should check that the petrol and diesel prices used reflect the costs of producing Euro IV and Euro V compliant fuels, respectively;
- There is no coordinated discussion in Chapter 7 as to how the assumed mix of 235ML new biofuels capacity was derived. This is a deficiency in the Report and begs the question as to whether it is most likely to be the least–cost, technically viable mix — although it is evident from the discussion in Chapter 7 under each raw material source that these are in the set of low cost biofuels;
- ACIL Tasman agrees that the ACCC methodology for converting world oil price projections of an 'average' crude oil to Australian ex-refinery prices is appropriate. We note it was validated in terms of estimated domestic refinery prices;
- ACIL Tasman understands the use of a single scenario for projecting future oil prices. An improved methodology would involve the selection of at least two scenarios (high and low oil prices) that might be regarded as

encompassing the most plausible outcomes, with exchange rates chosen that are consistent with the oil price scenarios

  - ACIL Tasman suggests a high price scenario be modeled assuming real crude oil prices at US$45/barrel, with an associated exchange rate of A$0.73
  - the low price scenario would assume US$25/barrel by 2010, with an associated exchange rate of A$0.71;

- Outside the oil price scenarios, sensitivity tests of exchange rates should be carried out to reflect the fact that many factors other than oil prices, particularly inflation rates in Australia and the USA, influence exchange rates. Rates of A$0.80 and A$0.60 could be tested;
- The energy content of biofuels used in the Report is a matter of technical fact. We note that for biodiesel the rates vary depending on the raw material source from 88% to 99%. The Report chose 90% without explanation;
- New information on the cost of producing biofuels would suggest that ABARE has underestimated the capital and operating costs for ethanol produced from molasses; and
- The Report has assumed that ethanol and biodiesel projects would require real per-tax rates of return of between 6% to 8%. ACIL Tasman would recommend that that real pre-tax rate of return should be in the range of 10-15%.

Chapter 14

The Report highlights shortcomings of most of the studies done to date. In summary, while there seems to be reasonable agreement about direct employment impacts of individual new plant, there is no common understanding of the extent of flow-on effects that might emerge within a region or between regions.

The key assumption in the Report is the choice of 2 as an employment multiplier. In our view, this is reasonable on a State-wide basis. In the case of Queensland (and we would expect NSW) there are regional input-output tables and associated multipliers that could be referenced for the study.

Provided project and location data is now available, ACIL Tasman recommends that employment multipliers be estimated from State and regional input-output tables. Assumptions about sourcing of feedstocks need to be specified in order to adjust the multipliers if the feedstocks are being taken from existing sources. The new ABARE Ausregion model may be useful if it can disaggregate States into regions.

Chapter 15

AUSTEM is likely to be a suitable tool to measure the nation-wide economic impacts of achieving the biofuels target. However, the chapter provides very limited information about the assumptions used or the modeling methodology.

We would recommend that in any new report the assumptions and modeling methodology would be better explained.

1 Introduction

1.1 This review

The Task Force on Biofuels was established on 30 May 2005 to examine the latest evidence on the impacts of ethanol and other biofuels use on human health, environmental outcomes and automotive operations, and to assess the costs and benefits of biofuel production, taking into account the most recent economic analyses of fuel supply in Australia.

The Task Force was directed to examine the findings of the report "The Appropriateness of a 350 Million Litre Biofuels Target" (the Report) prepared in December 2003 by CSIRO, ABARE and the BTRE.

On 28 June, the Task Force commissioned ACIL Tasman to undertake an independent review of the specific values to be used as the key inputs in a re-run of the industry viability analysis undertaken in the December 2003 Study, as well as an independent review of the methodologies used in Chapters 7, 14 and 15.

Specifically, the Task Force requested ACIL Consulting to advise on the following questions:

- Are the methodologies used in chapters 7, 14 and 15 of the December 2003 study the standard economic methodologies for addressing the analytical questions explored in these chapters, or are there other, more appropriate methodologies?
- In the consultant's professional opinion, are the new assumed input values for the re-run of the viability analysis reasonable (i.e. lie in about in the middle of what might be considered a reasonable consensus range), or are they noticeably higher or lower?
- If they are noticeably higher or lower, what values, in the consultant's professional opinion, would represent better consensus range values, and why?

The Task Force provided revised assumptions to ACIL Tasman on 4 July.

1.2 The "appropriateness" test

The Report was tasked with determining the "appropriateness" of setting a biofuels target of 350ML in transport uses by 2010. Consistent with the terms of reference, the Report defined "appropriateness" to include consideration of:

- Net environmental benefits relating primarily to greenhouse gas emissions and air quality impacts;

- Net economic benefits relating to the economy-wide impacts of government support required, if any, to meet the target;
- Net regional benefits relating to economic and other community impacts in regions; and
- Industry viability relating to biofuel cost competitiveness with petrol and diesel.

ACIL Tasman agrees with the definitions used in the Report and the standard economic methodologies used for this analysis. However, ACIL Tasman would have approached the task from the point of view of identifying whether the proposed 350ML target addresses demonstrated market failures efficiently. It may well be that there are no demonstrated market failures but, if there were, the use of a market share target of 350ML in 2010 is not considered an efficient or appropriate response.

Our approach would have been to undertake a benefit-cost analysis of the biofuels target involving:

- Estimation of net economic, environmental and community impacts at national and regional levels
  - using projected market prices where they are efficient
    - the Report has done this in its net economic, net regional and industry viability assessments
  - where market failures are found, using estimates of efficient market prices
    - the Report has done this by estimating un-priced health impacts and comparing the greenhouse gas emission savings with the costs of other programs such as the Greenhouse Gas Abatement Program
    - ACIL Tasman would have also included a discussion of the appropriateness of the 350ML target as a policy instrument to address these market failures, whereas the terms of reference for the Report did not invite such a discussion; and
- Identification of any benefits and costs that cannot be priced
  - ACIL Tasman has not identified any benefits or costs that could not be represented by market prices
  - we consider that oil prices and government taxes appropriately reflect the net benefits and costs of increased energy security, whereas the Report sees energy security as an un-priced item
  - we consider that regional community net benefits and costs are captured in the estimation of economic activity and employment impacts, whereas the Report's definition of net regional benefits includes economic impacts and "other" (undefined) community impacts.

While ACIL Tasman's approach may have been different, there would have been substantial alignment with the Report on the tasks to be performed in estimating net benefits and costs.

However, in addition, ACIL Tasman would have very likely concluded that conceptually the 350ML target is "inappropriate" because it would be an economically inefficient, environmentally ineffective and socially inequitable policy instrument to address the environmental market failures identified. Such a conclusion is possible from a first principles assessment of this type of policy instrument:

- Technology targets can only be economically efficient if they are known to be the only least-cost solution to the market failure
  - in economic efficiency terms, the best outcome that can be hoped for is that the target is set so that it is very likely to be met by business-as-usual, in which case the economic losses might be restricted to the transactions costs involved in setting, monitoring and enforcing compliance with the target, if that is the way the target is to be implemented;
- It is well known and accepted that the global nature of climate change requires emission reduction policies to be comprehensive in terms of sectors and greenhouse gases in order to be environmentally effective. With respect to local pollution and related health problems, setting air-shed standards that apply to all emission sources is more effective than attempting to pick technology winners; and
- The 350ML target may be beneficial to a few select communities, including regional communities, but would disadvantage others depending on how the increased taxation to pay for the subsidies is raised.

2 Review of industry economics (chapter 7)

2.1 Report findings

The Report finds that:

- The competitive medium term price of petrol in Australia is estimated at 29c/L[1] (in 2003 dollars), requiring ethanol to be priced at 20c/L because ethanol has 32% lower energy content than petrol
  - the medium term price of ethanol produced from waste starch is below 20c/L in existing capacity (around 18c/L and possibly lower), but above it in new capacity where capital costs add 7-9c/L
  - the medium term price of ethanol produced from cereal grains is estimated at 32c/L
  - the medium term price of ethanol produced from C molasses is estimated to be between 26c/L (existing capacity) and 33c/L (new capacity); and
- The competitive medium term price of diesel in Australia is estimated at 33c/L (in 2003 dollars), requiring biodiesel to be priced at 30c/L because biodiesel has 10% lower energy content than diesel
  - the medium term price of biodiesel produced from waste cooking oil is estimated at 35c/L
  - the medium term price of biodiesel produced from tallow is estimated at 66c/L
  - the medium term price of biodiesel produced from oil seeds is estimated at 76c/L
  - the medium term price of biodiesel produced from canola oil is estimated at 119c/L.

From these findings, the Report determines for 2010 that business-as-usual existing capacity will supply 85ML of ethanol (80ML from waste starch and 5ML from C molasses) and 30ML of biodiesel from waste oil. The Report also assumes that the 350ML target would be met by new capacity involving:

- 60ML of ethanol from C molasses;
- 145ML of ethanol from cereal grains; and
- 30ML of biodiesel from waste oil.

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1 Using the data on page 46 of the Report, ACIL Tasman calculates 27.82c/L. The difference may be due to rounding.

There is no coordinated discussion in Chapter 7 as to how the assumed mix of new capacity was derived — leaving aside the Executive Summary, the first reference to the assumed mix of biofuels to meet the target is in Chapter 11 (page 109). This is a deficiency in the Report and begs the question as to whether it is most likely to be the least–cost, technically viable mix — although it is evident from the discussion in Chapter 7 under each raw material source that the selected mix is within the set of low cost biofuels. ACIL Tasman notes that the analysis of emissions and health costs incorporates sensitivity analysis of other mixes (for example all ethanol sourced from C molasses) in Chapter 13.

ACIL Tasman also notes that a new 150ML biofuels plant has been announced for Darwin based on imported palm oil from Malaysia.[2]

2.2 Methodology and assumptions

The methodology in the Report to test the commercial viability of biofuels in the Australian transport fuels market involves:

- Adopting some general assumptions about government policy, transport fuels markets and biofuels technology;
- Estimating the expected prices of petrol and diesel in 2010 to establish a competitive threshold price for biofuels; and
- Estimating the expected prices of biofuels in 2010.

2.2.1 General assumptions

General assumptions adopted for the Report include:

- Australia is a price taker in world oil markets and the ex-refinery prices of petrol and diesel are set by the import parity price of those products;
- Existing and intended (for example, fuel standards and excise) Government policy is implemented;
- Given the 2010 timeframe, only existing technically viable technology is considered;
- Capital availability and market potential are not barriers to biofuels penetration; and
- Ethanol viability is assessed on the basis of competitiveness with petrol as an extender (for example, a 10% blend), but not as an octane enhancer.

The reasons for these general assumptions are satisfactorily discussed in the Report and ACIL Tasman agrees they are appropriate. However, in our view the assumptions and the conclusions drawn from the analysis are best

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2 The Australian 7 July 2005, *'Green" fuel plant a saviour for Top End.*

considered from within an overall framework that examines the existence of market failure.

In addition, there may be an inconsistency in the Report between the general assumption about existing and intended government policy on fuel standards and the threshold competitive prices for petrol and diesel used in the analysis.

In Chapter 6 of the Report (pages41-42), the timetable for the introduction of Euro III (petrol) and Euro IV (diesel) standards is set out. Further, the Report states that

> "The study has assumed that Euro IV (petrol) vehicle standards will be mandated in Australia from 2008 and Euro V (diesel) vehicle standards will be mandated from 2009." (sub-section 6.3.1, page 42)

However, in Chapter 7 the threshold competitive prices established in Table 5 (page 47) would appear to exclude the additional costs of moving to Euro IV (petrol) and Euro V (diesel). Specifically, the Report quotes (see page 48) estimates of an additional 4c/L for ethanol (bringing the ethanol threshold price to about 24c/L) and 2c/L for biodiesel (bringing the biodiesel threshold price to about 32c/L).

2.2.2 Estimated petrol and diesel threshold competitive prices

There are three key elements that determine the estimation of the threshold competitive prices of petrol and diesel:

- The world price of crude oil and the conversion of that projected price to an ex-refinery price of petrol and diesel in $US;
- The $US and $A exchange rate; and
- The energy content of petrol and diesel relative to biofuels.

World oil prices (in real terms)

The Report adopts the ACCC methodology[3] for estimating ex-refinery product prices from projections of international crude oil prices. This methodology involves:

- Projections of world oil prices
  - in 2002/2003 both ABARE and the IEA projected world oil prices at around $US21/barrel in 2010 (in 2003 dollars);
- Conversion of world oil prices to West Texas Intermediate terms by multiplying by 1.116, recognizing the higher quality of WTI which is representative of the crude needed to produce petrol and diesel, and adding $US3.10/barrel to cover refining costs; and

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3 ACCC (2002), *Reducing Fuel Price Variability*, Canberra, Australia

- Adoption of ABARE's projected long term exchange rate of $A1=$US0.60
  - we note some confusion in the Report about whether the projection is $US0.65 or $US0.60 (see page 46)
  - at $US0.65 the threshold competitive price for ethanol in petrol falls to about 26c/L, meaning ethanol needs to be priced at about 17.5c/L. We note that this demonstrates the value of sensitivity tests on key variables.

ACIL Tasman agrees that the ACCC methodology for converting world oil price projections of an 'average' crude oil to Australian ex-refinery prices is appropriate. We note it was validated in terms of estimated domestic refinery prices.

However, ACIL Tasman suggests the methodology could be improved with the use of more than one scenario for projecting future real oil prices. In circumstances where none of the major oil companies, OPEC or the USA Government have any reliable track record in projecting oil prices over the medium term, an improved methodology would involve the selection of at least two scenarios (high and low) that might be regarded as encompassing the most plausible outcomes. It is important to emphasize that, as with all projections, oil price projections do not represent an assessment of what will happen, but rather, an assessment of what might happen under various scenarios.

Defining these scenarios is important. As recently discussed in the BTRE Working Paper 61[4], some argue that for the first time since the early 1970s the projection of oil prices may need to be less concerned with the implications of supply-side constraints imposed by OPEC or geopolitical events, and at least equally concerned that demand may play a greater role. In particular, in the medium term it is possible that demand is growing more quickly than refinery supply capacity.

An example of the scenario methodology is that adopted by the US Department of Energy (DOE). The DOE's most recent projections (AEO2005[5]) were finalised in October 2004 when oil prices where about US$46/barrel. The world oil price cases in AEO2005 are designed to address the uncertainty about the market behavior of OPEC. They are not intended to span the full range of possible outcomes. The cases are defined as follows:

- Reference case. Prices in 2010 are projected to be about US$25 per barrel (2003 dollars) as both OPEC and non-OPEC producers add new

4 BTRE (2005), *Is the World Running Out of Oil? A Review of the Debate*, Working Paper 61, Canberra, Australia

5 Energy Information Administration (2005), *Annual Energy Outlook 2005*, Washington , USA

production capacity over the next 5 years. After 2010, oil prices are projected to rise to more than US$30 per barrel in 2025;

- High A world oil price case. Prices are projected to be at about US$34 per barrel through 2015 and then increase to more than US$39 per barrel in 2025;
- High B world oil price case. Projected prices are US$37 in 2010 and rise to US$48 per barrel in 2025; and
- Low world oil price case. Prices are projected to decline to US$21 per barrel in 2009 and to remain at that level out to 2025.

In addition, sensitivity tests should be carried out. The Report does not perform sensitivity tests on the commercial viability estimates (but does on the health cost estimates). We note, however, that the Report would estimate that the competitive price for ethanol in petrol would be 27c/L at US$30/barrel compared with 20c/L at US$21/barrel (see bottom of page 46).

This sensitivity to oil prices is important to the final conclusions drawn from the Report. For example, at 27c/L it may be that the 350ML target would be met by the market without government subsidy. We consider that sensitivity testing on oil prices is a necessary component of the methodology and note that the Report does sensitivity testing in relation to health estimates.

Oil prices and exchange rates

It is not clear in the Report whether the assumptions for oil prices and exchange rates are compatible. ACIL Tasman's knowledge of other ABARE work would suggest the assumptions are compatible.

In ACIL Tasman's view, it is important that the scenarios cover not just a storyline about oil prices, but also the implications for Australian economic growth relative to world economic growth, with the associated implications for exchange rates. Of course, exchange rates are influenced by many other variables, not least domestic policies influencing inflation, but these matters need not be used to complicate the scenario storylines.

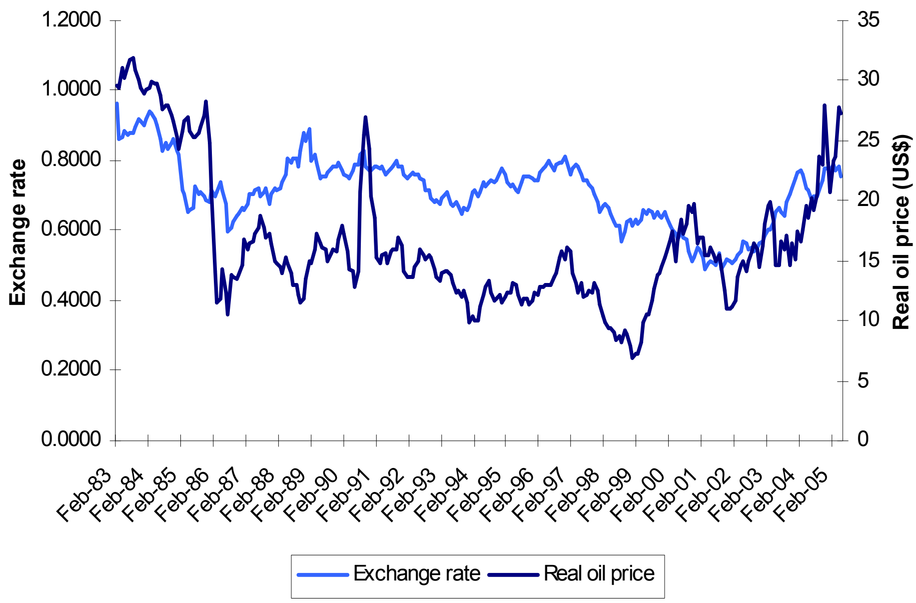
In general terms, and other things being equal, in the medium term it is possible to postulate that:

- The Australian dollar is "high" relative to the US dollar when world economic growth is high, which in turn requires moderate to low real oil prices
  - moderately high oil prices can flow through to higher export prices for coal and LNG without significant constraints on world growth, thereby boosting the value of the Australian dollar

  - high global economic growth has in the past meant high demand for Australian commodities; and
- The Australian dollar is "low" relative to the US dollar when world economic growth is low, which in turn can occur when real oil prices are high.

This relationship is predicated on the observation that Australia's economic growth is driven, more than in any other OECD country, by the trade in commodities, with Australia's terms of trade particularly sensitive to fluctuations in energy commodity prices. Figure 1 tracks the A$:US$ exchange rate and the real price of oil in US dollars. Clearly there are compatible trends between the two data sets, although from February 1999 until November 2001 there is a major discontinuity with oil prices increasing significantly and the Australian dollar not responding. However, some form of relationship resumes from 2002.

Figure 1 **Exchange rates and oil prices**



Data source: ACIL Tasman

Importantly, it is the case that the services sector of the Australian economy continues to grow as a proportion of the total economy, and that Australia's exposure to trade is falling over the long term. Further, we note that presently the Australian dollar is relatively high notwithstanding negative balance of payments.

Notwithstanding some relationship between the oil price and the exchange rate, there are no hard and fast rules about the behaviour of exchange rates. In particular, there are many domestic policy settings in Australia and the USA that would drive inflation in both countries and could therefore change the exchange rate significantly. Consequently, it is important to do sensitivity tests for the impact of high and low exchange rates. Rates of A$0.80 and A$0.60 could be tested.

In the context of new assumptions recently provided by ABARE (see Section 5 below), ACIL Tasman has undertaken some international modelling that might inform the high and low oil price scenarios to be used in a new analysis.

Energy content of biofuels

The energy content of biofuels used in the Report is a matter of technical fact on which ACIL Tasman is not qualified to comment.

We note that for biodiesel the rates vary from 88% to 99%, depending on the raw material source. The Report chose 90% without explanation. The study could be improved by matching the energy content of the raw materials from Table 4 with the cost estimates made in Section 7.5 of the Report.

2.2.3 Estimated biofuel prices

ACIL Tasman supports the approach taken in the Report to:

- where possible, identify cost ranges for feedstocks given the uncertainty involved and the paucity of accurate data;
- use short-run marginal cost to determine the market share of existing plant and long-run marginal cost to determine investment in new plant; and
- use opportunity costs for cereals, sugar and oils for ethanol and biodiesel feedstock
  - it could be expected that ABARE would now have new projections for the feedstock prices in 2010.

The Report has assumed that ethanol and biodiesel projects would require real pre-tax rates of return of between 6% to 8%. The justification for these rates of return is that they are consistent with the long-run average for the stock market and are equivalent to the rates of return for regulated energy infrastructure.

However, in the context of an unregulated biofuels market, these would appear to be very low commercial rates of return considering the technical and market risks involved. The Report itself suggests that rates of return of around 20% are not uncommon for these types of projects (page48). In an analogous situation, ACIL Tasman understands that bankers require pre-tax real rates of return for projects that qualify for the Mandatory Renewables Energy Projects scheme to be in the order of 10-15%. For recent conventional power generation, bankers are requiring real pre-tax rates of return of around 9%.

On the other hand, a mandated market share, as proposed by a 350ML target, could be expected to reduce market risk, at least for those projects that would fall within the target, provided the market share is guaranteed for the investment life (that is at least 20 years for a bankable investment). To take the reduced market risk delivered by regulation into account would, however, be an error in calculating the true economic cost of the target.

ACIL Tasman would recommend that that real pre-tax rate of return should be in the range 10-15%.

In relation to capital and total operating costs, the NSW Department of Energy, Utilities and Sustainability has recently released a new report on biofuels prepared by Mark Ellis & Associates.[6] The data presented in that report suggests that costs used by ABARE for biodiesel are appropriate (in the range of 4-10c/L for capital costs and 20-90c/L for operating costs).

However, the capital and operating costs used by ABARE for ethanol sourced from molasses would appear to be low at 7-9c/L for capital and 26c/L for operating from a 60ML plant, respectively. Mark Ellis & Associates estimate capital costs at 10c/L and operating costs range from 26-44c/L for a 100ML and 10ML plant, respectively.

6 Mark Ellis & Associates, *NSW Bioenergy Handbook*, for DEUS, NSW, 2004.

3 Review of regional impacts (chapter 14)

3.1 Report findings

The Report finds that:

- A subsidy of around $30 million per annum would be required to support 4 new plants to produce biofuels to meet the 350ML target;
- If all additional production of 235ML is ethanol, then around 4 new plants will be needed in non-urban areas resulting in:
  - 144 additional direct full-time equivalent jobs in the plants
  - 288 additional indirect full-time equivalent jobs in the regions close to the plants;
- Total additional employment in regional areas will be lower than the above estimates
  - one of the plants is likely to be a biodiesel plant located in an urban area and sourcing feedstock from waste cooking oil
  - some of the jobs created in the regions close to the new plants will be draw from other areas in Australia
  - the increase in taxation (or reduced government expenditure in other areas) needed to fund the subsidy will reduce jobs in other areas of the economy; and
- A more accurate regional analysis is possible if the locations and characteristics of each of the new plants are known.

3.2 Methodology and assumptions

The Report's methodology involved a literature review of existing studies. The Report highlights shortcomings of most of the studies done to date. In summary, while there seems to be reasonable agreement about direct employment impacts of individual new plant, there is no common understanding of the extent of flow-on effects that might emerge within a region or between regions.

In particular, employment multipliers used by a range of studies are reported to vary from 2 to 60. In ACIL Tasman's experience, there are few circumstances where employment multipliers for any industry would exceed 5 on a narrow regional basis, and more than 2 on a State basis. For example, the Queensland Treasury approved Queensland Multi-Regional Model (QMRM) compiled at the University of Queensland using data and input-output tables supplied by the Government Statistician's Office has State-wide employment multipliers for new coal mine developments at less than 2. This is in the context of direct coal mining jobs attracting above average wages, and therefore the flow-on effects can be expected to be relative high.

Estimation of multipliers is a complex issue and is specific to the region and to the nature of the project. Assumptions about existing skill sets, levels of unemployment and whether feedstocks are sourced from new plantings of crops or re-directed from existing plantings have very significant influences on the level of the multipliers that might be appropriate. The Report assumes an employment multiplier of 2 on a State-wide basis, which does not seem unreasonable.

The best available tool for estimating regional impacts of new investment in biofuels is input-output analysis. Regional multipliers can be estimated for employment and value added from the input-output tables. When supplemented with general equilibrium analysis, reasonable estimates of economic impacts and identification of regional winners and losers should be possible.

Input-output analysis should be undertaken on a regional basis and a State basis to better understand the impacts on regions. States like Queensland have published input-output tables and associated multipliers, and in the QMRM model regional tables have been derived. We note that at the time of the Report it was not possible to undertake the analysis to this level because of data constraints.

Provided data is now available, ACIL Tasman recommends that employment multipliers be estimated from State and regional input-output tables. Assumptions about sourcing of feedstocks need to be specified in order to adjust the multipliers if the feedstocks are being taken from existing sources.

4 Review of general equilibrium modeling (chapter 15)

4.1 Report findings

The Report finds that:

- A subsidy of around 21c/L will be required to increase ethanol production by 205ML above the reference case and 6c/L for 30ML of additional biodiesel above the reference case;
- The subsidy is $31 million per annum if applied only to the additional production;
- The economic cost is a lower GDP of $70.9m million per annum, made up of
  - losses associated with more costly transport fuels of $15 million
  - $55.9 million of losses associated with re-allocation of capital and labour away from more productive uses and increased taxation to pay the subsidy;
- Other indicators of the economic cost or benefit included
  - reduced exports of $51.1 million per annum
    - no results are presented for imports
    - or of the impact on exchange rates;
  - increased employment in biofuels industries of 144 direct and 288 indirect jobs
    - no results are presented for changes to employment in other sectors of the economy
    - given the reduction in GDP and exports referred to above it can be expected that employment will have declined in at least some other industries;
  - avoided health costs of $3.3 million per annum; and
  - at an assumed $10/tonne CO2-e, reduced greenhouse gas emissions of 268,000 tonnes are worth $2.68 million per annum.

4.2 Methodology and assumptions

4.2.1 The AUSTEM model

General equilibrium models like AUSTEM provide a good framework to estimate the economic impacts of achieving the biofuels target since they capture all the key interactions and linkages between the different sectors of the Australian economy. In particular, the general equilibrium model captures the interactions between the various energy sectors and the uses of energy, allowing the spill over and feedback effects of achieving the target to be measured and the impact on economic welfare to be estimated.

The Report provides very little information on the specifics of the AUSTEM model. Although the ABARE website does provide some documentation of the model, it is difficult to make a true assessment of the suitability of AUSTEM for this modeling exercise without extensive consultation with ABARE. AUSTEM is basically a much enhanced version of the well known ORANI-E model used by McDougall (1993) and as such is related to other well known GE models such as MONASH used by The Centre of Policy Studies.

AUSTEM is one of a collection of general equilibrium models at ABARE. It has similar characteristics, enhancements and strengths to other ABARE models such as GTEM and STATETEM. For example, ABARE's general equilibrium models contain a comprehensive and explicit emissions accounting framework to allow an assessment of the emissions impacts of achieving the biofuels target.

Importantly, ABARE's models contain an enhanced treatment of the energy sector and related activities. For this reason, AUSTEM is likely to be a suitable tool to measure the nation-wide economic impacts of achieving the biofuels target.

From the discussion about AUSTEM in the Report it is clear that ABARE has further developed the model for this study. In particular, ABARE has added two new industries to the model (ethanol and biodiesel) to get a better understanding of the interactions between these two industries and all other sectors of the Australian economy, adding a significant amount to the rigor of the modeling work done. But there is no description in Chapter 15 of how this was done or the data used. The process of developing the complete economic structure of the new industry in a general equilibrium model can involve the use of many assumptions (not listed), and the model results can change significantly under different assumptions.

As with all general equilibrium models, there are certain aspects that AUSTEM will not handle well. For example, transactions costs associated with establishing, maintaining and enforcing the biofuels scheme do not appear to be modeled. It is unlikely that these costs could be modeled under the AUSTEM framework without further model development. Also, models like AUSTEM do not estimate some of the flow-on economic effects, benefits or otherwise, that may arise with the reduction in GHG emissions such as changing land and farm productivity.

Finally, models like AUSTEM do not measure the non-economic impacts of changes in emissions such as avoided health costs. However, it is a strength of the Report that estimation of these impacts has been made outside the model.

4.2.2 The reference case and the modeling of the target

Since the model measures the change in economic indicators, two of the most important assumptions of the modeling are:

- The definition of the reference case[7]; and
- The way in which the policy target is imposed on the reference case.

The reference case involves assumptions that:

- Existing and intended government policy on transport fuel taxation and fuel standards will be carried out before 2010
  - as discussed above in Section 2.2.1, it is possible that the cost of fuel standards on conventional petrol and diesel are not been fully incorporated into the reference case; and
- those policies will deliver 115ML of biofuels into the market
  - as discussed above in Section 2.2.1, it is not clear how this market share has been derived from the discussion in Chapter 7 of the Report.

An alternative approach would have been to establish a reference case without the influences of intended government policy on excise and fuel standards. A case could then have been modeled to estimate the market share that biofuels might capture under the intended policies. The 350ML policy target could then be modelled as a next step.

Further, it is not overly clear from the Report how the 350ML policy target has been applied to the reference case. There are generally three ways it could be modeled. The Report seems to suggest that the first option was used.

The three options are:

- The estimated subsidy is applied to investment in biofuels industries. The subsidy simulates investment by essentially lowering the required rate of return needed for new investment in these industries and thereby simulating production of biofuels; or
- The subsidy could be applied to the output of the industry which effectively increases the price that producers of biofuels receive and thereby simulates production and investment in these sectors; or

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7 The reference case simulation is the "business as usual" case against which other simulation results are compared.

- The subsidy is applied to the use or consumption of biofuels which essentially lowers the price paid by consumers and simulates demand. (This third option is unlikely to be the one used by ABARE since its focus is on the use or consumption of biofuels, whereas the intended scheme is more focused on production and output.)

It is also interesting to note that the size of the required subsidy was established before AUSTEM was used. It is common practice in these types of modeling exercises to allow the model to determine the size of the subsidy given a fixed target for some variable, in this case the production and use of biofuels. It could be argued that a general equilibrium model, by its very nature, is a more suitable tool to estimate the size of the subsidy given that it accounts for the interactions of the subsidy with all other sectors of the economy. The current study estimates the subsidy in a 'back of the envelope' partial approach that is then applied in a general equilibrium context. In any case, it would be an interesting exercise to estimate the size of the required subsidy using AUSTEM or some other suitable model.

ACIL Tasman concludes that the modeling is appropriate, however, more explanation of the methodology should be encouraged.

5 Review of revised assumptions and methodology

5.1 ABARE revised assumptions

The revised assumptions suggested by ABARE are set out in Table 1.

We note that, consistent with ACIL Tasman's hypothesis, ABARE has suggested a higher exchange rate for the Australian dollar against the US dollar associated with a higher oil price projection. This is appropriate.

Table 1 **Revised assumptions**

		Medium term assumptions	
		2003 viability study	Current assessment
Ex-refinery price inputs			
Oil	US$/bbl	21	30
Exchange rates	US$/A$	0.60	0.65
Refining costs	US$	3.10	-
Transport cost	USc/l	1	-
Biofuel fixed & operating costs			
Capital costs - ethanol	$m/ML	1	1
Capital costs – biodiesel	$m/ML	0.63	0.63
Return to capital	%	7	7
Operating costs (labor, energy etc)	c/L	5-10[a]	5-10
Ethanol feedstocks			
Sorghum/feed grains	$/t	137	152
C molasses	$/t	50	-
B molasses	$/t	114	-
A molasses	$/t	250	-
Biodiesel feedstocks			
Waste oil	$/t	170	-
Tallow	$/t	450	450
Canola seed	$/t	353	300
Canola oil	$/t	910	-

a . In the study, the average of 7.5c/l was used in assessing viability
Data source: ABARE

ACIL Tasman remains of the view that examination of high and low oil price scenarios would improve the analysis. In this respect, we explore in Section 5.2 below some scenarios we have tested in the Oxford Economic Forecasting's international economic model.

In addition, it is evident from submissions to the Task Force that there may be new information about the cost and operational assumptions that should be investigated by ABARE for its relevance:

- There is some technical evidence that suggest that, although the energy content of ethanol is 68%lower than petrol, the energy losses may be mitigated to some extent by improved fuel economy in vehicles (Sugar Research Institute);
- The capital costs assumed for ethanol plant are significantly higher with an estimate of $75 million for a 75ML plant (CSR), or 10c/L. This is consistent with the Mark Ellis & Associates estimate;
- Distribution and retailing costs for ethanol need to be taken into account (AIP);
- The costs of sorghum and other feedstock for ethanol are underestimated because the ABARE prices do not include the costs of transport, handling and finance of around $20-50/tonne (Stock Feed Manufacturers); and
- The value of by-product feed meal is overstated by at least around $70/tonne (Stock Feed Manufacturers).

In addition, submissions (Stock Feed Manufacturers; Livestock Feedgrain Users Group; Australian Dairy Farmers) have questioned the assumption that the increased demand for ethanol feedstock would not increase the costs for other industries. ACIL Tasman agrees with the methodology adopted by ABARE that the increased domestic demand would likely be met by reduced exports or imports at near those prices. However, in times of drought it has been pointed out that imports of grain have been unnecessarily restricted by Australian quarantine requirements, thereby creating price spikes. ACIL Tasman agrees that, in these circumstances, additional demand for ethanol production would exacerbate the spikes. By the same token, the price than ethanol producers would need to pay would also be very high and not competitive with petrol prices, which are largely unaffected by drought.

Further on methodology, ABARE suggests that a new model, Ausregion, would allow national economic impacts estimated by AUSTEM to be disaggregated across Australian regions. ABARE suggests

> "Ausregion provides a comprehensive depiction of the Australian economy at the level of the eight states and territories and has the capability of incorporating sub-state regions on a flexible basis. Ausregion has 44 sectors in its basic structure but incorporates design flexibility to add additional sectors as required. Ausregion provides comprehensive capability for quantitative assessments at the national, state and regional level across a broad range of issues."

ACIL Tasman assumes that Ausregion is based on input-output tables and is therefore likely to be a better approach to the estimation of regional impacts than was possible in 2003.

5.2 ACIL Tasman's oil price projections

In making projections it is important to have an internally consistent set of measures that allow different configurations of assumptions to be tested. It is also important to examine the relationship between parameter changes of central concern and their effects on other parts of the economy that are of interest in undertaking such studies.

ACIL Tasman is in partnership with the UK consulting firm Oxford Economic Forecasting (OEF). Through this relationship ACIL Tasman has available the highly regarded OEF macroeconomic model of the international economy.

The OEF model is a global macroeconomic model, comprised of the detailed results of 44 individual models of major economies from around the world (including key emerging markets), and headline projections for another 35 smaller countries and 8 regions that are brought together into a single composite.

The individual economy models, including a 175-equation model of the Australian economy, can each be run on their own. However, the results are integrated into a single recursive unit where outcomes in each of the economies can affect outcomes elsewhere.

Real world changes in any of the larger economies will often profoundly affect the outcomes in smaller economies. The model is designed so that these effects can be traced through each economy.

The model provides an ability to test scenarios and to estimate the effects that different initial conditions will have on outcomes in areas that will affect the Australian economy, as well as any of the economies Australia is dependent on for export sales or imports.

It is, moreover, a model which has received a large degree of international recognition. It is the most widely used international macroeconomic model in the world. Clients include the IMF, the World Bank, the Asian Development Bank, as well as governments, central banks, investment banks, fund managers and multi-national companies. It has a rigorous and consistent structure for risk assessment and scenario analysis. For further details on the model go to www.oef.com.

5.2.1 Consensus scenario

Of specific importance to this study is the ability of the model to provide five-year projections for each of the relevant variables as well as being able to examine the effects of alternative scenarios.

Each month, the model is updated and incorporates a consensus or base case scenario using data on current economic conditions. In the context of this review, the projections are made for the real price of crude and for exchange rates. Each of these projections is taken out to 2010, but can be taken to 2015.

It should also be noted that because the OEF model is global, it automatically incorporates various feedback mechanisms from the effects of higher oil prices in economies with which Australia trades. The rest of the world is thus not a single line item but is part of an intricate series of relationships that reflect the actual existing trade patterns that now exist.

There is also a price of oil equation in the Australian model which feeds into other related variables of importance in this study. These are:

- the demand for oil;
- the demand for coal;
- the demand for gas; and
- the Australian domestic price of fuels.

The OEF currently projects the world price of oil (the spot price of Brent crude oil) to fall from US$60/barrel to US$36/barrel in nominal terms by 2010. In real terms, the OEF projections show the price of oil falling to about US$32/barrel. The exchange rate is projected to be A$0.725/US$ in 2010.

The effect of higher oil prices would be experienced in Australia from a number of directions. Most directly, the higher international price would translate into a higher domestic price with consequent effects on the demand for other fuels and on their prices.

More indirectly, large increases in oil prices would affect economic activity in the economies with which Australia trades. The effects on the United States and Japan, as the simulations show, would be very large and highly negative.

5.2.2 High and low scenarios

Two scenarios have been run. The first assumes that the price of crude oil falls to US$45 per barrel in 2005 prices by 2010. The effect on world energy demand is moderate, with increases in prices and a fall in global economic activity.

To some extent the data show that Australia is protected by its domestic supply of energy reserves. Nevertheless, as shown in Table 2, there is a decline in economic activity relative to the base case scenario. Australia's GDP falls by 0.5% while the CPI increases by 0.8% relative to the levels that would otherwise have occurred.

It is noteworthy that the value of the Australian dollar would be expected to rise relative to the US dollar. The scenarios show a much more severe downturn occurring in both the US and Japan.

The data show other significant changes in Australia that may help to explain the difference in domestic outcomes relative to overseas economies. These figures would also have significance for the price of and demand for biofuels in this environment:

- the price level of domestic fuels would be expected to rise by 20.8% relative to 2004;
- the demand for domestic oil would rise only moderately with the level of demand growing by 2.6%;
- on the other hand, the domestic demand for coal is estimated to rise by 13.3%; and
- this would be in spite of the 18.8% rise in the price of domestic coal which would occur with the rise in the price of oil.

The second scenario is based on a fall in the price of crude oil to US$25/barrel in 2005 price terms in 2010. In this low price scenario, as the table shows the level of GDP would rise by 0.4% relative to the base case scenario while the CPI would be 0.9% lower than it would otherwise have been.

Table 2 **Impact of oil price scenarios on the Australian economy**

	GDP	$A Against US$	National Income	Consumer Demand	CPI
High oil price scenario	-0.5%	+1.2%	-1.0%	-0.8%	+0.8%
Low oil price scenario	0.4%	-1.0%	+0.8%	+0.6%	-0.9%

Data source: ACIL Tasman

ACIL Tasman's oil price range is slightly higher than that of the US Department of Energy and straddles the recently reported view of BP that they expect prices to settle back to US$40/barrel in nominal terms (about US$35/barrel in real terms) by 2010[8].

It should be noted that both the high and low scenarios assume that the real price of oil will fall over the next five years relative to the current price of around $60/barrel. The difference in outcomes between the high and low scenarios occurs because the base case in the OEF model projects a real price of oil of around $32/barrel in 2010.

8 The Australian 7 July 2005

Appendix 5 FCAI vehicle list

The contents of this appendix have been copied from http://www.fcai.com.au/ethanol.php.

Capability of vehicles to satisfactorily operate on ethanol blend petrol (10% or E10 maximum)

Most new and many older vehicle models can run on E10 blended petrol. Vehicle manufacturers and importers have provided the following information on the capability of their vehicles to operate on ethanol fuel blends up to a maximum of 10% or E10 subject to the fuel meeting the octane requirements of the vehicle, complying with relevant mandatory Australian fuel quality standards. The Australian Government has limited the level of ethanol in petrol in Australia to a maximum of 10%. The information below provides technical reasons why some models cannot or should not use E10.

For more information about national fuel quality standards or about national labelling requirements for ethanol blends, please visit the Department of the Environment and Heritage (http://www.deh.gov.au/atmosphere/ethanol/) or the Department of Industry, Tourism and Resources (http://www.industry.gov.au/).

Motor vehicles

Before use of E10 in motor vehicles not listed below, you should consult your handbook or manufacturer to check if the fuel is suitable. A list of manufacturer contacts is available at http://www.fcai.com.au/ethanol/2004/03/00000003.html.

Australian automobile manufacturers

Holden	All petrol engine vehicles since 1986 will operate satisfactorily on E10 except as listed below. The following models which do not operate satisfactorily on E10 fuel: Apollo (1/87–7/89), Nova (2/89–7/94), Barina (1985–1994), Drover (1985–1987), Scurry (1985–1986), Astra (1984–1989).
Ford	All petrol engine vehicles since 1986 will operate satisfactorily on E10 except as listed below. The following models may not operate satisfactorily on E10 fuel because of drivability concerns: Focus (All), F-series (1986–1992), Ka (All), Maverick (1988–1993), Mondeo (All), Transit (1996 onwards). The following models do not operate satisfactorily on E10 fuel: Capri (1989–1994), Courier (All), Econovan (pre-2002), Festiva (1991–1999), Laser 1.3L & 1.5L (1980–1989), Laser 1.6L (1989–2002), Raider (All), Telstar (All).
Mitsubishi	All petrol engine vehicles since 1986 will operate satisfactorily on E10. Mitsubishi vehicles with carburettor fuel systems built before 1991 may experience hot fuel handling concerns and may experience a lower level of durability in some fuel system components.

Toyota	All Toyota models manufactured locally or imported by Toyota Australia since 1987 will operate satisfactorily on E10 fuel except as listed below. The following models will not operate satisfactorily on E10 fuel due to material compatibility issues: Camry with carburettor engines pre July 1989 and Corolla pre July 1994. Supra—pre May 1993, Cressida—pre Feb 1993, Paseo—pre Aug 1995, Starlet—pre July 1999. Land Cruiser—pre Aug 1992, Coaster—pre Jan 1993, Dyna—pre May 1995, Tarago—pre Oct 1996, Hilux , Hiace, & 4 Runner—pre Aug 1997, Townace—pre Dec 1998.

Vehicle importers

Alfa Romeo	All Alfa Romeo vehicles imported since 1998 must run on minimum 95 RON fuel (premium unleaded petrol). Post 1998 Alfa Romeo vehicles will operate satisfactorily on E5 ethanol blended petrol (European Standard EN 228). E10Â ethanol blended petrol is not recommended as there are material compatibility and drivability issues. E10 may be used in emergency situations. E10Â ethanol blended petrol is not recommended for earlier model Alfa Romeo vehicles due to material compatibility issues.
Audi	All current Audi vehicles must run on minimum 95 RON fuel (premium unleaded petrol). All Audi vehicle models since 1986 will operate satisfactorily on E10 except as listed below: Audi A3 1.8L (Engine Code 'APG' 2000 onwards) and A4 2.0L (Engine Code 'ALT' 2001 onwards) will operate satisfactorily on E5 ethanol blended petrol (European Standard EN 228). However, E10 ethanol blended petrol is not recommended for these vehicle models as there are material compatibility and drivability issues. E10 may be used in emergency situations.
Bentley	All petrol engine vehicles since 1990 will operate satisfactorily on E10.
BMW	All petrol engine vehicles since 1986 will operate satisfactorily on E10.
Citroen	All Citroen vehicles are required to run on minimum 95 RON fuel (premium unleaded petrol). Citroen vehicles will operate satisfactorily on E5 blended petrol (European Standard EN 228). However, E10 blended petrol is not recommended because of drivability and/or material compatibility issues. E10 may be used in emergency situations.
Chrysler	All petrol engine vehicles since 1986 will operate satisfactorily on E10.
Daewoo	GMDaewoo does not recommend the use of ethanol blended petrol.
Daihatsu	Use of E10 in any Daihatsu model vehicles is not recommended because of material incompatibility.

Honda	All Honda vehicles should use the fuel recommended in the Owner's Manual. The following models will operate satisfactorily on E10: Insight—2004 onwards; Civic range (including Civic Hybrid)—2004 onwards; S2000—2004 onwards; CRV—2003 onwards; MD-X—2003 onwards; Accord & Accord Euro—2003 onwards. Honda does not recommend E10 for other vehicle models because there may be drivability issues.
Hyundai	Hyundai vehicles will operate satisfactorily on E10, but if engine drivability concerns occur revert back to 100% unleaded petrol.
Ferrari	Ferrari does not recommend the use of ethanol blend petrol. E10 may be used in emergency situations.
Jaguar	All petrol engine vehicles since 1986 will operate satisfactorily on E10.
Kia	All petrol engined vehicles since 1996 will operate satisfactorily on E10 but if engine driveability concerns occur revert back to 100% unleaded petrol. Please refer to Owner' s Manual for further details.
Land Rover	All petrol engine vehicles since 1986 will operate satisfactorily on E10.
Lexus	All models will operate satisfactorily on E10 except for the model listed below: The following model will not operate satisfactorily on E10 fuel: IS200—pre May 2002.
Maserati	Maserati does not recommend the use of ethanol blend petrol. E10 may be used in emergency situations.
Mazda	Mazda 323 1.8L (1994 onwards), Mazda 323 2.0L (2001 onwards), Mazda2 (11/02 onwards), Mazda3 (All), Premacy (5/02 onwards), Mazda6 (8/02 onwards), 800m and Millenia (8/98 onwards), RX-8 (7/03 onwards), MPV (8/99 onwards), Tribute (All) and E-series (2002 fuel injected models onwards) vehicles will operate satisfactorily on E10. All other models not listed above do not operate satisfactorily on E10.
Mercedes-Benz	All petrol engine vehicles since 1986 will operate satisfactorily on E10.
MG	MGF (2000 onwards), MG ZT (2002 onwards) and MG TF (2002 onwards) vehicles may operate satisfactorily on E10. However, use of E10 may affect engine calibration and emissions. MGF (pre-2000) does not operate satisfactorily on E10.
Nissan	Nissan vehicles manufactured from 1 January 2004 onwards are capable of operation on ethanol-blended fuels up to E10 (10% ethanol), providing that blending of the ethanol component to the petroleum component of the fuel has been properly made at the fuel refinery (ie there is no ‘splash-blending’ of the fuel). For Nissan vehicles manufactured prior to 1 January 2004, Nissan Australia does not recommend the use of E10 because of drivability concerns and/or material compatibility issues.

Peugeot	All Peugeot vehicles are required to run on minimum 95 RON fuel (premium unleaded petrol). Peugeot vehicles will operate satisfactorily on E5 blended petrol (European Standard EN 228). However, E10 blended petrol is not recommended because of drivability and/or material compatibility issues. E10 may be used in emergency situations.
Proton	All petrol engine vehicles since 1986 will operate satisfactorily on E10.
Rover	Rover 75 (2001 onwards) vehicles may operate satisfactorily on E10. However, use of E10 may affect engine calibration and emissions.
Renault	All petrol engine vehicles since 2001 will operate satisfactorily on E10 but Renault does not recommend its use
Rolls Royce	All petrol engine vehicles since 1990 until 2002 will operate satisfactorily on E10.
Saab	All petrol engine vehicles since 1986 will operate satisfactorily on E10.
Subaru	Subaru Liberty B4 (all year models) and Impreza WRX STI (1999 and 2000) do not operate satisfactorily on E10. All other since MY1990 petrol engine Subaru vehicles will operate satisfactorily on E10.
Suzuki	Suzuki Alto, Mighty Boy, Wagon R+, Swift/Cino, Ignis Sport (1.5 litre requires 98 RON), Sierra, Stockman, Vitara, X-90, Jimny (SOHC) and Super Carry vehicles do not operate satisfactorily on E10. Suzuki Baleno and Baleno GTX will operate satisfactorily on E10 but Suzuki does not recommend its use in these vehicles. Ignis (1.3 litre), Liana, Grand Vitara/XL-7, Jimny (DOHC) and Carry (1.3 litre) vehicles will operate satisfactorily on E10.
Volkswagen	All Volkswagen vehicles will operate satisfactorily on E10, but Volkswagen does not recommend it.
Volvo	All petrol engine vehicles since 1986 will operate satisfactorily on E10.

Motorcycles

Before use of E10 in motorcycles not listed below, you should consult your handbook or manufacturer to check if the fuel is suitable.

BMW	All motorcycles since 1986 will operate satisfactorily on E10.
Harley Davidson	All motorcycles since 1986 will operate satisfactorily on E10.
Honda	All motorcycles and all terrain vehicles may operate satisfactorily on E10 but Honda does not recommend it because there may be drivability issues. Drivability, performance or durability issues resulting from the use of E10 will NOT be covered by warranty.
Suzuki	All motorcycles and all terrain vehicles do not operate satisfactorily on E10 fuel.
Yamaha	All motorcycles and all terrain vehicles do not operate satisfactorily on E10 fuel.

Technical reasons for inability to use E10

The following are reasons why certain vehicle models cannot or should not use E10 because of material incompatibility and driveability issues respectively. There are also comments on possible exhaust and evaporative emissions issues. This list was compiled from information submitted by manufacturers.

Cannot use because of material incompatibility issues

Early deterioration of components in fuel injection system:

- Fuel tanks
- Fuel lines/hoses
- Injector seals
- Delivery pipes
- Fuel pump and regulator

Vehicles with carburettor fuel systems may experience hot fuel handling concerns and may experience a lower level of durability in some fuel system components.

Some manufacturers advise not to use E10 with any model equipped with a carburettor because of material incompatibility.

Should not use because of driveability issues

Vapour pressure of fuel with ethanol will be greater (if not chemically adjusted) and probability of vapour lock or hot restartability problems will be increased.

Oxygen content of ethanol is 34.7%. This can cause the engine to run lean although the Engine Control Unit (ECU) can generally compensate via feedback from the

O_2 sensor under light throttle conditions. However, hesitation or flat-spots during acceleration can occur due to this lean-out effect.

Difficulty in starting and engine hesitation after cold start

Exhaust and evaporative emission levels

Lean-out resulting from the oxygenating effect of ethanol in the fuel may affect exhaust emissions.

Fuel containing ethanol can increase permeation emissions from fuel system components.

Vapour pressure of fuel with ethanol will be greater (if not chemically adjusted at the refining stage) and can lead to increased evaporative emissions.

Appendix 6 Media release

PRIME MINISTER

TASKFORCE ON BIOFUELS

I am pleased to announce today the appointment of a taskforce to examine the latest scientific evidence on the impacts of ethanol and other biofuel use on human health, environmental outcomes and automotive operations.

On this basis, and taking into account the most recent economic analyses of fuel supply in Australia, the Taskforce will assess the costs and benefits of biofuel production.

The Taskforce will examine:

- the findings of the December 2003 CSIRO/ABARE/BTRE desktop study into the appropriateness of a 350 million litre biofuels target;
- the findings of the DEH study into the impacts of E10 and E20 on automotive operation;
- other international and Australian scientific research on the health and environmental impacts of supplementing fossil fuels with oxygenates such as ethanol and other biofuel blends;
- the economic and scientific bases upon which decisions have been made to support ethanol and other biofuel production in North America, Europe and other countries.

The Taskforce will comprise Dr Conall O'Connell, Deputy Secretary, Department of Environment and Heritage; Dr David Brockway, Chief, Division of Energy Technology, CSIRO; Dr John Keniry, Chairman Ridley Corporation Limited; and Mr Max Gillard, Vice President and Chief Operating Officer, Toyota Technical Centre, Asia Pacific Australia.

The Taskforce will report to the government by the end of July 2005.

It will be supported by a small whole-of-government secretariat based in the Department of Prime Minister and Cabinet.

30 May 2005

Glossary and acronyms and abbreviations list

AQIRP	Auto/oil Air Quality Improvement Research Program (United States)
bbl	barrel (oil)
BTEX toxics	benzene, toluene, ethylbenzene and xylene
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
Dairy RAP	Commonwealth Dairy Regional Assistance Programme
diesohol	a 15% emulsion of hydrous ethanol in diesel; also known as ‘e-diesel’
DITR	Department of Industry, Tourism and Resources
EGCS	Energy Grants (Credits) Scheme
EPA	Environment Protection Authority
ETBE	ethyl tertiary butyl ether
EU	European Union
FCAI	Federal Chamber of Automotive Industries
FFV	flexible fuel vehicle
GHG	greenhouse gas
GL	gigalitres (billions of litres)
kPa	kilopascal
LPG	liquefied petroleum gas
LSD	low-sulphur diesel
ML	megalitres (millions of litres)
MON	motor octane number
MTBE	methyl tertiary butyl ether
NEPM	National Environment Protection Measure

NOx	nitrogen oxides
PAH	polycyclic aromatic hydrocarbon
PM10	particulate matter with an aerodynamic diameter of less than 10 μm
ppm	parts per million
pre- and post-1986 vehicles	Pre-1986 vehicles are those vehicles (made mainly before 1986) that have a carburettor or mechanical fuel injection. Most post-1986 vehicles have electronic fuel injection.
RON	research octane number
RVP	Reid vapour pressure
TTW	tank-to-wheel
ULP	unleaded petrol
ULSD	ultra low-sulphur diesel
UNECE	United Nations Economic Commission for Europe
US EPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
VoSL	value of statistical life
WTW	well-to-wheel
XLSD	extra low-sulphur diesel

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