Australian Institute of Petroleum

DISCUSSION PAPER:

Better Fuel for Cleaner Air

Ministerial Forum on Vehicle Emissions

AIP SUBMISSION TO:

Department of Environment and Energy

APRIL 2017

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BACKGROUND

About AIP

The Australian Institute of Petroleum (AIP) was established in 1976 as a non-profit making industry association. AIP's mission is to promote and assist in the development of a sustainable, internationally competitive petroleum products industry, operating efficiently, economically and safely, and in harmony with the environment and community standards. AIP provides a wide range of factual information and industry data to assist policy makers, analysts and the community in understanding the key market and industry factors influencing Australia's downstream petroleum sector. AIP is represented on key advisory bodies including the ATO Petroleum Corporate Consultation Forum (PCCF), the Fuel Standards Consultative Committee (FSCC), the National Oil Supplies Emergency Committee (NOSEC) and National Plan Strategic Industry Advisory Forum (NPSIAF) and AIP sponsors or manages important industry environmental and health programs. The Australian Marine Oil Spill Centre (AMOSC) is a wholly owned AIP subsidiary.

AIP presents this Submission to the Department on behalf of AIP's core member companies:

- BP Australia Pty Ltd
- Caltex Australia Limited
- Mobil Oil Australia Pty Ltd
- Viva Energy Australia Pty Ltd.

Should you require additional information, the relevant contact details are:
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About AIP Member Companies

AIP member companies operate across all or some of the liquid fuels supply chain including crude and petroleum product imports, refinery operations, fuel storage, terminal and distribution networks, marketing and retail. Underpinning this supply chain is considerable industry investment in supply infrastructure, and a requirement for significant ongoing investment in maintaining existing capacity. Over the last decade, AIP member companies have invested over $10 billion to maintain the reliability and efficiency of fuel supply meeting Australian quality standards.

Moreover, AIP member companies deliver the majority of bulk fuel supply to the Australian market.

- In relation to conventional petroleum fuels, AIP member companies operate all major petroleum refineries in Australia and supply around 90 percent of the transport fuel market with bulk petroleum fuels.
- In relation to gaseous fuels, AIP member companies are the major suppliers of bulk LPG to the domestic market, representing around two thirds of the market.
- In relation to biofuels, AIP member companies are the largest suppliers of ethanol and biodiesel blend fuels to the Australian market.

The Australian petroleum industry is also a significant contributor to the domestic economy providing direct and indirect economic benefits from its own activities and underpins the competitiveness of key export industries like mining, agriculture and manufacturing. In addition, as a technologically advanced industry, the refining industry employs and trains many highly skilled technical staff and international expertise flows readily into the Australian workforce.

Given their significant role and investment, AIP member companies have a very strong interest in consultations relating to government policy proposals impacting on the downstream petroleum industry, including the refining industry's ongoing viability and competitiveness, given their significant contribution to local economies and communities. Since the commencement of the *Fuel Quality Standards Act* (FQSA), AIP has strongly supported orderly transitions to cleaner fuel standards where a community benefit has been clearly demonstrated in terms of environmental and health outcomes, and where the cost impacts on refineries and consumers can be managed effectively.

AIP KEY MESSAGES

- AIP supports orderly transitions to cleaner fuel standards where a community benefit has been demonstrated in terms of health and environmental outcomes, and where the cost impacts on refineries and consumers can be managed.

- AIP has been unable to support the introduction of 10ppm sulfur petrol because of the lack of operability benefits for vehicles, limited environmental benefits, and the significant cost impact on consumers, refineries, and on society. The refining industry is concerned that it would have to invest approximately $979 million which may threaten the economic viability of the remaining refineries in Australia.

- In responding to the Government's imperatives, the AIP Board decided it is possible to introduce 10ppm sulfur across all petrol grades by 1 July 2027, to support effective implementation and management of the significant costs which will be imposed on the industry by this change.

- The current petrol average sulfur levels in the Australian market are already well below the regulated maximum limits. AIP suggests the transition to 10 ppm sulfur could be supported by an interim reporting mechanism step to safeguard the current petrol sulfur levels.

- This position does not guarantee that each of Australia's refineries will continue to operate into the future but rather allows the necessary timeframe for each member company to carefully consider the most cost effective solution to meet this new specification.

- AIP reiterates that any harmonisation of fuels quality with European standards should take regard of the FQSA principle that harmonization must be appropriate under Australian conditions. AIP advises there are important differences between European and Australian conditions, such as environmental concern regarding MTBE impact on drinking water resources, and more temperate climate which have important ramifications for key parameters, particularly petrol octane and diesel cetane.

EXECUTIVE SUMMARY

Supporting Cleaner Fuels Standards for Australia

- Since commencement of the *Fuels Quality Standards Act (FQSA)*, AIP has supported orderly transitions to cleaner fuel standards where a community benefit has been demonstrated in terms of health and environmental outcomes, and where the cost impacts on refineries and consumers can be managed.
    - AIP member companies supported and implemented the cleaner fuel standard changes for 50ppm sulfur diesel, 50ppm sulfur premium unleaded petrol (PULP) and 10ppm sulfur diesel.
- Since 2000, AIP has been unable to support the introduction of 10ppm sulfur petrol because of the lack of operability benefits for vehicles and limited environmental benefits based on the available evidence.
- AIP continues to believe that this position is robust and strongly supported by the available evidence.
- However, in responding to the Government's imperatives, the AIP Board decided it is possible to introduce 10ppm sulfur across all petrol grades by 1 July 2027, to support effective implementation and management of the very significant costs which will be imposed on the industry by this change.
- Consequently, AIP and member companies are seeking to work cooperatively with Government to implement 10ppm sulfur petrol by 1 July 2027, in order to provide:
    - refineries with scope for the most cost effective solution and to optimise timing of investment
    - necessary time to minimise market and consumer impacts
    - certainty and a suitable transition for all industry, including vehicle manufacturers
    - a pathway for Government resolution of this issue and for a positive policy outcome.
- While a long implementation period is needed to achieve these goals, the Government could consider:
    - the 'interim step' outlined in this submission to safeguard the higher current quality of petrol in the Australian market compared to the existing petrol quality standard
    - an incentive for introduction of the new specification - similar to the incentives for 50ppm sulfur diesel, 50ppm sulfur premium unleaded petrol and 10ppm sulfur diesel - which previously facilitated a smooth transition for industry and the community.

Changing fuel standards for petrol: environment & health impacts

- There is significant evidence to suggest that the air quality benefits for Australia will be minimal.
- The Regulation Impact Statement in 2010 conducted by the DITRE found only a small net reduction for regulating vehicle emissions and the majority of the benefit was derived from regulating vehicles.
- There is significant evidence that the operability benefits do not exist, however, AIP does concede that there may be future technology facilitation benefits. There are a number of future technologies that are insensitive to sulfur and may require fuels different to petrol and diesel.
- The key guiding principle since the FQSA inception has been harmonisation with European standards <u>to Australian conditions</u>. There are very important differences between European and Australian standards, particularly the effective ban of MTBE in Australia which limits octane options substantially.
- A key reason for AIP's opposition to changing to a 10ppm sulfur petrol fuel standard - from 150ppm sulfur unleaded petrol (ULP) and 50ppm PULP currently - is that market fuel quality is better quality than the prevailing petrol standard. For example:
    - The average sulfur in ULP in Melbourne is 60ppm, and in Sydney is 26ppm.
    - The average sulfur in PULP in Melbourne is 28ppm, and in Sydney is 16ppm.
    - Almost half of the PULP supplied to Sydney is below 10ppm sulfur.
- As more vehicles requiring PULP enter the market there is a reasonable expectation that there will be further falls in sulfur levels across Australia without the need for regulatory intervention.
- About 30 percent of the Australian produced petrol that is above 70ppm sulfur which gives the Australian refineries flexibility and underpins their economic viability.
- Consequently, AIP strongly considers that the health and environmental benefits need to be modelled on market fuel quality otherwise i will be significantly overestimated if modelled on the current fuel standards.
- The introduction of 10ppm sulfur petrol in other jurisdictions has been done for reasons that do not apply to Australia such as addressing acute air quality problems.

Changing fuel standards for petrol: significant cost impacts on refineries

- AIP has assessed the impacts and costs on refineries of implementing 10ppm sulfur petrol, utilising some key simplifying assumptions, in particular, that sulfur is the only parameter considered.
- The costings are based on the AIP proposal to introduce 10ppm sulfur petrol from 1 July 2027, and with an interim step to safeguard the current quality of market fuel over the transition period.
- This position does not guarantee that each of Australia's refineries will continue to operate into the future but rather allows the necessary timeframe for each member company to carefully consider the most cost effective solution to meet this new specification.
- AIP also proposes an interim reporting standard of 80ppm pool average with a 120ppm cap in ULP and 40ppm pool average and 50ppm cap for PULP. It should be strongly recognised that it is not possible to implement a standard under the current structure of the FQSA and maintain compliance.
- Given there are contestable benefits from existing vehicles utilising 10ppm, AIP strongly suggests that further investigation is undertaken to examine 30ppm sulfur in ULP to address pipeline interface issues at distribution terminals.
- Each AIP member undertook significant investigation and modelling of the solution with optimal construction times (i.e. synchronizing with major scheduled maintenance events every 4-6 years).
- It is critical that any changes to fuel standards are coordinated with the scheduled maintenance periods or otherwise substantial costs could be incurred that have not been estimated in this current work.
- The estimates do not include changes to other petrol parameters such as aromatics, Methyl Tertiary Butyl Ether (MTBE) and other oxygenates, octane or olefins but do take account of the changing requirements of the octane pool, i.e. the ongoing switch to Premium Unleaded Petrol (PULP) from Unleaded Petrol (ULP).
- It is critical that all parameters of the standard are defined before a final construction cost estimate is calculated for a Regulation Impact Statement (RIS) assessment.
- The estimates are in 2017 dollars and no provision has been made for pre Front End Engineering and Design (FEED) work that must be completed or loss of business and opportunity costs of resources diverted during the construction period (5 years). The costs have been benchmarked against similar construction projects at other refineries using standard engineering estimation techniques and the cost variances utilised are the standard company practices for each AIP member.
- The resultant costs will be different for each refinery and depend on the strategy employed to meet the standard; however, each refinery will need to construct a de-sulfurisation unit, address octane loss from the desulfurisation process either through construction or blending or both, and augment infrastructure and utility facilities.
- The likely total capital cost is **A$979 million** which is similar to the advice that was provided by AIP in the submission to the Ministerial Forum on 8 April 2016.
- Using standard company construction cost variances, the capital expenditure is likely to range from $703m - $1,408m, but qualitative feedback is that it is unlikely to be at the lower end of the estimates.
- A considerable range of likely construction costs exists between the refineries that reflects different refinery configurations and strategies employed to meet the sulfur reduction (average is $250 million).
- In addition to the capital costs there will be increased operating costs that include direct costs (labour, catalyst, materials, energy intensity) and margin costs due to downgrading (octane destruction) of product streams in the process.
- The expected increase in operating costs is in the range of **$128m - $192m** which equates to an estimated cost of **1.1.-1.7 cents per litre**. This result confirms the previous advice provided by AIP on 8 April 2016 that increased operating costs will likely exceed any price premium for improved quality.
- AIP estimates the increase in refinery emissions will be between **160,000 -320,000 tonnes** per annum to produce lower sulfur petrol. At an assumed $20 per tonne carbon price, this would equate to an additional impost on refineries of between **$3.6m and $7.2m** per annum. Further work will be required to improve the accuracy of this estimate.

Changing Fuel Standards for Petrol: Market & Price Impacts

- The ACCC notes that Australian prices are set by Import Parity Price (IPP) and are therefore a result of the supply and demand in the Asian region.
- Australian specification fuels (known as Oz spec) attract a quality premium for all grades because the Australian regulated specification is different to other regional standards, largely because of the prohibition of MTBE which has implications for octane levels.
- AIP commissioned Facts Global Energy (FGE) to undertake a price premium assessment of Australian specification 10ppm sulfur petrol, in particular to gain insight on the drivers of the supply and demand in the Asian region.
- Currently the 10ppm market is oversupplied which explains why Australian companies are able to source low sulfur material to meet Australian (50ppm sulfur) PULP demand. FGE assesses this situation will continue until 2025 which underpins the continuation of low sulfur imports into Australia.
- At an assumed AUD/USD exchange rate of 75 cents, the estimated price premium is **0.6 cents cpl in 2017 growing to 1.75 cents cpl in 2027.**
- AIP and member companies consider that with a continuing ban on MTBE and other oxygenates, the price premium for Oz spec is likely to be higher than that assessed by FGE. In this sense, these FGE estimates could be considered conservative.

Australian Refineries: Economic and Community Impacts

- Australian refineries have been very long standing participants in the local market as the major transport fuel suppliers, with all current refineries being operational for over 50 years.
- The Australian refineries refine about 27 billion litres of crude oil a year (including 7 billion litres of local crude and condensate) into the high value products needed by industry and consumers.
- In 2016, the refineries produced 26 billion litres of refined products, with petrol and diesel accounting for approximately 80 percent of this production.
- From this refinery production, the four Australian refineries currently supply around 47 percent of Australia's total liquid fuel needs, and around 65 percent of petrol consumed in our market.
- Other Australian industries are positively impacted by refineries which provide key inputs to their own activities. Approximately 65 percent of the total value of Australian liquid fuel consumption is in the transport, mining, construction, agriculture and manufacturing industries.
- Total new capital investment in the refining industry was **$2 billion over the last 5 years.**
- As a high-tech industry, the refining sector has highly skilled workforces with an even mix between direct employees and contractors whose numbers can double during major turnaround work.
- Australian refining companies directly employ 2,000 highly skilled workers (FTEs) at their refineries, and over 10,000 employees nationally. Their workforce is significantly higher when including contractors.
- The Australian refineries also spend hundreds of millions each year purchasing goods and services in their local area and State, contributing to significant jobs and business opportunities.
- The refineries also make a very significant contribution to government revenue, including collecting and paying around $15 billion in fuel excise to the Federal Government from fuel sales in our market.
- As a result of these direct economic benefits, the refining industry's contribution to GDP/GSP is significant and comparable to other important Australian industries, and the presence of a refinery leads to higher private consumption (economic welfare) and business investment.
- Independent economic modelling has found that a refinery contributes around **$1 billion in economic pa activity on average to the local economy** (inc. direct impacts and flow-on impacts to other sectors).
- This economic modelling does not capture the key positive externalities and indirect benefits generated by the refining industry which are also economically important, including reliability and security of fuel supply, sharing inputs with other industries, and innovation, technology and knowledge spillovers.
- Australian refineries are also active investors and participants in numerous community development activities to enhance the education, environment and health outcomes of the local area. These are expected to have wider economic benefits like higher GDP and consumer living standards.

Changing fuel quality standards: AIP's Assessment of Options

- The Department's Discussion Paper discusses five policy options for changing Australian fuel standards, and invites other options or *"possibilities for the Government to consider"* which AIP has responded to.
- Considering the industry, consumer and economic impacts above, AIP's position on these proposed options is:
  - *Option A* (no change) is the most desirable as it will maximize community benefits
  - *Option B* is not supported because it may result in the closure of one or more Australian refineries resulting in net community costs and removes ULP from the market with negative consumer impacts
  - *Option C* is not supported because it may result in refinery/refineries closure and net community costs
  - *Option D* is not supported because it will close the Australian refining industry resulting in net community costs and will be very difficult and expensive to source in the Asian region
  - *Option E* is not supported as it does not ameliorate the costs to the Australian refiners.
- The only apparent barrier to retaining current fuel standards (Option A) appears to be the introduction of Euro 6C and the impacts on triggering of On Board Diagnostics (OBD). It is claimed by the vehicle industry that this requires the whole of the gasoline pool to be converted to 10ppm sulfur petrol. These claims need to be fully tested because it will only apply to new vehicles when Euro 6C is introduced and there may be ways of capturing most of the benefits of Euro6 without introducing the OBD requirements.
- The 2015 FQSA review found there were $100m in health benefits from moving the current standard to 10ppm sulfur petrol. However, this does not take into account the market quality of fuel currently supplied in Australia and if you assume the sulfur response curve for pollutants is linear, then the lower sulfur levels in market fuel would imply avoided health costs below $30 million. AIP will work closely with the RIS consultant to ensure that accurate data is supplied and health costs are accurately modelled.
- Instead of the Department's identified options, AIP supports **Option F** (an alternative option developed by AIP) because it minimises impacts on all stakeholders and thereby maximises the community benefit and involves:
  - Introduction of 10ppm sulfur petrol in all grades on 1 July 2027
  - No changes to any other fuel parameter (e.g. MTBE or other oxygenates, aromatics)
  - Continuation of the ULP grade.
- Option F also proposes an **interim step** that could be of interest to Government to safeguard current market fuel quality and capture some minor environmental benefits before 2027 and involves:
  - 80ppm pool average and 120ppm maximum in ULP from 2021(reported not regulated)
  - 40ppm pool average and a 50ppm maximum in PULP from 2021 (reported not regulated)
  - No changes to any other parameter.
- Even under Option F there will be considerable (adverse) consequences:
  - Motorists will face a price premium of up to 2 cpl.
  - There are large capital costs ($979m) and increases in operating costs (1.1-1.7cpl) for refineries
  - Increases in greenhouse gas emissions at the refinery of 5-10 percent.
  - Threats to refinery viability, risking $1 billion on average in economic contribution per refinery per year
  - In the event of refinery closures there will be knock on impacts that will affect specific local communities such as Geelong and to other industries with key links to the refining industry.
  - A reduction in Australia's liquid fuel supply diversity and security.
- Also under Option F:
  - There are limited health benefits
  - Mandatory vehicle standards can be introduced without changes to fuel standards (as has been demonstrated with Euro 5)
  - The environmental benefits of 10ppm sulfur in ULP are yet to be tested and therefore AIP advocates for further investigation of 30ppm sulfur in ULP to manage pipeline interface issues at distribution terminals.

Changing fuel quality standards: changes to other fuel parameters and new standards

- The Department's Discussion Paper also proposes changes to other parameters in petrol and diesel, and also new standards proposals. AIP position on these proposals include the following:
- *Aromatics and Methyl Tertiary Butyl Ether (MTBE) in petrol:*
  - AIP does not support a change to the aromatics standard in petrol because a central and critical guiding principle for fuel quality standards in Australia has been the harmonisation with European standards <u>subject to Australian conditions</u>.
  - A key difference between Australian standards is that MTBE is limited to 1 percent (effectively a ban) under the FQSA whereas in Europe total ethers are allowed up to 22 percent. Western Australia considers the risk of MTBE to groundwater so serious it has limited MTBE in fuels to 0.1 percent.
  - The change in the aromatics standards will be costly and difficult to implement and there have been no identified operability or environmental benefits.
- *Proposed PULP 98 standard:*
  - AIP and member companies do not consider that a PULP 98 standard is necessary.
  - However, if Government considers that such a standard should be made then the MON level should be retained at 85 as per the current FQSA for PULP.
- *Cetane in diesel:*
  - AIP strongly supports setting both Cetane Index (CI) and Derived Cetane Number (DCN) for the diesel standard (both mineral diesel and biodiesel blends) at the current 46 minimum.
  - Adoption of a 46 minimum cetane will not impose any additional costs upon the petroleum refiners, importers or fuel blenders and we are not aware of any adverse operability issues associated with a DCN of 46 in diesel (whether or not it contains biodiesel), nor have we seen any compelling evidence of environmental benefit. There are, however, significant costs associated with implementing a 51 cetane.
- *PAH in diesel:*
  - AIP member companies believe there would be negligible environmental and operability benefits of reducing the PAH limit based on available evidence.
  - Tightening PAH spec to 8 percent max would substantially constrain refinery flexibility and threaten refinery viability. Most domestic refineries would likely need investment in expensive high pressure diesel hydrotreater reactors to achieve any substantial reduction in PAH.
- *Proposed B20 standard:*
  - AIP supports the development of a B20 fuel quality standard, but AIP's Submission (2012) to the Department of Sustainability, Environment, Water, Population and Communities outlines in detail the proposed B20 test properties and test methods which are appropriate in AIP's view.
- *Fuel additives for inclusion on the Register of Prohibited Additives*
  - AIP member companies support, for inclusion on the Register of Prohibited Fuel Additives N-methylaniline (NMA), and tetraethyl lead, but has no opinion at this stage on polychlorinated n-alkanes. The Department should consult with OEMs and additive suppliers on the treatment of methylcyclopentadienyl manganese tricarbonyl (MMT).

COMPETITION LAW CONSIDERATIONS

- *To protect commercial confidence and to manage competition law sensitivities, AIP requested each individual member company to provide data directly to the AIP in strict confidence. AIP aggregated all data and will not share the individual company data with the member companies.*
- *The assumptions made regarding oil price, product produce, and key differentials (such as the sweet/sour crude differential) for use by the member companies were set by AIP based on its own industry and market knowledge.*
- *The long time-horizon for some of the analysis presented in this AIP Submission creates natural uncertainties, so the estimates presented should be treated as a reasonable estimation by AIP and independent third parties for the purposes of this consultation process.*
- *For avoidance of doubt, each member company will individually develop and implement its own plans and manage its own budget program independently of AIP and the other members.*
- *References to "Industry" in this document should be construed as being AIP's assessment, rather than individual company views.*

(1)THE AUSTRALIAN REFINING INDUSTRY

KEY MESSAGES

- The Australian refining industry is part of highly competitive global oil and petroleum product markets.
- Over the past decade, the Australian industry has been through a period of significant restructure.
- The Australian refining industry is a price taker in the Asian region, and there is a direct relationship between Australian and Asian fuel prices.
- Australian refineries are smaller than regional competitors, but do have their own competitive advantages including market access and integration, efficiencies and reliability.
- There has been significant investment in Australian refineries in recent years to maintain competitive and reliable refinery operations.
- Australian refineries continue to be challenged by:
  - excess refinery capacity in Asia
  - increased competition from mega-refineries in Asia
  - commercial pressures for increased business efficiencies and avoidance of new costs
  - general tightening of regulatory requirements
  - implementation of climate change policies
  - competing demand and high cost for maintenance and construction services, and skilled labour.
- Profitability and ongoing viability will be determined largely by supply and demand factors in the Asian refining industry.
- With the significant surplus of supply of petroleum products in the Asian region, demand for petroleum products has not been strong enough to absorb the output from new refinery capacity installed in Asia each year for the last decade.
- Asian excess supply capacity has provided a ready source for fuel imports to Australia.
- The growth in imports reflects the gap between fuel demand and production from Australia's four oil refineries which must compete with imports from Asian refineries.
- Australian refineries meet just below half of all petroleum product demand in Australia, but approximately two-thirds of total petrol demand.
  - Since 2000, demand for both diesel and jet fuel has increased significantly and has largely been met through imports of those products.
  - While representing the largest portion of fuel product market share, petrol demand has remained flat over that time. However, petrol's substantial portion of market share highlights the importance of that fuel type to the continued viability of Australian refineries.
  - There are marked variations in petroleum product use across Australian States and Territories.
- Australian refineries see a long term viable future through ongoing cost containment programs and in an environment where new costs are not imposed by unnecessary Government regulation.
- The experience with changes to the diesel fuel standard presented significant challenges to the domestic refining industry and directly led to a refinery closure.
- Continued viability of Australian refineries will require a stable policy and investment environment, and energy policy based on open, efficient and competitive market principles.
- As major energy users, the growing cost of energy in Australia is eroding one of the few competitive advantages traditionally enjoyed by Australian refineries, posing further challenges for them.

(1.2) INTRODUCTION

The global petroleum refining industry is highly competitive. Both international oil companies (IOCs) and national oil companies (NOCs) continually assess the supply and demand parameters in regional markets with a view to capturing greater market share through investment in new capacity or through introducing efficiencies into their own operations. The investment decisions made in other countries can have significant impacts on the relative competitiveness of the Australian industry. Government policy also impacts on investment decisions and operational viability.

Australia's direct competitors are Asian refineries. In recent years, the bulk of the growth in refining capacity has occurred in Asia which now represents almost 35 percent of global capacity. This market share is expected to continue to grow.

The refining industry has been successfully operating in Australia since the 1920s. While the operations have continuously changed and evolved over the years, including the number of operating refineries, AIP members have confidence in the future in meeting global market challenges and consumer fuel needs.

This section discusses:
- Australian liquid fuels supply and demand;
- Australian refineries and competitiveness, and
- Australia's links to global and regional fuels markets.

(1.3) AUSTRALIAN LIQUID FUELS SUPPLY AND DEMAND

In 2015–16, Australia's domestic refineries supplied around 45 percent of total petroleum products required by Australia's major industries and the fuel distribution network of around 6 400 service stations. The reliability of the fuel supply chain is robust given the unique logistic and geographic challenges in Australia.

Australian petroleum refineries are highly capital intensive, technically sophisticated facilities that employ a wide range of highly skilled personnel and provide significant economic and other benefits to key Australian industries.

The Australian oil refining industry produces a range of petroleum products comprising:

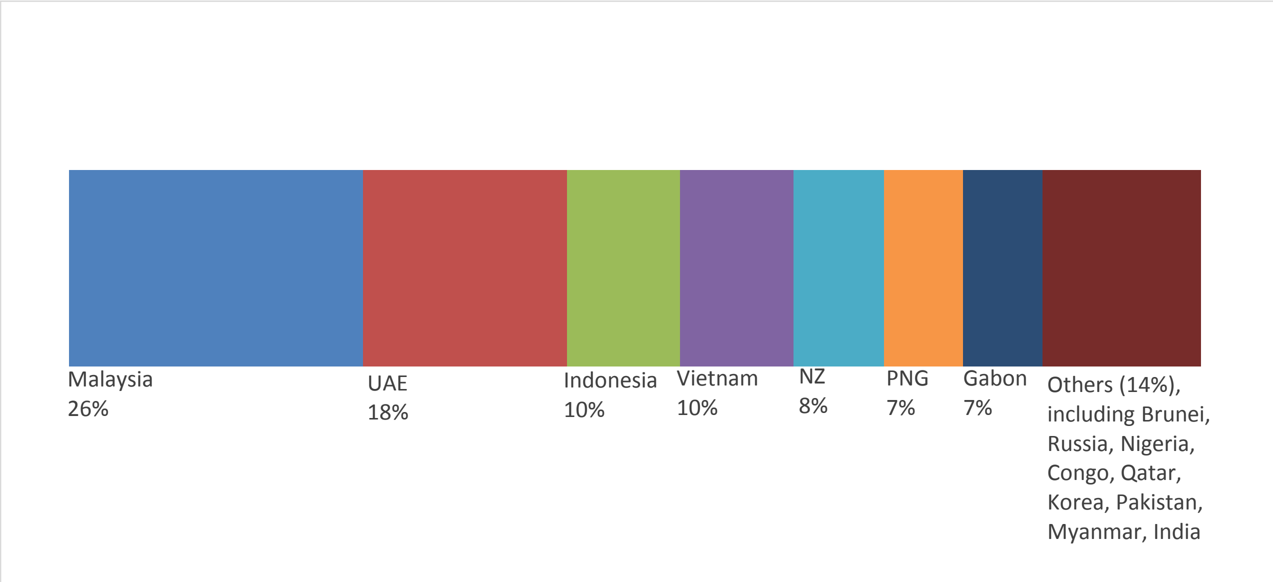
- petrol (45%)
- diesel (35%)
- jet fuel (13%)
- fuel oil (2%)
- LPG (3%)
- other products (2%).

It also produces a substantial volume of chemical feedstock.

In 2015–16, Australia consumed 55 400 ML (mega litres) of petroleum products - or around 150 ML per day- a 5.8 percent increase since 2010-11. Australian refineries produced 25 800 ML of petroleum products, of which around 2 percent was exported (excluding LPG). Net imports from over 20 countries accounted for 53 percent (or 31 000 ML) of total consumption, as highlighted in the following chart. A proportion of this imported volume was supplied to northern and north western areas of Australia where it is more economic to supply directly from Asia due to domestic refinery locations and local terminal configuration. Numerous import terminals are located around Australia providing ready access to the Australian market. The bulk of imported fuel came from refiners and regional suppliers in Japan and South Korea and imports from India are increasing.

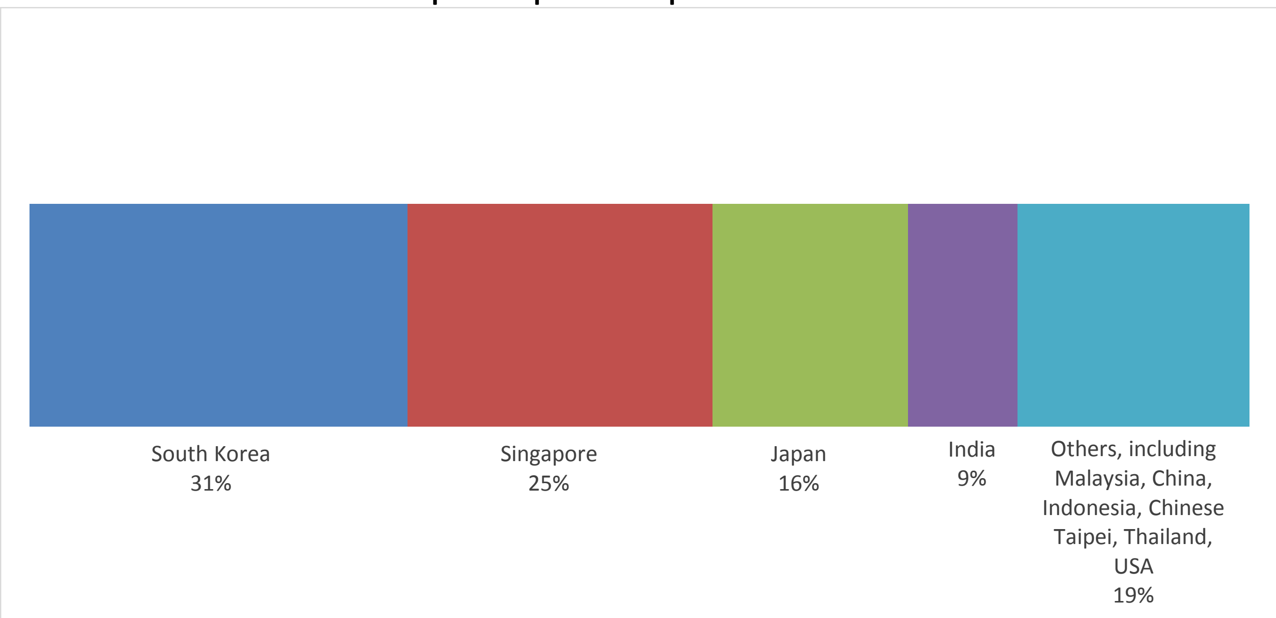
While Australia has its own indigenous crude oil production, this has been declining and around 76 percent was exported in 2015–16. These crudes are largely unsuitable for Australian refineries to manage their product slate, while the locations of Australian refineries also contribute to the quantity of exports. Crude oils required to meet the product demand mix in Australian refineries were imported from over 25 countries, but mainly from the Asia-Pacific region (71 percent) including New Zealand and PNG. The remaining third of crude oil imports was sourced from the Middle East (17 percent), Africa (10 percent) and others (2 percent).

Imports of crude oil 2015–16



Source: Australian Petroleum Statistics (various publications)

Imports of petroleum products 2015–16



Source: Australian Petroleum Statistics (various publications)

Changing Australian demand for petroleum products

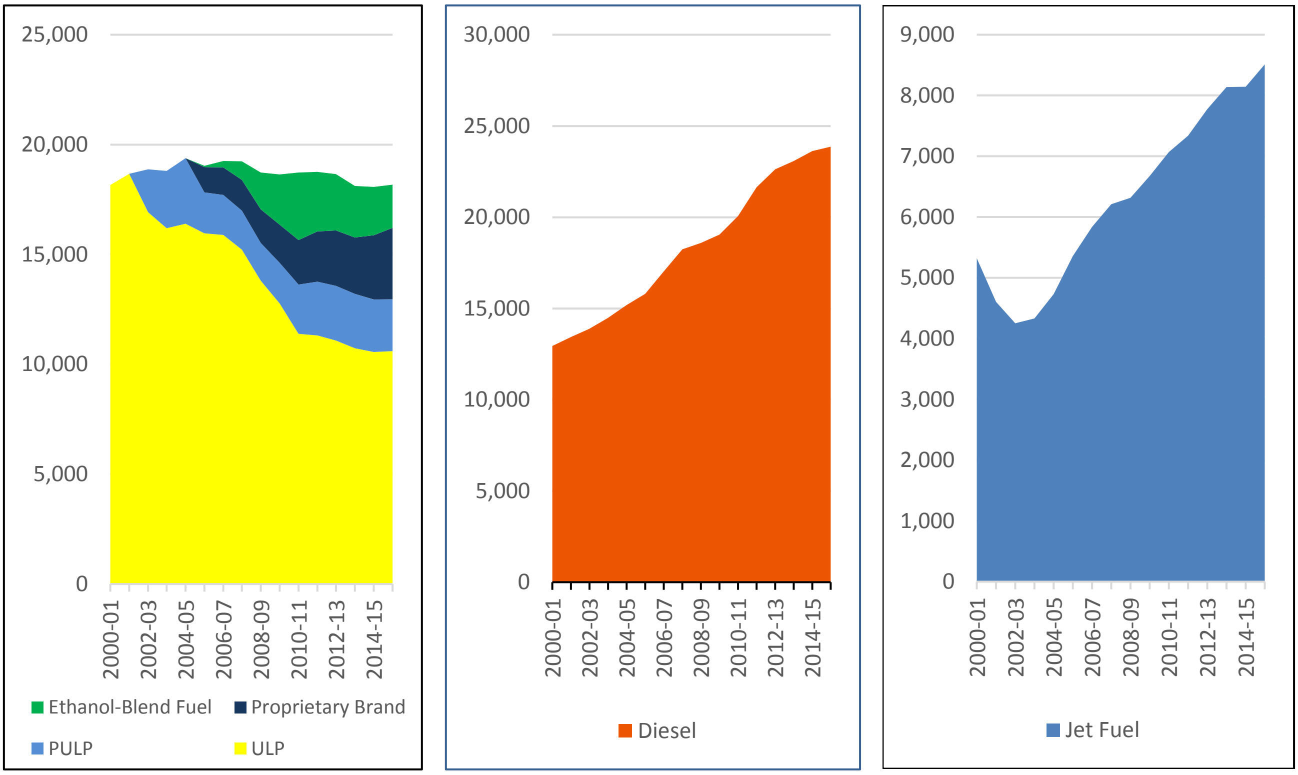
Over the past decade, Australian use of petroleum products has increased by around 2 percent per year.

Petrol, diesel and jet fuel use now comprise 89 percent of the total petroleum product demand.

Since 2003–04:

- Diesel use has increased by around 85 percent due largely to growth in mining industry activities in Australia and growth in sales of vehicles with new generation diesel technology engines
- Jet fuel use has increased by around 60 percent due to growth in air travel for business and leisure
- Petrol use has remained constant as vehicle fuel efficiency has continued to improve. Use of regular unleaded petrol (ULP) has declined by more than 40 percent as consumers chose new vehicles that recommend the use of higher octane fuels or have moved to ethanol blend petrol. The demand for ethanol blend petrol increased to a peak of 16 percent of petrol use in 2010–11, largely as a consumer preference response to the ethanol fuel mandate in NSW, but has subsequently declined to less than 11 percent of total petrol use.

Australian use of main petroleum products: 2001–02 to 2015–16, ML



Source: Australian Petroleum Statistics (various publications)

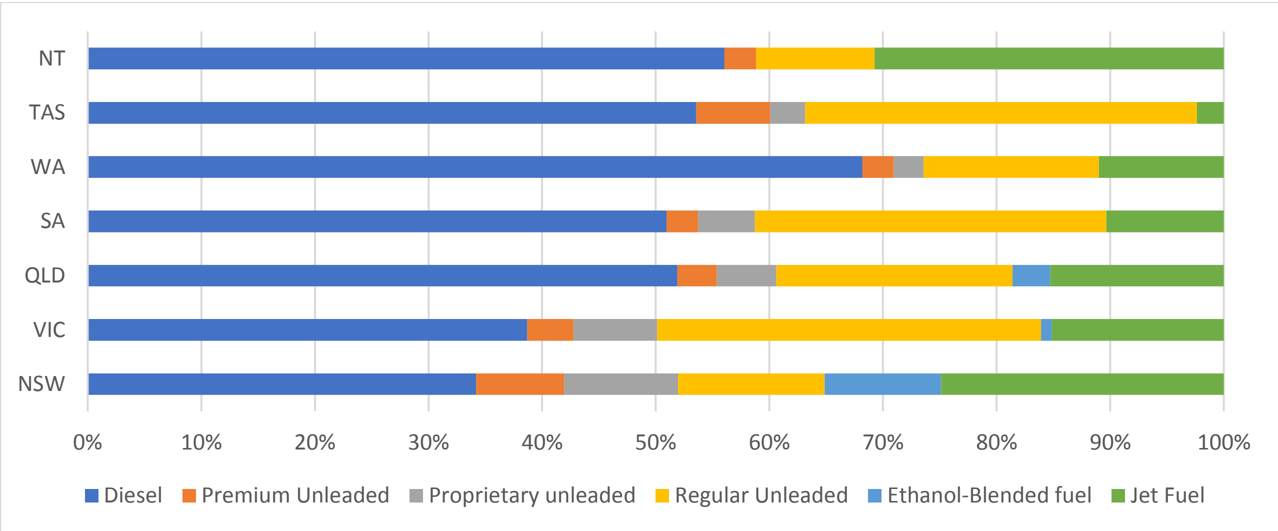
There are some important observations about fuel quality and urban air quality as a result of these changes in fuel demand patterns.

- Total petrol demand in Australia has been static over the last 15 years.
- While the number of vehicles has increased, average vehicle kilometres travelled (vkt) has decreased and vehicle fuel economy has improved.
  - These trends for these parameters are expected to continue with the Australian petroleum industry consequently expecting total petrol demand to decline over the medium-term outlook.
  - Therefore, total emissions from petrol driven vehicles could be expected to decline further just on the basis of the observed total fuel demand trends.

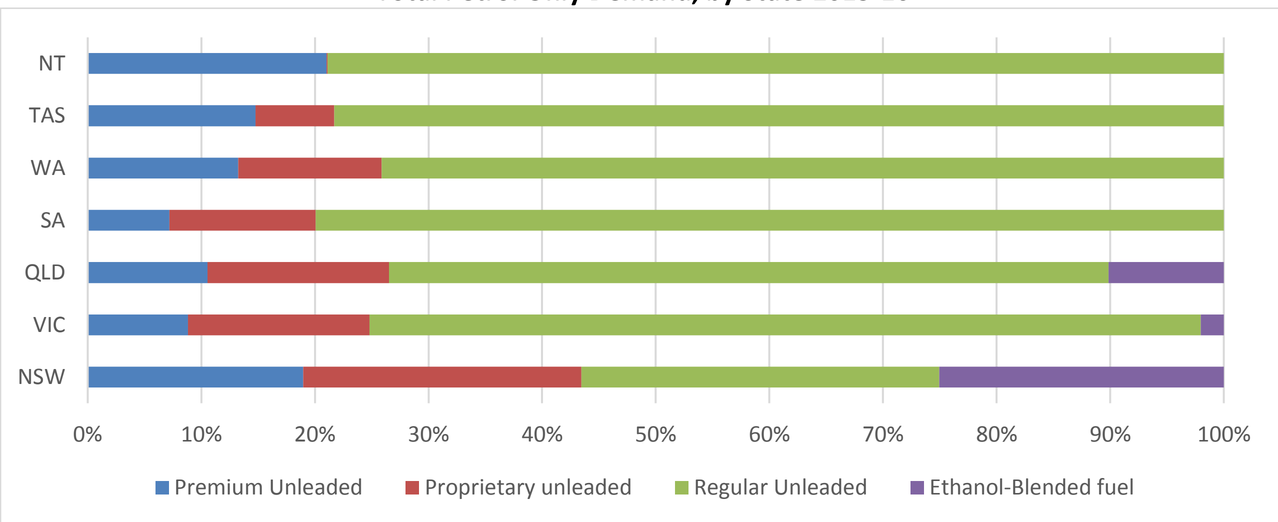
- The migration from ULP to PULP and ethanol blends (E10) will lower the sulfur levels utilised in the Australian gasoline fleet by the fuel grade switching with PULP and E10 having lower sulfur levels than ULP.
    - Therefore, total emissions could be expected to decline on the basis of grade switching and the fleet utilising lower average sulfur fuels.
    - The PULP proportion of the petrol market is 30 percent with an average of 1 percent of the petrol market converting to PULP per year.

As shown in the following two charts, there are also significant variations in petroleum product use across the Australian states and territories, which reflect a range of differing factors. These include the main economic activities and resources in jurisdictions, their population base and dispersion, the age and structure of vehicle fleets, and their infrastructure capacity and performance (e.g. airports). For example, there is higher diesel use in the mining States of WA, NT and QLD, higher jet fuel use in major airport centres, and higher use of premium gasoline in NSW as a consumer preference response to the government's ethanol mandate policy.

Total Petroleum Products Demand, by State 2015-16



Total Petrol Only Demand, by State 2015-16

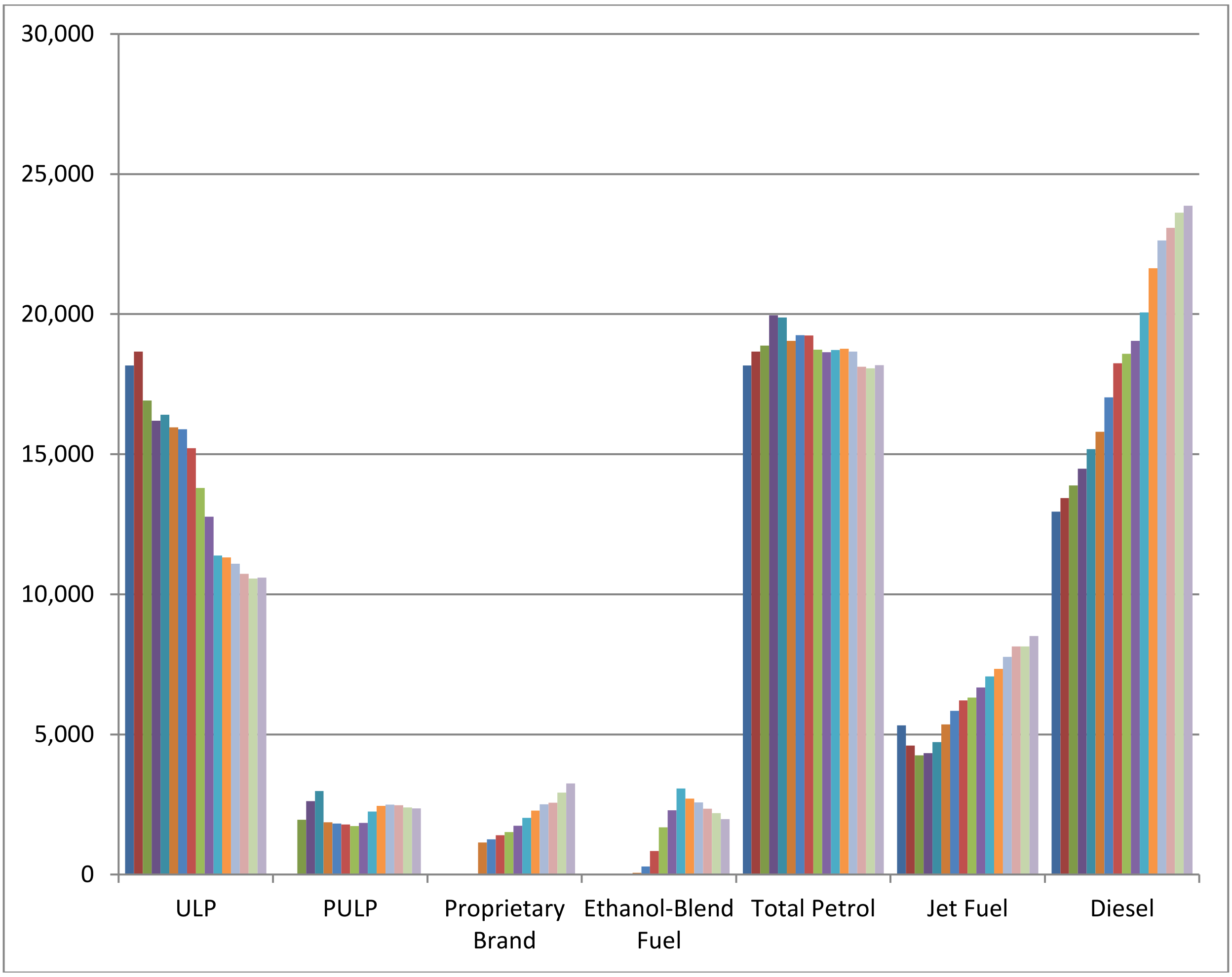


Source: Australian Petroleum Statistics (various publications)

These changes in production and demand patterns mean that there is a substantially different supply profile for each type of fuel. Overall, the following chart on petroleum demand shows that imports of diesel and jet fuel have increased substantially over the last decade and imports now constitute the majority of supply. However, petrol is still largely supplied from Australian oil refineries with the import proportion at around 35 percent of the total.

The decision by ExxonMobil to increase production at the Altona refinery and other planned de-bottlenecking initiatives by ExxonMobil and other Australian refiners suggest that the import proportion for petrol is likely to decline further.

Australian petroleum products demand: 2000-01 to 2015-16



Source: Australian Petroleum Statistics (various publications)

The substantial (and increasing) portion of Australian refining supply of petrol to the Australian market underlines the importance of the Australian petrol market to the continued viability of the Australian refining sector. It also emphasises the importance of Australian refineries to the ongoing Australian liquid fuel supply reliability, especially for petrol.

The changing patterns of demand mean that the average pool levels of sulfur will continue to reduce and more so in some States, particularly NSW. These observations have implications for the abatement of motor vehicle emissions that could be achieved from any change to fuel standards. That is, the lower the current average sulfur in the petrol pool, the less the potential abatement opportunities from motor vehicle emissions by lowering sulfur levels in the fuel quality regulations.

(1.4) AUSTRALIAN REFINERIES AND COMPETITIVENESS

Over the past decade, Australia's refining industry has been through a period of substantial restructure. As a result, Australia now has four refineries, each with its own discrete competitive advantages that has ensured its current viability.

Although the refineries were generally constructed in the 1950s and 1960s, they have been extensively upgraded since then, notably during 2005 and 2006 in order to meet tighter fuel standards.

These refineries are relatively small by world standards, with the largest having a capacity of 8 650 ml pa (megalitres per year), compared with the four largest Asian refineries which produce between 30 000 ml pa and 70 000 ml pa. Australian refineries offer none of the economies of scale benefits that are available from these larger refineries.

Australian refineries 2017

Refinery	Capacity (ml pa)
Lytton (Caltex—Brisbane)	6500
Altona (Mobil—Melbourne)	5222
Geelong (Viva Energy—Geelong)	7470
Kwinana (BP—Kwinana)	8650
Total	**27842**

Refinery competitiveness

Economies of scale provide a key competitive advantage in refining, with larger refineries having lower unit costs of production and the ability to purchase inputs (e.g. crude oil) in larger parcels hence at lower unit costs.

Economies of scale arise from larger production runs, lower capital and labour costs per unit of production, and lower purchasing costs for larger volumes of inputs, such as crude oil and energy. Newer refineries also benefit from the latest technology with efficiencies realised from greater flexibility in the crude oil inputs and product slates produced.

Refiners seek to run the optimal mix of crude oils through their refineries, depending on the relative price of available crudes, the specific equipment and storage at the refinery, and the desired output mix to meet the demand and quality standards of their target markets.

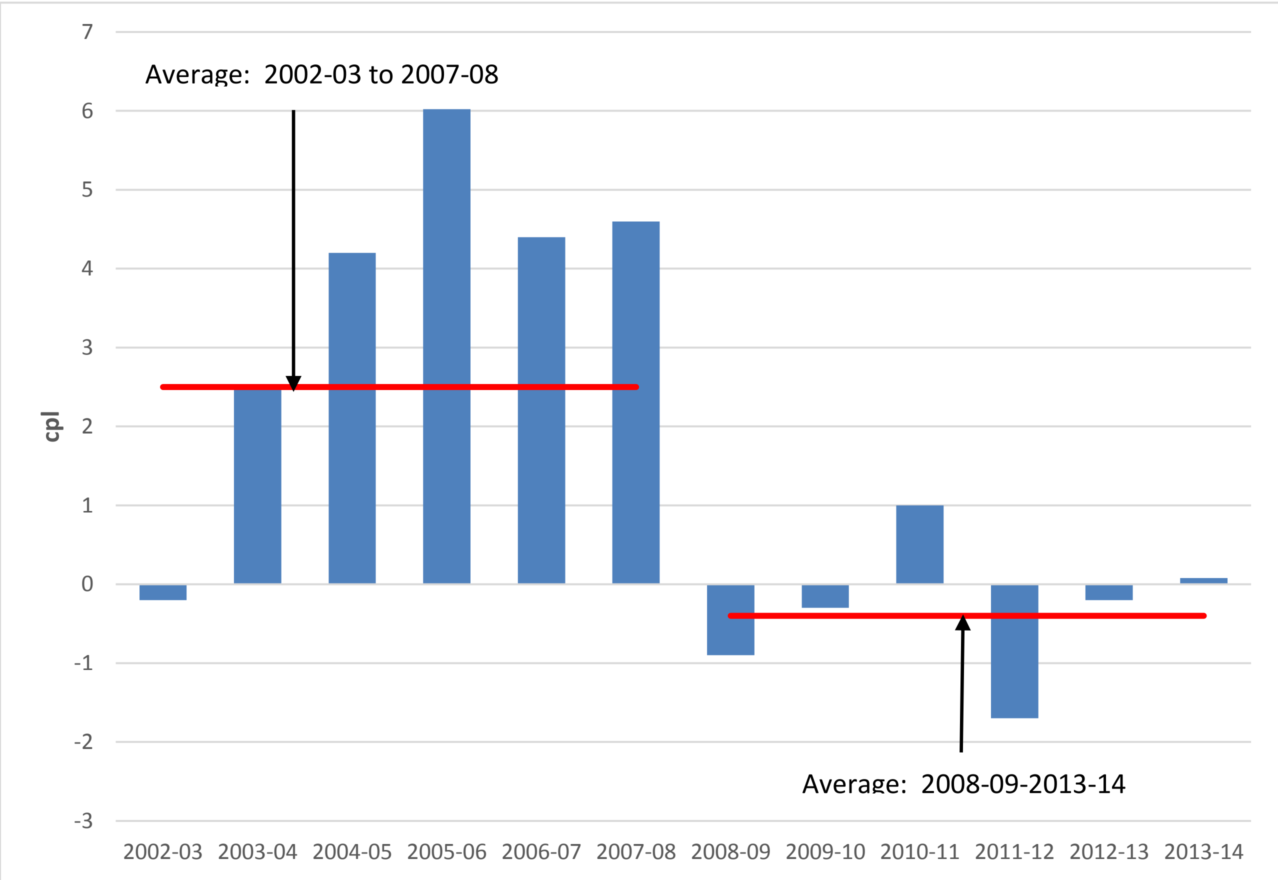
Each Australian refinery will seek to maintain an individual competitive advantage through concentrating on areas where a significant cost or efficiency advantage is evident. For example, the use of competitively priced domestic feedstock, high utilisation rates, establishing niche markets and access to key markets all underpin competitive advantage.

While the cost of crude oil is the major input cost for refineries (around 90 percent according to the ACCC), other key expenses for refineries include:

- crude oil shipment and storage
- additives, catalysts and chemicals
- capital costs, financing and depreciation
- wages and salaries
- plant maintenance
- site security and systems
- regulatory measures
- product shipment and storage
- utilities and energy charges
- government taxes and charges.

Refining is a highly cyclical business, as the following chart shows. This latest data from the ACCC highlights the different net profitability performance of the domestic refining sector over a decade where the average ranged from around 2.5 cents per litre (cpl) in the early part of the last decade, with average losses through to 2014 of around 0.5 cpl. The ACCC is yet to update this data. While it is expected to show an improved performance due to an upturn in the cycle, excess supply in the Asian region – discussed later in this chapter – will continue to present a challenging environment for the Australian refining industry.

Refinery sector real unit net profit, all products: 2002-03 to 2013-14



Source: ACCC Annual Price Monitoring Report, Dec 2014

Refineries seek to manage the challenges they face by improving the efficiency of their operations through enhanced refinery yields, reliability and cost containment. Continued availability of highly trained technical staff and contractors will contribute to high levels of refinery efficiency.

Compared to refineries across Asia, Australian refineries suffer from substantial disadvantages in operating and capital costs that virtually preclude Australia from consideration for major new refinery projects. The relatively small Australian refineries offer no economies of scale benefits. Australian labour and construction costs for new and expanded refinery investments remain high compared to costs in most countries in Asia.

As an industrialised nation, Australia offers none of the capital or operating cost benefits available in many developing countries. The taxation and investment regimes applying in Asia are highly attractive for new facility construction and for substantial refinery upgrades, through the provision of taxation holidays, substantial investment allowances and investment facilitation.

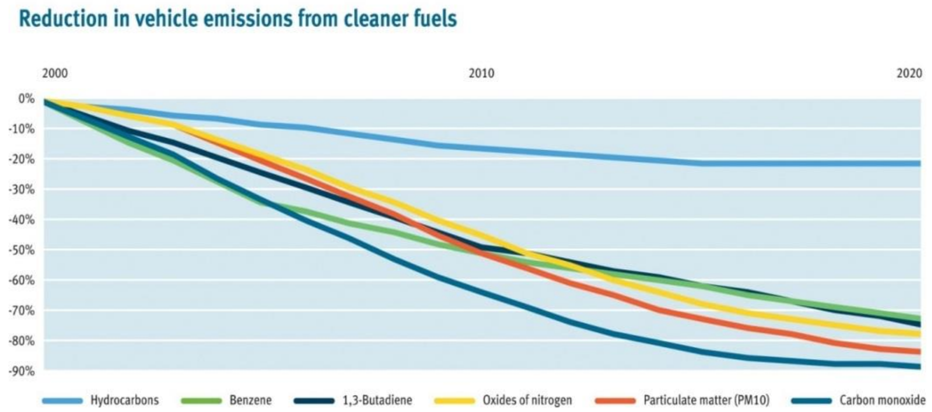
These competitive disadvantages for Australian refineries compared to Asia can impact adversely on the decisions that must be taken locally on investments in major refinery upgrades and overhauls. The closure of the Clyde refinery in 2009 was a direct result of these disadvantages that included:

- not regionally competitive because of the small scale
- did not generate sufficient cash to justify further investments
- alternative supplies could be sourced from the Asian region

More complex and costly environmental and other regulatory measures also pose significant constraints on new investment in Australia and provide ongoing challenges for existing Australian refineries. Overlapping federal, state and local government regulations also increase the complexity of operations and raise the costs of doing business in Australia.

The impact of fuel standard regulations on refinery competitiveness

In 2003, Australia had eight operating refineries with the capacity to supply over 95 percent of Australia's liquid fuels demand. The Australian Government's Cleaner Fuels Program that commenced in 2001 required a progressive tightening of fuel standards to deliver urban air quality benefits and facilitation of more advanced motor vehicle technologies. The major parameters that were altered in petrol were sulfur, aromatics, olefins and benzene to facilitate lowering of tailpipe emissions and facilitate gasoline direct injection technologies. Lowering sulfur in diesel directly reduced emissions (NOx and PM) and facilitated common rail direct injection diesel engines. The combination of improved fuel quality and engine technologies was expected to deliver ongoing reductions as detailed in the following chart as the motor vehicle fleet progressively turned over.



Source: Fuel Standard (Petrol) Determination Regulation Impact Statement 2001

As a direct result of the capital investment needed to meet these fuel specifications, Mobil announced the mothballing of the Port Stanvac refinery in Adelaide in 2003 and it was announced in 2009 that the facility would be permanently closed and decommissioned. Port Stanvac has since been demolished. The Cleaner Fuels program also caused the de-rating of the Mobil Altona refinery in Melbourne reducing from 7,800 ML pa to 4,750 ML pa. These Mobil decisions reduced the capacity of the Australian refining sector by 15 percent. However, the Altona refinery is now expanding its capacity.

Australian fuel prices

Although there are global markets for petroleum products, crude oil, petrol and diesel are different products and are bought and sold in their own specific markets. Australian refineries must price their petroleum products to be competitive with imports (i.e. import parity pricing) from the Asian region. The Singapore price of unleaded petrol (MOPS95) is the key petrol benchmark for Australia. If Australia's prices were below Singapore, Australian fuel suppliers would have no commercial incentive to import to Australia (because sales of that fuel would be at a loss here). In addition, Australian refiners would have an incentive to export production rather than sell into the local market.

Refiner margins are the differences between product prices and crude oil prices, both of which are set by the market, not by oil companies.

There is no tariff protection and all seaboard capitals have import facilities which handle some 40 percent of domestic fuel demand. The price at these terminals is the wholesale fuel price (or Terminal Gate Price or TGP) and is closely linked to the Singapore price. The Singapore Price plus shipping costs and Australian taxes consists of around 95 percent of the entire wholesale price. The remaining 5 percent of the TGP is accounted for by insurance, local wharfage and terminal costs, and a wholesale marketing margin where competitively possible. Australian fuel also attracts a quality price premium above the benchmark Singapore fuel price, given the combination of unique fuel quality standards specific to Australia. Australian specification fuel (known as Oz spec) is different to other regional standards largely because the Australian prohibition of MTBE, as well as differences in allowable limits for aromatics and olefins, and attracts a premium because of these differences.

Once fuel leaves the terminal gate, retail prices vary across metropolitan and regional markets. The TGP is typically 95 percent of retail prices. It also includes transport costs, administration and marketing costs, and service station running costs such as wages, rent and utilities. A small proportion of the pump price is received by fuel retailers to cover these costs and leave a small margin. ACCC analysis shows retail sector net profit on petrol over the last 12 years averaged 1.35 cpl.

Overall, the historical industry profitability on all fuels sold has averaged 2cpl.

Ultimately, profitability of the Australian refining industry is therefore largely determined by product prices in Asia, and its viability depends on our competitiveness against imports from refiners in Asia. Australian refineries continue to pursue increased refinery capacity through a range of selective debottlenecking opportunities that are aimed at reducing average production costs. However, future growth in Asian imports is still expected to meet demand growth, providing additional supply diversity.

(1.5) AUSTRALIA'S LINKS TO GLOBAL AND REGIONAL FUELS MARKETS

The global refining industry is fundamentally changing as emerging and maturing trends re-shape the global supply and demand patterns for crude oil and petroleum products.

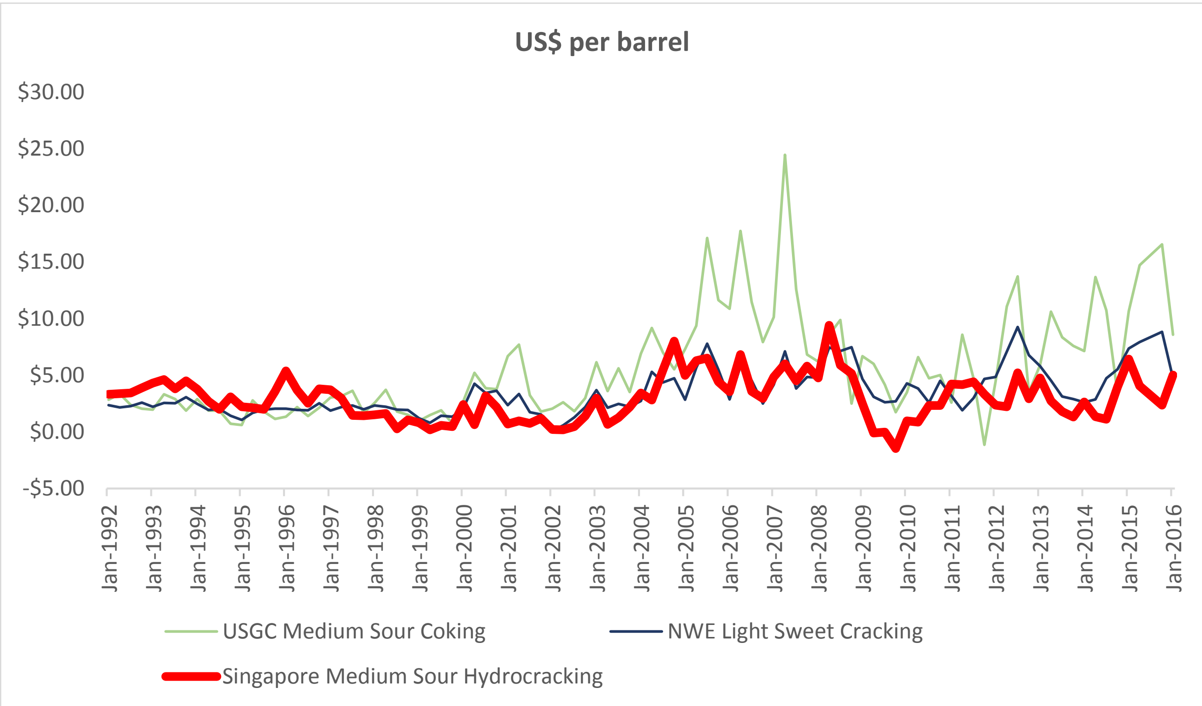
Although crude oil and petroleum products are traded globally, major regional markets have developed around the main demand centres of North America, Europe and Asia, with each market having its own characteristics. Refineries play an integral role in these regional markets, with the financial viability of individual refineries heavily influenced by supply and demand in the markets.

Prior to the Global Financial Crisis (GFC) in 2008, there was a significant surge in investment in refinery upgrades and in new refinery construction commitments, largely in response to growing demand for petroleum products and the associated strong refiner margins. This was particularly apparent in Asia.

However, the GFC resulted in a substantial reduction in global petroleum product demand, with only modest prospect of a recovery of lost demand over the short to medium term. As a consequence, refiner margins dropped substantially, in some cases falling into negative territory. The refining industry, particularly in Europe and OECD Asia, reacted to this financial challenge by terminating or deferring investment plans, reducing the utilisation rates for refineries, and progressively closing less viable refineries.

The three key regional benchmarks are highlighted in the chart below. The benchmark for Australian refineries is the Singapore margin.

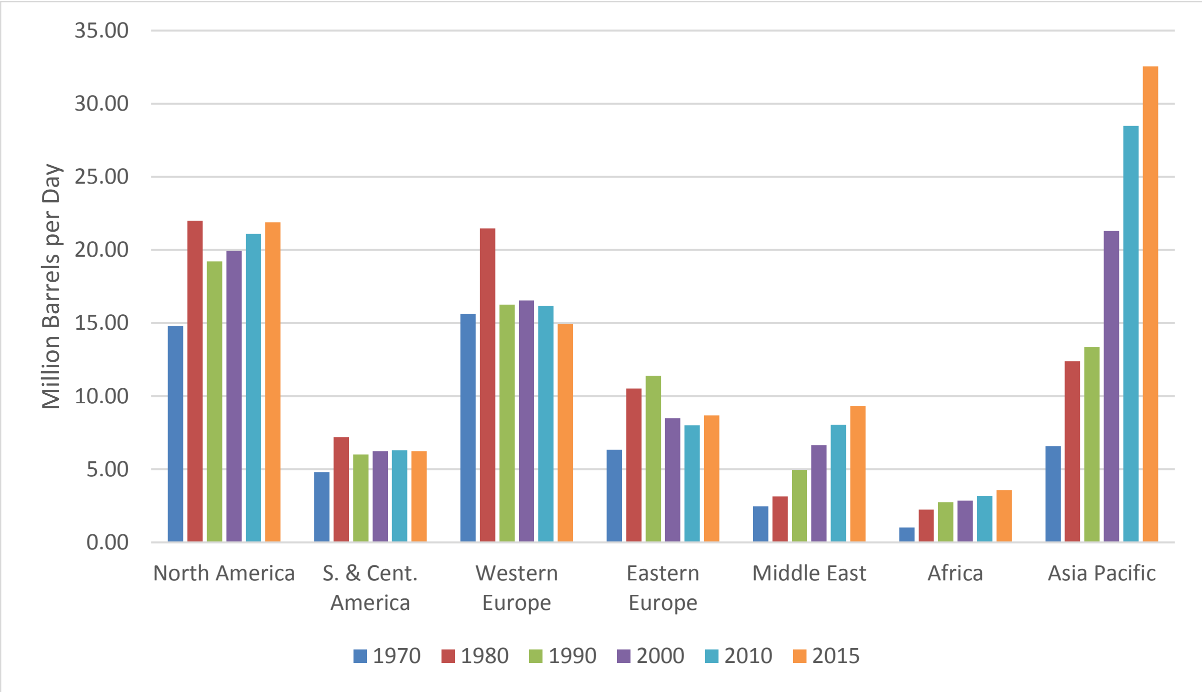
Regional refining margins 1992-2016



Notwithstanding these developments, a number of countries, particularly China and India, continued to press ahead with major refinery construction programs as part of national development goals.

Although petroleum product demand has slowly recovered from the GFC, these trends have continued to play out across Europe, North America and Asia, with older refineries closing, continuing refinery construction across Asia and the Middle East, and lower than usual refinery utilisation rates at many refineries. For example, China has added, on average, almost 1 million barrels per day of refining capacity every year from 2010 to 2015. This construction and expansion program continued in China in 2015 with the addition of about 2 million barrels per day in new capacity. By comparison, since 2008 some 4 million barrels per day of older refining capacity has been closed in North America, Europe, Japan and Australia.

World Refining Capacity



While demand for petroleum products in China has been strong it has not been sufficient to absorb all the output from new capacity additions. This has created significant surplus supplies in the Asian region which continue to depress refiner margins despite many refineries operating at below average utilisation rates. However the rates of surplus are slowing, with the regional product balance likely to move back into balance in the middle of the next decade. Equally importantly, this surplus capacity creates a significant potential for China to increase utilisation rates at existing refineries to meet increases in Asian demand, particularly if refiner margins improve.

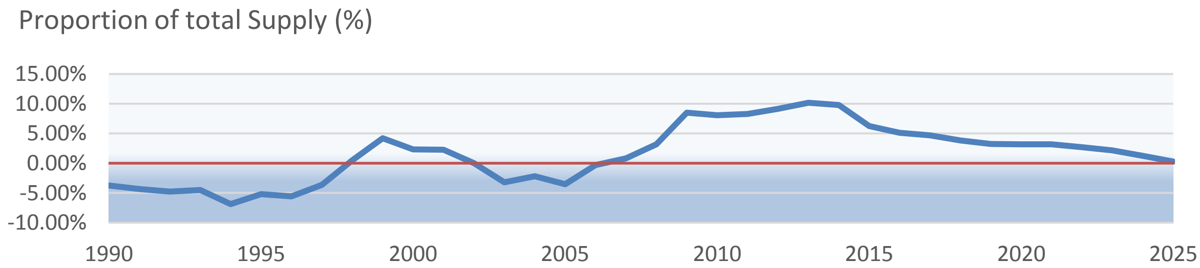
At the same time, global refining activities have been fundamentally affected by changes in the availability of domestically produced crude oil and condensate in North America. The ready and rapidly increasing availability of 'light tight' crude oils from deposits such as Bakken and Eagle Ford, combined with the increasing supply of heavier crude oil from Canadian oil sands, has resulted in a very well-supplied crude oil market in the US. These substantial supplies, and the US ban on exports of crude oil, have led to discounted crude oil prices for US refiners. These factors now underpin the competitiveness of the US refining sector, enabling it to operate at high utilisation rates and to displace imports of diesel from Europe. Since 2008, US imports of crude oil have dropped by over 2 million barrels per day, and petroleum industry analysts, including the IEA, BP and ExxonMobil, are forecasting a continuing high level of crude oil production in North America over the next decade.

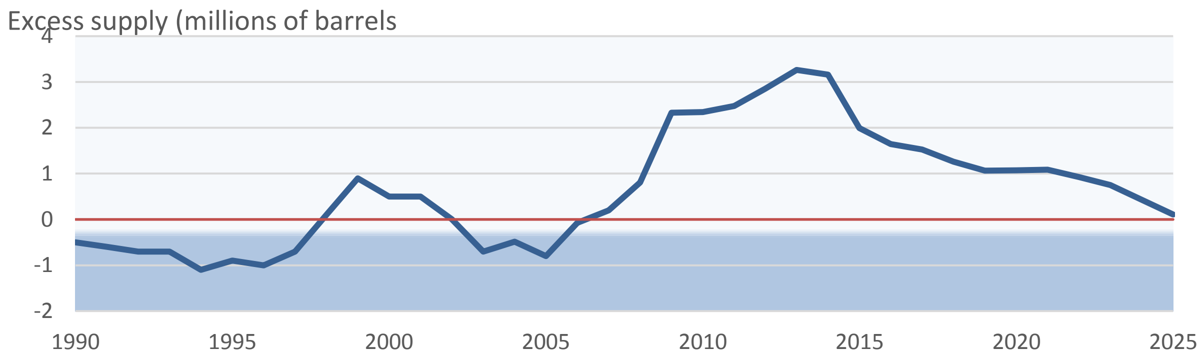
This development in North America has compounded the effects of the other global trends in the refining industry, particularly in Europe, such that there is an ongoing global surplus refining capacity and depressed refiner margins in other markets. However, with substantial new refining capacity, the Middle East and Asia is moving to become the global hub for future petroleum product refining and trade. In its 2013 World Energy Outlook, the IEA concluded that in looking forward 'the new geography of demand and supply means a re-ordering of global oil trade flows towards Asian markets' with the prospect that 'Asia becomes the unrivalled centre of global oil trade'.

A surplus refining capacity is forecast for the Asian region through to around 2025, notwithstanding the refinery rationalisation that is occurring across Asia, particularly with less viable refineries in Japan and Australia. Nonetheless, the extent of the oversupply is significantly below the scale that was observed from 2008 to 2015 when Australian refineries experienced substantially depressed profitability.

The change in the Asian regional supply balance points to a slowly improving outlook for Australian refineries and underpins investments being made to drive a sustainable ongoing future. However, history has shown that periods of improving margins lead to over investment in the refinery sector in Asia which then again suppress margins. The capital investment fluctuations explain the cyclical nature of the refining business.

Asian excess supply capacity





(2)AUSTRALIAN FUEL STANDARDS: CURRENT AND FUTURE

KEY MESSAGES

- Since 2000, AIP has been unable to support the introduction of 10ppm sulfur petrol because of the lack of operability benefits and the limited environmental benefits based on the available evidence.
- AIP continues to believe that this position is robust and strongly supported by the available evidence. However, in responding to the Government's imperatives, the AIP Board decided it is possible to introduce 10ppm sulfur by 1 July 2027.
- This position does not guarantee that each of Australia's refineries will continue to operate into the future but rather allows the necessary timeframe for each member company to carefully consider the most cost effective solution to meet this new specification.
- AIP and member companies believe that formally setting a timetable for the new specification,
- A key reason for AIP's opposition to changing the fuel standard was that market fuel quality in Australia is a better quality than the prevailing petrol standard.
- The average sulfur in unleaded petrol (ULP) in Melbourne is 60ppm, and in Sydney is 26ppm.
- The average sulfur in premium unleaded petrol (PULP) in Melbourne is 28ppm, and in Sydney is 16ppm.
- Almost one half of the PULP supplied to Sydney is below 10ppm sulfur.
- As more vehicles requiring PULP enter the market there will be further falls in sulfur levels across Australia without the need for regulatory intervention.
- While the averages are low, about 30 percent of the Australian produced petrol is still above 70ppm sulfur which gives the Australian refineries flexibility that underpins their economic viability.
- The introduction of 10ppm sulfur petrol in other jurisdictions has been done for reasons that do not apply to Australia such as addressing acute air quality problems.
- There is significant evidence to suggest that any air quality benefits in Australia will be minimal.
- Consequently, AIP strongly considers that the health and environmental benefits need to be modelled on market fuel quality otherwise they will be significantly overestimated if modelled on the current fuel standards.
- The Regulation Impact Statement in 2010 conducted by the DITRE found only a small net reduction for regulating vehicle emissions and the majority of the benefit was derived from regulating vehicles.
- There is significant evidence that the operability benefits do not exist, however, AIP does concede that there may be future technology facilitation benefits.
- There are a number of future technologies that are insensitive to sulfur and may require fuels different to petrol and diesel.
- The key guiding principle since the inception of the Fuel Quality Standards Act (FQSA) has been harmonisation with European standards to Australian conditions.
- There are some very important differences between European standards and Australia standards, particularly the effective ban of MTBE in Australia which limits octane options substantially.
- Consequently, the foregoing context leads to the following AIP positions:
  - AIP considers Option A the most desirable as it will maximize community benefits
  - AIP does not support Option B because it may result in the closure of one or more Australian refineries resulting in net community costs and removes ULP from the market with negative consumer impacts
  - AIP does not support Option C because it may result in the closure of one or more Australian refineries resulting in net community costs
  - AIP does not support Option D because it will close the Australian refining industry resulting in net community costs and will be very difficult and expensive to source in the Asian region
  - AIP does not Option E as it does not ameliorate the costs to the Australian refiners.
  - AIP supports Option F (an alternative option developed by AIP) because it minimises impacts on all stakeholders and thereby maximises the community benefit and involves the following features:
    - Introduction of 10ppm sulfur petrol in all grades.

    - No changes to any other fuel parameter (e.g. MTBE or other oxygenates, aromatics
    - Continuation of the ULP grade
  - Option F also includes an interim solution that would seek to safeguard the current market quality of fuels and includes:
    - 80ppm pool average and 120ppm maximum in ULP from 2021 (reported not regulated)
    - 40ppm pool average and a 50ppm maximum in PULP from 2021 (reported not regulated)
    - No changes to any other parameter
- Even under Option F there will likely be considerable (adverse) consequences:
  - Motorists will face a price premium of up to 2 cpl.
  - There are large capital costs ($979m) and increases in operating costs (1.1-1.7cpl) for refineries
  - Increases in greenhouse gas emissions at the refinery of 5-10 percent.
  - Threats to refinery viability, risking $1 billion on average in economic contribution per refinery per year
  - In the event of refinery closures there will be knock on impacts that will affect specific local communities such as Geelong and to other industries with key links to the refining industry.
  - A reduction in Australia's liquid fuel supply diversity and security.
- Also under Option F:
  - There are limited health benefits
  - Mandatory vehicle standards can be introduced without changes to fuel standards
  - The environmental benefits of 10ppm sulfur in ULP are yet to be tested and therefore AIP advocates the further investigation of 30ppm sulfur in ULP to manage pipeline interface issues at distribution terminals.

(2.2) INTRODUCTION

This Chapter outlines current fuel quality standards in Australia and forecast quality and consumption in the future as key background and evidence base to the consideration of any policy proposals or options for changing Australian fuel standards.

The coverage of this chapter includes:

- an overview of the AIP Board Position on Fuel Quality as an important scene setter
- the current quality and consumption of Australian petrol
- the forecast quality and consumption of Australian petrol into the future
- the link between fuel quality and vehicle emissions based on the current evidence base
- an AIP assessment of the discussion paper policy options for changing fuel quality standards
- a discussion of the rationale for the proposed interim solution

(2.3) OVERVIEW: AIP BOARD POSITION ON FUEL QUALITY

The AIP position on the introduction of 10ppm sulfur petrol has evolved over time.

Since 2000, AIP has been unable to support the introduction of 10ppm sulfur petrol because of the lack of operability benefits for vehicles and the limited environmental benefits based on the available evidence.

AIP also noted that the quality of fuel supplied to the Australian market was significantly better than the prevailing standards and there is a reasonable expectation that the sulfur levels in the Australian petrol pool would continue to decline over time as more vehicles require higher octane (lower sulfur) fuels.

The AIP Board finalised its position at its meeting of 19 March 2014, where the facts about fuel quality and operability were agreed:

- Long term use of higher sulfur fuels (up to 150ppm sulfur) will not cause significant impairment of catalysts and any effects will be largely reversible.
- Reducing the sulfur content of petrol from 150ppm to 50 ppm would only deliver limited environmental benefits in terms of reductions in tailpipe emissions.
- Tailpipe emissions improvements from lowering sulfur to 50ppm occur for some criteria pollutants (carbon monoxide and hydrocarbons) that are not a concern in Australia.
- 50ppm sulfur petrol is readily available in Australia.
- Future motor vehicle technology developments may require higher octane fuels such as Premium Unleaded Petrol (PULP).
- The production of 50ppm sulfur ULP would increase emissions and costs at Australian refineries.
- The introduction of a 50ppm sulfur ULP fuel standard would adversely affect the ongoing viability of some Australian refineries and is likely to lead to the closure of some of the remaining refineries.
- The introduction of a 10ppm sulfur standard across all grades of petrol would significantly threaten the ongoing viability of the Australian refining industry

AIP continues to believe that this position is robust and strongly supported by the available evidence. However, in responding to the Government’s imperatives, the AIP Board decided on 31 May 2016 that it is possible to introduce 10ppm sulfur by 1 July 2027. AIP and member companies believe that this proposal can minimise the impacts on all stakeholders.

Consequently, AIP and member companies are seeking to work cooperatively with Government to implement 10ppm sulfur petrol by 1 July 2027 which provides:

- **refineries with scope for the most cost effective solution to meet this new fuel standard**
- **scope for refineries to optimise the timing of investment**
- **necessary time to minimise market and consumer impacts**
- **certainty and a suitable transition for all industry, including vehicle manufacturers**
- **a pathway for Government resolution of this issue and for a positive policy outcome.**

AIP and member companies could agree to the implementation of 10ppm sulfur in all grades of petrol from 1 July 2027 subject to the successful negotiation of some key caveats that include demonstration of environmental benefits from the existing vehicle fleet (that is, it may not be necessary or desirable to introduce 10ppm sulfur regular unleaded fuel) and no changes to other parameters in the petrol standard such as aromatics and olefins. However, he environmental benefits of 10ppm sulfur in ULP are yet to be tested and therefore AIP advocates the further investigation of 30ppm sulfur in ULP to manage pipeline interface issues at distribution terminals.

This position does not guarantee that each of Australia's refineries will continue to operate into the future but rather allows the necessary timeframe for each member company to carefully consider the most cost effective solution to meet this new specification. It also supports the scheduled major turnarounds and other planned investments. The potential for this additional investment to ultimately bring about further refinery closures is a major risk, therefore each AIP member company has committed to keep the Government closely informed of its respective options and decision making processes throughout the proposed implementation period.

Given the potential for this additional investment to ultimately bring about further refinery closures, each AIP member company has committed to keep the Government closely informed of its respective options and decision making processes throughout the proposed implementation period.

To help address potential concerns from environmental, health and other stakeholder groups around the length of the implementation period, AIP and member companies also propose that the Government explores an incentive which encourages introduction of the new specification - similar to the incentives for 50ppm sulfur Diesel, 50ppm sulfur Premium Unleaded Petrol and 10ppm sulfur Diesel which facilitated a smooth transition and broader community support for these fuel standards.

We believe that formally setting a timetable for adoption of the new specification, coupled with investigation of incentives for adoption, will create the necessary certainty against which industry can plan and at the same time manage stakeholder expectations towards an agreed outcome.

(2.4) THE CURRENT QUALITY & CONSUMPTION OF AUSTRALIAN PETROL

The sulfur levels of petrol supplied to the Australian market are a critical parameter in estimating the environmental benefits of changing the fuel standard for petrol. Sulfur levels of fuel currently supplied to the Australian market are considerably below the parameters specified in the FQSA. Failure to recognise this fact will lead to a significant over-estimate of the environmental benefits. Moreover, it is important that the motor vehicle industry takes the market quality of fuel into consideration when determining whether vehicles can operate on Australian fuels.

Actual petrol sulfur levels in current Australian fuel

There is no formalised collection of Australian market fuel quality but AIP is aware that the sulfur levels in petrol supplied to the Australian market are considerably below the standards specified by the FQSA.

In addition, the trend of fuel grade switching from ULP to PULP has been occurring for the last fifteen years. Consequently, AIP sought to fill this information gap by collecting the fuel sulfur data for all petrol batches produced or imported into NSW and Victoria in 2014-15 and developing scenarios for fuel grade switching. The overall goal was to determine the current pool average sulfur levels and determine how these could change over time.

The key outputs of the AIP investigation are:

- sulfur levels in petrol by grade
- sulfur levels in the overall petrol pool
- a projection of fuel consumption by grade to 2030
- identification of data constraints and key assumptions

AIP has collected data for NSW and Victoria that covers the entire supply of petrol of AIP member companies by individual import load or batch produced at an Australian refinery. There are gaps in the scope of collection largely from the import of gasoline loads by independent operators, however, AIP estimates the coverage at over 90 percent of the gasoline pool. Moreover, we do not consider that the exclusion of this data will have any material impact on the accuracy of the data because the overwhelming majority of fuel is covered and AIP expects that the sulfur profile of gasoline by independent importers would be similar to that of imports of AIP member companies.

AIP has not sought to provide a rigorous market based forecast of fuel by grade as this is a commercial-in-confidence activity. AIP has sought to develop some plausible scenarios for fuel grade volume forecasts using the growth rates over the last 15 years and to highlight some of the key drivers of demand in the market. A key assumption is that there will be no growth in gasoline demand over the next 15 years. This assumption does not take account of the general expectation that there is likely to be a gradual decline in gasoline consumption over this period nor does it take into account any disruptive changes such as the significant take up of alternative fuels and engine technologies like electric vehicles and hybrids.

Average Sulfur (ppm) in Gasoline: 2014-15

	Sydney ULP	Sydney PULP	Sydney PULP 98	Melbourne ULP	Melbourne PULP
Average	26	16	10	60	28
Minimum	1	1	1	1	1
Maximum	85	45	31	147	49

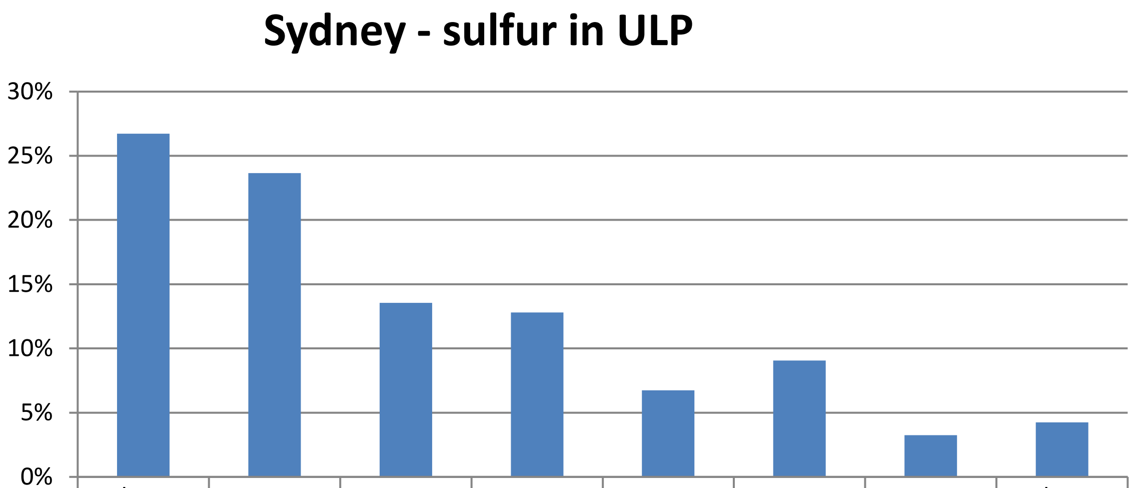
Note: Average is a volume weighted average

The volume weighted average for all grades of gasoline was considerably below the maximum sulfur levels specified by the FQSA. In general, the Melbourne sulfur levels were higher than Sydney largely because the Sydney market is predominantly supplied by international imported product whereas the Melbourne market is supplied from domestically refined fuel.

The following graphs show the distribution of the sulfur levels for each grade of fuel which also demonstrate the fairly wide distribution of the sulfur levels within each of these grades.

SYDNEY – Sulfur in ULP:

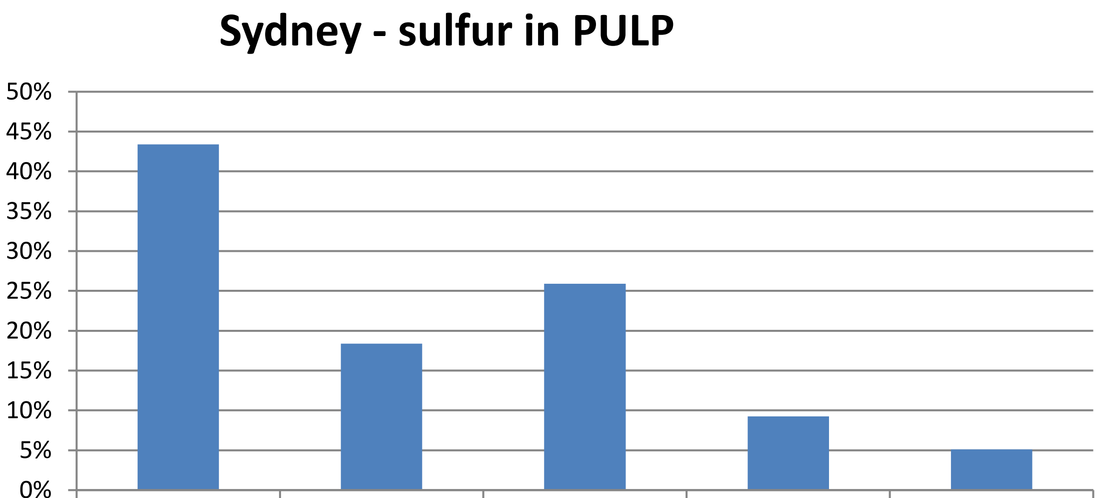
- Almost one third of the ULP supplied to Sydney was below 10ppm sulfur
- Over 80 percent of the ULP supplied to Sydney was below 50ppm sulfur
- There were very few loads of gasoline with sulfur levels above 70ppm and the maximum was 85ppm.



	Below 10 ppm	10-20ppm	20-30ppm	30-40ppm	40-50ppm	50-60ppm	60-70ppm	Above 70ppm
Sydney sulfur in ULP	27%	24%	14%	13%	7%	9%	3%	4%

SYDNEY – Sulfur in PULP:

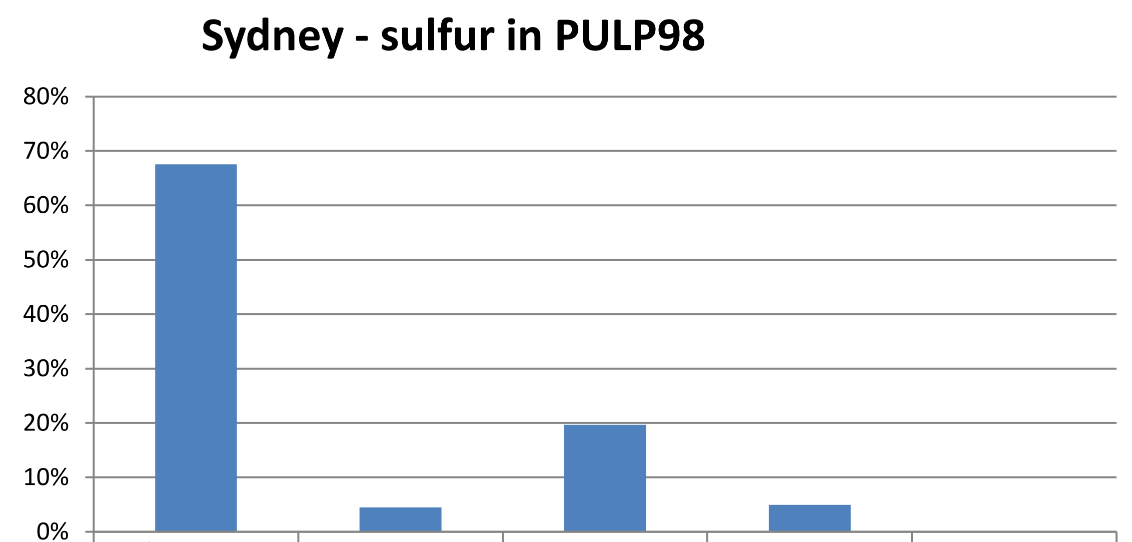
- Almost one half of the PULP supplied to Sydney was below 10ppm
- Over 80 percent of the PULP supplied to Sydney was below 30ppm



	Below 10 ppm	10-20ppm	20-30ppm	30-40ppm	40-50ppm
Sydney - sulfur in PULP	43%	18%	26%	9%	5%

SYDNEY – Sulfur in PULP 98:

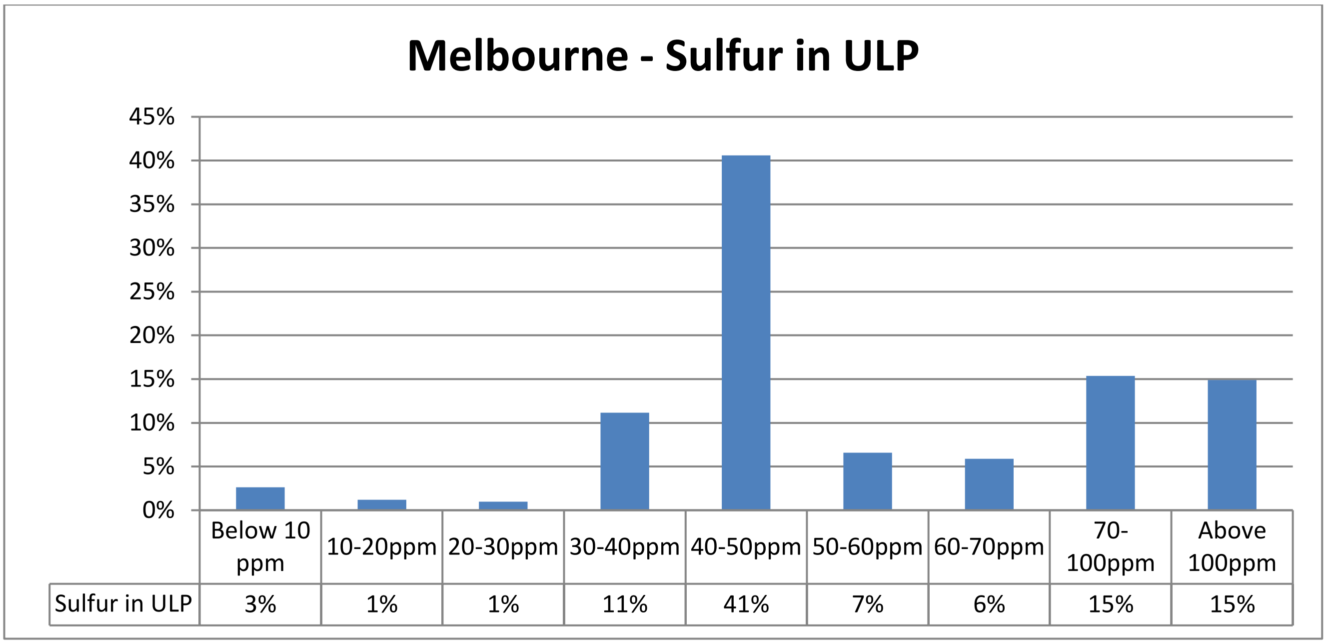
- Almost 70 percent of the PULP 98 supplied to Sydney was below 10ppm sulfur
- 95 percent of the PULP 98 supplied to Sydney was below 30ppm
- PULP 98 is the fastest growing segment of the fuels market



	Below 10 ppm	10-20ppm	20-30ppm	30-40ppm	40-50ppm
Sydney - sulfur in PULP98	68%	4%	20%	5%	0%

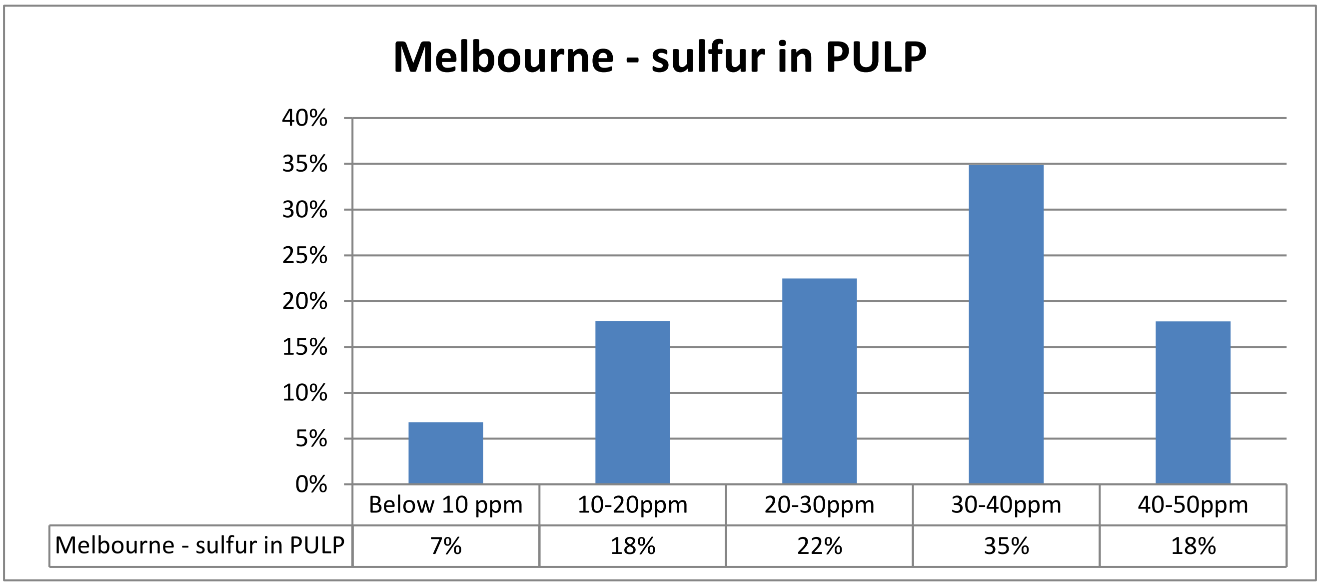
MELBOURNE – sulfur in ULP:

- Over 50 percent of the ULP supplied to Melbourne was less than 50ppm sulfur
- About one third of the ULP supplied to Melbourne had sulfur over 70ppm where the maximum was 147ppm - the ability to produce some product at these levels of sulfur provides the refineries with operating flexibility to retain economic viability



MELBOURNE – Sulfur in PULP:

- Almost 50 percent of the PULP supplied to Melbourne was below 30ppm sulfur
- Over one third of the PULP supplied to Melbourne was 30-40ppm sulfur



Historical Petrol Consumption in Australia

The following table shows Australian Petroleum Statistics for total petrol consumed in Australia in kilolitres and average annual growth rates. This base data was used to determine assumptions applied in development of scenarios to project fuel consumption by grade to 2030.

	Total	ULP	PULP	e10
2000-01	18168	18168	N/A	N/A
2001-02	18669	18669	N/A	N/A
2002-03	18873	16919	1953	N/A
2003-04	19962	17345	2617	N/A
2004-05	19876	16900	2976	N/A
2005-06	19048	16032	3016	N/A
2006-07	19251	15892	3069	289
2007-08	19234	15213	3186	835
2008-09	18734	13802	3248	1684
2009-10	18644	12773	3582	2288
2010-11	18725	11390	4266	3069
2011-12	18762	11313	4735	2714
2012-13	18659	11090	5000	2569
2013-14	18122	10737	5033	2352
2014-15	18148	10598	5334	2216
AAGR (14 yrs)	0%	0%	0%	0%
AAGR (10 yrs)	0%	-3%	8%	0%
AAGR (5 yrs)	-1%	-1%	5%	-6%
AAGR (3 yrs)	-1%	-2%	3%	-5%
AAGR (1 year)	0%	-1%	6%	-6%

AAGR: average annual growth rate

The key features of this data show:

- Total petrol consumption has been static for the last 15 years
- Consumption of PULP has increased as new vehicles requiring PULP have been purchased
  - Growth has been variable, generally ranging between 3-6 percent per annum
- Ethanol consumption growth driven by the State Government mandates in NSW and more recently Queensland, has reduced in recent years.

Uncertainties in future fuel consumption:

- *Total consumption*
  - Continued improvements in fuel economy; there is an established trend for improvement that is expected to continue for the foreseeable future
  - Substitution for alternative technologies and fuels (e.g. diesel, hybrids, EVs, gaseous fuels)
  - Substitution to alternative forms of transport (e.g. greater use of public transport)
- *PULP growth*
  - New vehicles increasingly requiring PULP
  - Substitution by the existing fleet to PULP
  - Emergence of PULP as the base grade of fuel
  - State Government ethanol mandates, particularly in NSW, has seen customers prefer PULP
- *E10 growth*
  - Significant uncertainty around the ability to meet the NSW and Queensland State government mandates due to consumer aversion to ethanol blended fuels
  - Lower oil prices undermine the competitive advantage of biofuels

(2.5) FORECAST QUALITY AND CONSUMPTION OF AUSTRALIAN PETROL

Scenario assumptions and parameters

The following scenarios, detailed over the next 3 pages, are not intended to be a comprehensive assessment and modelling of these factors, rather they are straight line arithmetic projections based on the following set of broad assumptions.

1. In a couple of the scenarios ULP is predicted to be removed from the market while there is continued supply of e10. These results clearly do not accord with reality and AIP stresses these are arithmetic projections not based on practical considerations.
2. The data sets are for State total consumption for each grade drawn from the Australian Petroleum Statistics.
3. The sulfur levels utilised are the volume weighted average sulfur levels derived from the 2014-15 data earlier in this paper and the total petrol sulfur level is the volume weighted by grade
4. There are significant differences in the petrol consumption between NSW and Victoria with PULP being significantly higher in NSW largely driven by the ethanol mandate.
5. PULP has not been separated into PULP95, PULP98.
6. PULP98 has significantly lower sulfur levels in Sydney and PULP 98 is the fastest growing segment of the petrol market (see analysis of real data discussed above).
7. Estimates of the levels of sulfur in the petrol pool are therefore conservative.

Results

This moderate scenario analysis suggests that sulfur levels in the petrol pool will decline gradually over time as PULP penetration increases in the petrol market and without changes to any fuel standard the petrol sulfur levels will be well below the current regulated standard within a 10-year horizon.

Scenario 1

- Petrol demand is constant
- PULP growth is moderate at 3 percent pa
- E10 declines at a moderate rate of minus 3 percent pa
- ULP supplies the remainder of the market
- Volumes are kilolitres

Scenario 1 - NSW	Total	ULP	PULP	e10	Sulfur
2014-15	5855	1612	2382	1860	21
2015-16	5855	1596	2454	1805	21
2016-17	5855	1577	2527	1751	21
2017-18	5855	1554	2603	1698	21
2018-19	5855	1527	2681	1647	21
2019-20	5855	1496	2762	1598	21
2020-21	5855	1461	2845	1550	20
2021-22	5855	1422	2930	1503	20
2022-23	5855	1379	3018	1458	20
2023-24	5855	1332	3108	1414	20
2024-25	5855	1281	3202	1372	20
2025-26	5855	1226	3298	1331	20
2026-27	5855	1167	3397	1291	20
2027-28	5855	1104	3499	1252	19
2028-29	5855	1037	3604	1215	19
2029-30	5855	965	3712	1178	19

Scenario 1 - Victoria	Total	ULP	PULP	e10	Sulfur
2014-15	4730	3599	1050	81	53
2015-16	4730	3568	1081	81	53
2016-17	4730	3536	1113	81	52
2017-18	4730	3502	1147	81	52
2018-19	4730	3468	1181	81	52
2019-20	4730	3432	1217	81	52
2020-21	4730	3396	1253	81	51
2021-22	4730	3358	1291	81	51
2022-23	4730	3319	1330	81	51
2023-24	4730	3280	1369	81	51
2024-25	4730	3238	1411	81	50
2025-26	4730	3196	1453	81	50
2026-27	4730	3153	1496	81	50
2027-28	4730	3108	1541	81	49
2028-29	4730	3061	1588	81	49
2029-30	4730	3014	1635	81	49

Under the moderate growth of PULP, consumer switch to PULP has a minor effect of the overall sulfur level in the petrol pool

Scenario 2

- Petrol demand is constant
- PULP growth is at the average growth of 6 percent pa
- E10 demand is constant
- ULP supplies the remainder of the market

Scenario 2 - NSW	Total	ULP	PULP	e10	Sulfur
2014-15	5855	1485	2452	1918	21
2015-16	5855	1338	2599	1918	21
2016-17	5855	1182	2755	1918	20
2017-18	5855	1017	2920	1918	20
2018-19	5855	842	3095	1918	20
2019-20	5855	656	3281	1918	20
2020-21	5855	459	3478	1918	19
2021-22	5855	250	3687	1918	19
2022-23	5855	29	3908	1918	18
2023-24	5855	0	3937	1918	18
2024-25	5855	0	3937	1918	18
2025-26	5855	0	3937	1918	18
2026-27	5855	0	3937	1918	18
2027-28	5855	0	3937	1918	18
2028-29	5855	0	3937	1918	18
2029-30	5855	0	3937	1918	18

Scenario 2 - Victoria	Total	ULP	PULP	e10	Sulfur
2014-15	4730	3569	1080	81	53
2015-16	4730	3504	1145	81	52
2016-17	4730	3435	1214	81	52
2017-18	4730	3363	1286	81	51
2018-19	4730	3285	1364	81	51
2019-20	4730	3204	1445	81	50
2020-21	4730	3117	1532	81	50
2021-22	4730	3025	1624	81	49
2022-23	4730	2927	1722	81	48
2023-24	4730	2824	1825	81	48
2024-25	4730	2715	1934	81	47
2025-26	4730	2599	2050	81	46
2026-27	4730	2476	2173	81	45
2027-28	4730	2345	2304	81	44
2028-29	4730	2207	2442	81	43
2029-30	4730	2060	2589	81	42

The historical growth rate for PULP leads to a gradual decline in the petrol pool sulfur level from 53 ppm to 42 ppm in Victoria.

Scenario 3

- Petrol demand is constant
- PULP growth is at the average growth of 6 percent pa
- E10 demand declines at historical rate of minus 6 percent until ULP is removed from the market in NSW while staying constant in Victoria
- ULP supplies the remainder of the market

Scenario 3 - NSW	Total	ULP	PULP	e10	Sulfur
2014-15	5855	1600	2452	1803	21
2015-16	5855	1561	2599	1695	21
2016-17	5855	1507	2755	1593	21
2017-18	5855	1437	2920	1497	20
2018-19	5855	1352	3095	1408	20
2019-20	5855	1251	3281	1323	20
2020-21	5855	1133	3478	1244	20
2021-22	5855	999	3687	1169	19
2022-23	5855	778	3908	1169	19
2023-24	5855	544	4142	1169	18
2024-25	5855	295	4391	1169	18
2025-26	5855	32	4654	1169	18
2026-27	5855	0	4686	1169	17
2027-28	5855	0	4686	1169	17
2028-29	5855	0	4686	1169	17
2029-30	5855	0	4686	1169	17

Scenario 3 - Victoria	Total	ULP	PULP	e10	Sulfur
2014-15	4730	3569	1080	81	53
2015-16	4730	3504	1145	81	52
2016-17	4730	3435	1214	81	52
2017-18	4730	3363	1286	81	51
2018-19	4730	3285	1364	81	51
2019-20	4730	3204	1445	81	50
2020-21	4730	3117	1532	81	50
2021-22	4730	3025	1624	81	49
2022-23	4730	2927	1722	81	48
2023-24	4730	2824	1825	81	48
2024-25	4730	2715	1934	81	47
2025-26	4730	2599	2050	81	46
2026-27	4730	2476	2173	81	45
2027-28	4730	2345	2304	81	44
2028-29	4730	2207	2442	81	43
2029-30	4730	2060	2589	81	42

The sulfur levels in the petrol pool will decline gradually over time as PULP penetration increases in the petrol market and without changes to any fuel standard the petrol sulfur levels will be well below the regulated standard. The highest sulfur level in the petrol pool is Victoria at 53 ppm which declines to just above 42ppm in higher growth PULP scenarios.

(2.6) THE LINK BETWEEN FUEL QUALITY AND VEHICLE EMISSIONS – THE EVIDENCE BASE

There is a significant evidence base derived from a number of Australian Government reviews and studies on different aspects of motor vehicle emissions and the relationship to fuel quality standards. In general, these studies have concluded that there is insufficient evidence to conclude that Australia should move to 10ppm sulfur petrol based on a net social benefit.

The Federal Chamber of Automotive Industries (FCAI) has often put forward the argument that the move by other countries to implement 10ppm sulfur petrol provides sufficient justification for Australia to also implement the fuel standard. This is an erroneous argument and provides little by way of direct evidence. The reasons for the introduction of 10ppm in other international jurisdictions have been to:

- facilitate sulfur sensitive technologies, such as lean burn GDI which is no longer considered a viable mainstream technological option (e.g. Europe, Japan, South Korea).
- take aggressive action to address specific, acute local air quality issues (e.g. US, Mexico and China).
- Implement a harmonisation policy in an environment where there is no cost to the domestic refining sector (e.g. New Zealand).

AIP strongly considers that the case has not been established that there is a net benefit for Australia for moving to 10ppm based on the significant body of work.

AIP is aware of positions from the automotive industries suggesting sulfur sensitivity of the car fleet. The direct technical evidence base for these positions comes from studies that are now dated and only tangentially relevant to the current Australian car fleet and its environmental performance. A large number of these studies are based on the assumption of a material market penetration of sulfur sensitive technologies, specifically lean burn gasoline direct injection (GDI) as an emissions reduction response in the transport sector this assumption is used to rationalise a 10ppm sulfur standard. As we know, this technology has not achieved the suggested market outcomes originally assumed. These international studies were not revisited or reassessed when the decision was made to introduce 10ppm sulfur petrol in international jurisdictions and/or the decision by motor vehicle manufacturers not to proceed with lean burn GDI technologies. Therefore, many of the conclusions drawn from these studies are not applicable to Australian conditions or the vehicle fleet and many subsequent reviewers have tried to infer the conclusion of these studies applies to Australian circumstances.

AIP strongly considers that the only way to definitively determine the sulfur impact on the current vehicle fleet is to undertake representative testing utilising Australian market fuel quality.

The following discussion provides a review of the successive studies (including a summary table), that have been undertaken to consider 10ppm sulfur petrol and assesses the available evidence and the reasons for the conclusions of each study/review process.

Summary of Research

Date of Review	Review	Main points	Conclusions
1998 - 2001	A number of discussion papers leading to RIS to implement petrol and diesel determinations – FQSA 2000	Review of sulfur impacts on motor vehicle emissions	Decision taken to delay introduction of 10ppm and review in 2003. Due to sulfur sensitivity technologies not widely available, refineries could not produce that quality, limited availability of 10ppm sulfur in the Asian region.
2005	McLennan, Magasanik Associates (MMA)	Review the petrol sulfur levels in 2003 and determine whether a case existed for implementation of 10ppm sulfur	Requirement for 10ppm sulfur petrol was largely driven by the sulfur sensitive technologies, specifically lean burn gasoline direct injection (GDI) technologies. Uncertainty identified in the fuel cost savings and emission abatement due to the uptake of sulfur sensitive vehicles in the fleet. Introduction of 10ppm should be delayed until such time as more information is obtained. Net benefit of introduction of 10ppm S petrol in 2010 ranges from -\$1,500 million to \$2,700 million (inconclusive)
2010	Euro 5/6 RIS	Determine whether there was a net benefit from the introduction of Euro 5/6 vehicle emission standards. Did not include changes to fuel standards.	Emissions reductions would be achieved through the introduction of the improved vehicle emission standards and through the turnover of the fleet. As fuel standards were kept constant in this analysis – conclusions suggested no need for further restrictions of sulfur levels in fuel. No evidence available to warrant that 150ppm S levels in ULP were a barrier to supplying Euro 5 compliant vehicles to the market
2010	AIP technical evidence presented to the Euro 5/6 RIS	Evidence base on the sulfur effects on emissions	Long-term use of high sulfur fuels does not damage catalysts. Tailpipe emissions improvements from lowering sulfur from 150ppm to 50ppm are relatively small. Future motor vehicle technology developments may require PULP.
2010	Martec Study on lean burn GDI	Commissioned by the American Petroleum Institute (API) to determine the current and future utilisation of lean combustion systems on petrol engines by global light-duty motor vehicle manufacturers	In markets with 10ppm S petrol, lean burn petrol penetration will decline through 2015 HCCI will become the dominant combustion strategy on non-charged petrol engines The maximum opportunity for lean burn GDI is limited to stranded V8 engine capital that is confined to 5% of the market. Lean burn technology will not be adopted as a mainstream technology but will only be introduced to limited high and specialised vehicle models.
2013	Orbital Report	Commissioned by Australian Government to confirm whether or not the current Australian sulfur limits will prevent in service compliance with the new vehicle emission standards or cause operational problems on the new vehicle emission control technologies likely to be introduced under these standards.	50ppm would offer a sufficient reduction in the risks of sulfur-related issues identified for new Euro5/6 vehicles meeting the new Euro 5 and 6 emission standard requirements
2013	SGS catalyst durability study	API commissioned this study to determine if the exhaust emissions effects caused by exposure to 80ppm S petrol were reversible after the vehicle was refuelled with 10ppm.	Lack of test data on the sensitivity and reversibility of very low emitting vehicles to sulfur in petrol, especially for vehicles aged to full useful life.

Fuel Quality Standards Act 2000

The Australian Government has undertaken a number of reviews of the sulfur impacts on motor vehicle emissions that commenced with a series of discussion papers conducted from 1998 to 2001 that culminated in the production of a Regulation Impact Statement to implement the relevant petrol and diesel determinations. The extensive process of consultation recommended a preferred option which was the subject of a Cabinet decision[1]. The selection of the most appropriate option for national fuel quality standards was based on three principal selection criteria.

The suite of standards recommended would need to, as far as possible would
1. *provide harmonisation with international standards i.e. 'Euro' standards;*
2. *satisfy the objectives of the seven guiding principles to ensure that any fuel standards selected were appropriate for the Australian context; and*
3. *provide a balance between environmental objectives and the capacity of the refining industry to supply cleaner fuels.*

The seven guiding principles mentioned above were:
(1) *Fuel standards are intended to manage those fuel qualities/parameters that are known to have the potential to impact adversely on the environment.*
(2) *Fuel standards should be compatible with relevant international or internationally accepted standards in order not to impede competition and trade.*
(3) *Fuel standards are intended to be mandated on a national basis.*
(4) *Fuel standards will apply to, and be enforced equally in respect of imports as well as domestically produced petroleum fuels.*
(5) *Fuel standards that directly address environmental or health issues will be determined on the basis of Australia-specific requirements. In such instances, harmonisation with European specifications may be neither necessary or desirable.*
(6) *The timetable for the introduction of new fuels standards will be based on Australian requirements. Harmonisation, in terms of timing, will not be based on European or any other regional timetable, except where there is a previous policy decision to this effect or the standard is technology enabling and the need for such harmonisation is clearly demonstrated.*
(7) *Consideration will be given to setting standards that provide as far as possible, flexibility in terms of compliance.*

At that time a decision was taken to review the introduction of 10ppm sulfur petrol in 2003. The reasons for the delay were:
- Sulfur sensitive technologies were not widely available in the car fleet
- Australian refineries could not produce that quality of petrol
- There was limited availability for import of 10ppm sulfur petrol in the Asian region.

McLennan, Magasanik Associates (MMA) 2005[2]

The MMA report was commissioned to give effect to the decision to review the petrol sulfur levels in 2003 and determine whether there was a case for implementation of 10ppm sulfur.

The MMA report was the first to identify that the requirement for 10ppm sulfur petrol was largely driven by the sulfur sensitive technologies, specifically lean burn gasoline direct injection (GDI) technologies. Much of

[1] Paper: Setting National Fuel Quality Standards, Commonwealth Position, September 2000

[2] McLennan Magasanik Associates -MMA (21 October 2005) *Costs and Benefits of Introducing 10ppm Sulfur in Premium Unleaded Petrol* Australian Greenhouse Office

the evidence that was utilised in that study was predicated on substantial improvements in fuel economy (up to 8 percent) facilitated by the introduction of lean burn technologies.

A key feature of the modelling was the recognition of the high level of uncertainty over values of many of the key variables affecting the benefits and costs. Thus extensive sensitivity analysis was undertaken to test the robustness of key results. Significant uncertainty was identified in the fuel cost savings and emission abatement due to the uptake of sulfur sensitive vehicles in the fleet. Fuel cost savings were sensitive to the discount rate utilised with a long payback period for vehicle fuel improvements. Refinery costs were sensitive to construction costs, increased emissions and the potential lead times for construction. MMA utilised a base case of five years' construction lead time to implement the standard. It is also worth noting that the current review by Marsden Jacobs of the FQSA is utilising the MMA assessments to determine the net benefit of the fuel standards framework.

MMA concluded that the major limitation of the study was that there was a high level of uncertainty over many of the key variables affecting the analysis. This uncertainty was compounded by the fact that many of the technologies utilised in Europe at that time relied in part on the use of MTBE to help achieve the low sulfur target, an option not likely to be feasible under current Government regulations. Moreover, developments in car technologies may favour technologies (such as hybrid cars) that promise even greater energy efficiency savings than may be obtained from sulfur sensitive drive trains (e.g. lean burn GDI).

Consequently, MMA concluded that the net benefit from introducing a 10ppm limit of sulfur in petrol in 2010 ranges from negative $1,500 million to positive $2,700 million.

The key MMA conclusion from the analysis is that the introduction of 10ppm sulfur petrol should be delayed until such time as more information is obtained. Although the analysis indicated that net benefits are possible, these net benefits can only occur under certain circumstances.

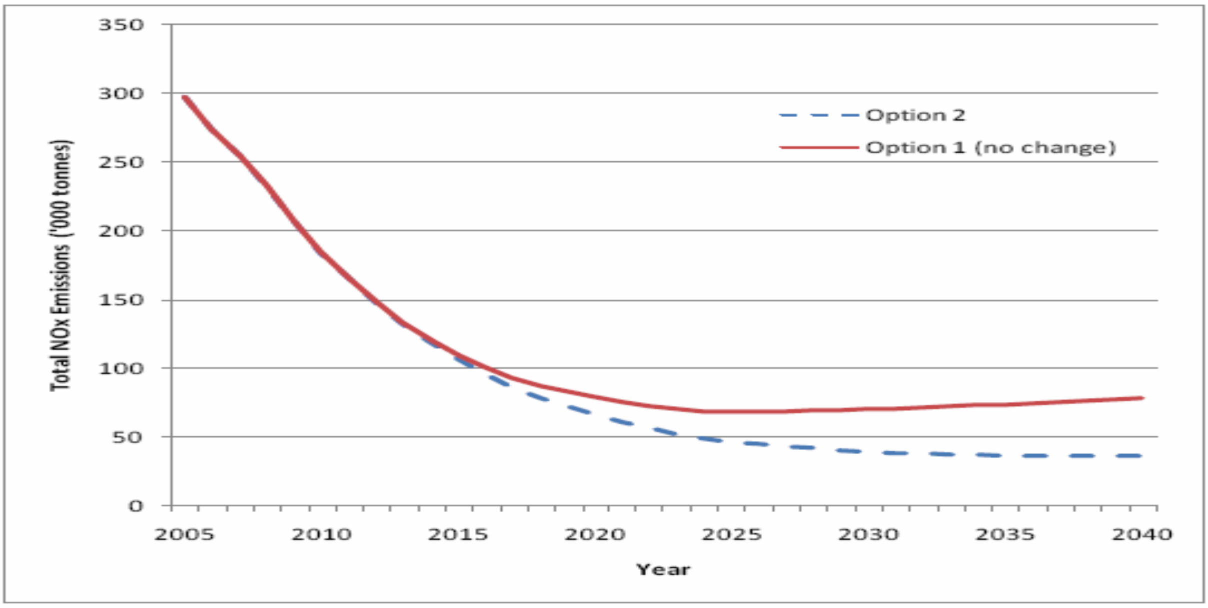
AIP considers that the conclusions of MMA study are robust and while it was conducted 10 years ago it identified the key issues that would need to be examined in any updated study. Furthermore, certainty around the introduction of lean burn GDI has improved, i.e. it will not be a mainstream technology, and the Australian market fuels sulfur levels have substantially reduced thereby reducing the environmental benefits. AIP contends that if the MMA study were replicated these two observations would deliver more negative results to the net community benefit in the sensitivity analysis.

Euro 5/6 Regulation Impact Statement (RIS) 2010[3]

The Euro 5/6 Regulation Impact Statement (RIS) was prepared to determine whether there was a net benefit from the introduction of Euro 5/6 vehicle emission standards. The RIS did not consider a change in fuel standards as there was no evidence presented that the Euro 5/6 emission levels could not be achieved by the current fuel standards.

A key finding of the RIS was the following graph:

[3] Department of Infrastructure and Transport (November 2010) *Final Regulation Impact Statement for Review of Euro5/6 Light Vehicle Emission Standards*



Source: BITRE Estimates (2009)

The estimates in this graph are for the introduction of Euro 5/6 vehicle emissions but given that the low mileage emission limits for Euro 5 and Euro 6 are identical it could be reasonably assumed that the bulk of these reductions are attributable to Euro 5.

The key point AIP wishes to emphasise is that the majority of the emission reductions shown in the graph would be achieved through the introduction of the improved vehicle emissions standards and through the turnover of the fleet without further tightening of petrol quality.

In this respect, there were some critical conclusions reached in the RIS on pages 68-69.

> *"The FCAI and all vehicle industry submissions argued that the 150ppm level was too high but did not provide any specific evidence to support their claim.*
>
> *The review is not aware of any evidence that 150ppm sulfur level in ULP is a <u>barrier</u> to supplying Euro 5 compliant vehicles to the market, and the public submissions provided no evidence to the contrary. Equally no evidence was supplied to suggest that sulfur levels below 50 ppm were essential, except in some technologies that appear to be in very limited use.*
>
> *There is less certainty over the impact of 150ppm sulfur on the durability and longevity of emission control systems in petrol vehicles (such as catalysts). While this remains an open question there is no evidence that the current fuel standards will prevent compliance with Euro5 standards or because operational problems will prevent in-service compliance with Euro5 standards or cause operational problems, and 50ppm sulfur petrol (95 Ron) is available to manufacturers where they have concerns about operation on 150ppm sulfur petrol (91 RON)".*

And on page 20 of the RIS:

> *"Based on the European approach, it would appear that a 50ppm sulfur level would be adequate to support Euro 5/6 petrol and LPG technologies. This conclusion is supported by a number of public submissions, including a major international manufacturer of engine/fuel systems components (Bosch).*

The FCAI submission also claims that some manufacturers are "desensitising" their OBD systems because the sulfur levels above 10ppm. However, no supporting information was provided to substantiate these statements.

In contrast, the AIP submission quoting a number of published reports, argues that there is no strong evidence to warrant a change in the sulfur levels in either 91 RON or 95 RON petrol stating that "most prospective technologies can operate satisfactorily…on 150ppm sulfur petrol" and that "150ppm sulfur ULP … is not an impediment to the introduction of Euro 5/6". The AIP submission also notes 95 RON fuel (50ppm limit) is available in the market place for those vehicles which manufacturers consider unsuitable for operation in 150ppm sulfur."

In terms of the overall net benefit, the Euro 5/6 RIS found that there was a positive community benefit for the introduction of Euro6 but it did not consider the cost of changing fuel standards. However, with the greatest positive community benefit of $807m estimated in the RIS, it is difficult to see how a positive community benefit can be achieved by a change in fuel standards, which is well below the costs estimated in the MMA study from 2005. It should also be noted that the continuation of the 150ppm standard for ULP was not a barrier to the introduction of Euro 5 vehicle standards.

AIP technical evidence presented to the Euro 5/6 RIS 2010

AIP presented the following technical evidence to Euro 5/6 RIS which provides a substantial portion of the evidence base on the sulfur effects on emissions. This work was also utilised by the Orbital Report.

1. Long term use of higher sulfur fuels does not damage catalysts

The available evidence[4] from an extensive literature review suggests that the use of fuel up to 500ppm does not have an appreciable effect on the operation of the catalysts and:
- Vehicles will still meet relevant emission standards after operation on higher sulfur fuels; and
- Even after operating for extended mileage on higher sulfur gasoline, vehicle emissions will be reduced if sulfur levels are lowered.

In a limited study of two catalysts[5] the authors concluded that catalyst aging was not affected by sulfur levels between 50 ppm and 450ppm. A further study conducted by the China Automotive Technology and Research Centre (CATARC)[6] concluded that it was clear that there was no damage to catalysts operating long term on 150ppm sulfur petrol. In a Mexican study[7], vehicles similar to Euro 3 vehicles were driven on petrol at either about 350ppm or 750ppm. After accumulating significant mileage on these high sulfur fuels, the test vehicles still met the emission standards on average and had a typical response to changing sulfur levels. Later literature reviews seem to confirm these results[8].

[4] Hochhauser AM, Schleyer CH, Yeh LI & Rickeard DJ (2006) *Impact of Fuel Sulfur on Gasoline and Diesel Vehicle Emissions* SAE International 2006-01-3370 p.9

[5] Bjorddal SD, Goodfellow CL, Beckwith P, Bennett PJ, Brisley RJ & Wilkins AJJ (1995) *An Evaluation of the Long Term Effects of Gasoline Sulphur Levels on Three Way Catalyst Activity* SAE International 952421.

[6] CATARC study quoted in Hochhauser AM, Schleyer CH, Yeh LI & Rickeard DJ (2006) *Impact of Fuel Sulfur on Gasoline and Diesel Vehicle Emissions* SAE International 2006-01-3370 p.5

[7] Schifter I, Diaz, L &Lopez-Salinas E (2006) *A Predictive Model to correlate Fuel Specifications with On-Road Vehicle Emissions In Mexico* Environmental Science and Technology Vol 40, No.4, pp.1270-1279.

[8] Hochhauser AM (2008) *Review of Prior Studies of Fuel Effects on Vehicle Emissions* Coordinating Research Council (CRC)

A further study by CONCAWE[9] concluded:

- No evidence of increased sulfur sensitivity after catalyst ageing
- Advanced European vehicles tested showed very little short term sensitivity to fuel sulfur
- Low emissions can be achieved without significant short-term sensitivity to fuel sulfur
- Reductions in fuel sulfur content from 150ppm to 10ppm seem unlikely to bring substantial emission benefits for current Euro3&4 vehicle technologies.

These results are supported by anecdotal evidence from the United States from in service emissions testing and reports of on-board diagnostic malfunction indicators. It is also important to note that the durability requirement for the US requirements was 100,000 miles or 160,0000km. On board diagnostics have been present on US cars since 1996 while the sulfur limit for conventional petrol was 1000ppm until 2004. Although the US national average sulfur level was around 300ppm, there were many areas which were around 800ppm and there were no reported problems of vehicles exceeding emission standards because of catalyst poisoning.

Therefore, the evidence would suggest that increasing the durability requirement would not cause the concerns about affecting the performance of the catalyst.

There are numerous studies that indicate that the effects of using high sulfur levels are reversed when the vehicle returns to using low sulfur fuels. A useful summary of these studies[10] concludes that studies show either complete reversibility or substantial reversibility depending on the criteria pollutant and the driving conditions. For example, it appeared that harsher driving conditions (generally experienced in Australia) will lead to greater reversibility than milder driving conditions.

AIP is not aware of any technology being constrained by sulfur levels other than lean burn gasoline direct injection engines (GDI) which must be operated on 10ppm sulfur Premium Unleaded Petrol (PULP) to avoid fuel economy and catalyst durability debits. These engines require low sulfur petrol because the lean environment requires the use of lean NO_x trap exhaust treatment technology which is sensitive to sulfur. Lean burn GDI engines can still operate at higher sulfur levels but will use more fuel due to the higher frequency de-sulfation cycles needed to remove accumulated sulfur compounds. Each de-sulfation cycle subjects the lean NOx trap to high temperature which over time reduces the efficiency of the trap at capturing NOx. Lean burn GDI is a miniscule portion of current automobile manufacturing and is declining in popularity as a technology with automobile manufacturers because of its complexity and therefore lean burn GDI is unlikely to ever be more than a very small niche in the automotive market.

Some technologies, such as turbo-boosted stoichiometric GDI are potentially constrained by octane level and some require at least 95 RON but we have not been able to find any evidence that the operability of these technologies is constrained by the sulfur level. These technologies use conventional advanced three-way catalysts and, as demonstrated in the foregoing evidence, there does not appear to be significant catalyst damage or any other reported operability issues. Moreover, the next generation of potential engine technologies, e.g. Homogeneous Charge Compressed Ignition (HCCI) and Controlled Auto Ignition (CAI), are very tolerant of fuel types and may actually require lower octane than current technologies. Later sections in this paper will expand on these issues.

AIP acknowledges that there may be technology specific differences between vehicle manufacturers that may lead to other factors such as increased fuel consumption from additional catalysts purges for very high sulfur levels (well above the current Australian typical sulfur levels). If these factors are considered

[9] CONCAWE Fuel Quality and Management Group (2003) *Fuel Effects on Emissions from Modern Gasoline Vehicles Part 1 – sulphur effects* Report 5/03 CONCAWE p39

[10] Hochhauser AM, Schleyer CH, Yeh LI & Rickeard DJ (2006) *Impact of Fuel Sulfur on Gasoline and Diesel Vehicle Emissions* SAE International 2006-01-3370 p.8

relevant by vehicle manufacturers with specific technologies, then the use of PULP with 50ppm sulfur could be specified in the owner's manual as the required fuel for any particular vehicle

2. Tailpipe emissions improvements from lowering sulfur from 150ppm to 50ppm are relatively small

There have been a range of significant studies considering the effects of sulfur levels on vehicle emissions. A useful summary of the papers is provided by Hochhauser[11] and incorporates a range of fuel parameters. These studies have been conducted over a significant period of time by independent organisations and the results have been published in peer reviewed journals.

In the 215 petrol studies reviewed there are limitations in drawing generalisations because of:

- comparability issues between the studies because of differences in statistical approaches;
- comparability issues because of the use of different drive cycles;
- limited sample size of vehicles tested; and
- fuel properties were not independently verified so that it is difficult to ascribe any impacts to different fuel parameters.

Nonetheless, the general consensus from these studies appears to be that:

- The relationship between increasing sulfur levels and emissions is linear.
- The majority of these studies showed relatively small responses to sulfur changes from 150ppm to 50ppm for criteria pollutants ranging from 1 percent to 10 percent for HC, CO and NO_x.
- Air toxics were only measured in a limited number of studies generally on older vehicles. Reducing sulfur levels also lowers emissions of the air toxics benzene and 1.3 butadiene but may increase the level of formaldehyde. It appears that the changes in the levels of toxics are between 5-10 percent for changes in 150ppm to 50ppm but this is not clear from the studies.
- The effect of sulfur has been consistent over time, as technology has evolved mass effects are smaller while percentage effects are similar.
- The newer fleets exhibited relatively lower responses to sulfur compared to the older vehicles.

In assessing any potential further reductions in emissions it is important to recognise the significant improvements in motor vehicle emissions that have been facilitated by the Commonwealth Government's cleaner fuels program. Since the commencement of cleaner fuel standards in 2002 it is expected that criteria pollutant emissions will reduce by up to 90 percent by 2020. Comparing pre- 2002 emissions to the expected reductions from changing the sulfur level to 50ppm for ULP would appear to yield only about a 1 percent improvement. The Euro 5/6 RIS supports this general conclusion by stating that "the fuel sulfur reductions embodied in the national fuel quality standards to 2006 would have already delivered the majority of direct air quality benefits available from sulfur reduction".

The small air quality benefit would be further reduced by the greater levels of energy consumption and direct emissions from refineries caused by the more severe processing of fuel to meet a 10ppm sulfur ULP standard. As explained in more detail later in the paper, desulfurisation of petrol is energy intensive and because the process can also reduce octane, augmentation with high octane blendstocks production may also be required. Being more energy intensive the production of 50ppm ULP will certainly increase greenhouse gas emissions but is also likely to increase emissions of sulfur dioxide and NO_x from the refineries. The exact nature of these emissions would need to be the subject of detailed study by the Australian refineries and are a function of the technology pathway chosen by each refinery to meet the standard.

Based on this range of evidence, AIP considers that there is a marginal environmental benefit in reducing sulfur in ULP from 150ppm to 50ppm. AIP also considers that it is important to consider the costs of any change including increased refinery emissions, increased fuel prices, increased refinery capital expenditure and the possible closure of Australian refineries.

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[11] Hochhauser AM (2009) *Review of Prior Studies of Fuel Effects on Vehicle Emissions* SAE International 2009-01-1811.

3. Future motor vehicle technology developments may require Premium Unleaded Petrol (PULP)

Gasoline Direct Injection (GDI) when paired with other strategies such as downsizing and turbo charging can potentially deliver significant improvements in fuel economy of up to 15 percent depending on the drive and load characteristics. It should be noted that combustion strategy improvements are only one approach to improve vehicle fuel efficiency and other improvements in valve technology (variable valve timing), gearboxes (eg six speed gearboxes), low friction oils and weight downsizing can also deliver substantial fuel economy saving. For a summary of the potential gains please refer to the report by the US EPA.[12]

The dominant GDI technology is stoichiometric GDI which is being favoured by vehicle manufacturers because of its simplicity and conventional pollution control equipment, the three-way catalyst, can be utilised. Stoichiometric GDI can readily operate on 150ppm sulfur levels and depending on the engine management system may be able to operate on 91 RON. However, the general trends in stoichiometric GDI deployment suggest that downsizing and turbo charging may require 95 RON or greater fuels, but this will depend on the individual engine technology.

In contrast, lean burn GDI substantially increases the air/fuel ratio and consequently conventional three-way catalyst is unable to reduce the NO_x requiring the use of lean NO_x catalyst ("NO_x trap"). The lean NO_x traps are sensitive to sulfur levels and the manufacturers require them to operate on fuel containing less than 10ppm sulfur to minimise the debits associated with the additional catalyst regenerations required to maintain catalyst performance which significantly reduces fuel efficiency. The need for lean NO_x traps increases the cost of lean burn GDI. In addition, under various load and driving conditions lean burn GDI achieves economy benefits similar to stoichiometric GDI. For these reasons, market penetration of lean burn GDI has been limited and largely confined to high performance and luxury segments of the market.

Stoichiometric GDI is expected to make a fairly rapid penetration into the new car market. In 2005, the proportion of new vehicles that were GDI was around 1 percent in the US and 5 percent in Europe. Stoichiometric technologies are expected to be the dominant technology into the future. The fleet turnover will mean that these vehicles will be a relatively small growing proportion of fleet over time but it seems likely that GDI will become the main technology in petrol markets subject to any further developments in technology.

The next round of improved vehicle technologies could include Homogenous Charge Compression Ignition (HCCI) or Controlled Auto Ignition (CAI) that combines features of both spark ignition and compression ignition. In test conditions[13] these engines have shown further improvements in fuel economy with the added benefit of lower PM and NO_x engine-out emissions and will therefore require less after-treatment to meet emission standards. In bench testing, these engines have been shown to run successfully on a variety of fuels, including under part-load and full-load operating conditions, although various technical issues need to be overcome. An implication for fuels is that these engines may be optimised by using different fuels than currently available.

Given the likely developments in engine technologies, AIP considers that the technology facilitation benefits have already been achieved by the introduction of the current Australian PULP standard. A further assessment of the fuels standards could be undertaken at a time if/when these technologies ultimately emerge into the mainstream.

[12] US EPA (2008) *EPA Staff Technical Report: Costs and Effectiveness Estimates of Technologies Used to Reduce Light-Duty Vehicle Carbon Dioxide Emissions* United States Environmental Protection Agency

[13] Cracknell RF, Rickeard DJ, Ariztegui J, Rose KD, Meuther M, Lamping M, Kolbeck A (2008) *Advanced Combustion for Low Emissions and High Efficiency Part 2: Impact of Fuel Properties on HCCI Combustion*
SAE International 2008-01-2404

Martec Study on lean burn GDI 2010[14]

The Martec Study was commissioned by the American Petroleum Institute (API) to determine the current and future utilisation of lean combustion systems on petrol engines by global light-duty motor vehicle manufacturers.

The study was based on original market research with more than 100 technical and commercial decision makers in the global light-duty vehicle industry. In addition to motor vehicle manufacturers, confidential interviews were conducted with technology suppliers across important powertrain functionalities, including fuel systems, valvetrain, turbocharging, exhaust after treatment, as well as other vehicle subsystems.

In essence, the study was an extremely detailed assessment of the likely uptake of lean burn technologies.

The study was conducted for the major low sulfur petrol markets of Japan, Europe and the US with the following conclusions:

1. In markets with 10ppm sulfur petrol, lean burn petrol penetration will decline through 2015.
    a. After peaking at about 2 percent of the market in 2010, European lean GDI engines will be replaced by stoichiometric downsized turbocharged engines offering performance and CO_2 benefits.
    b. In Japan, lean burn GDI peaked at about 2 percent of demand in 2001. Stoichiometric GDI engines with advanced valvetrains are required to support development of HCCI functionality through 2020.
2. HCCI will become the dominant combustion strategy on non-charged petrol engines
3. The maximum opportunity for lean burn GDI is limited to stranded V8 engine capital that is confined to 5 percent of the market.

These conclusions indicate that lean burn technology will not be adopted as a mainstream technology but will only be introduced to limited high-end and specialised vehicle models. Therefore, arguments that utilise this sulfur sensitive technology should be discounted as irrelevant to the debate.

Orbital Report 2013[15]

The Orbital report was prepared in response to the conclusions of the Euro 5/6 RIS. The Orbital Report was commissioned by DSEWPAC to confirm whether or not the current Australian sulfur limits will prevent in-service compliance with the new vehicle emission standards or cause operational problems on the new vehicle emission control technologies likely to be introduced under these standards.

The motor vehicle industry was specifically requested to provide evidence of the ability of current vehicles to meet the Euro 5/6 vehicle emission standards on Australian standards fuels. The most consistent feedback from stakeholders was that technology enablement would require 10ppm sulfur petrol to be available in the Australian market. The main technology identified by manufacturers, such as Mercedes-Benz, as requiring low sulfur fuels is lean burn GDI, where without the lower sulfur their argument is that the gains in fuel consumption and CO2 will effectively be nullified by increased catalyst regeneration requirements. These arguments seem to suggest that there are no operability concerns with running the vehicle on fuel above 10ppm and the main concerns with using 10ppm are environmental. Moreover, the motor vehicle manufacturers were nominating a technology (lean burn GDI) that would have very limited application.

[14] Martec (9 April 2010) *Technology Cost and Adoption Analysis: Impact of Ultra-Low Sulfur Gasoline Standards* American Petroleum Institute

[15] Orbital Australia (June 2013) *Review of Sulfur Limits in Petrol* Department of Sustainability, Environment, Water Population and Communities (DSEWPAC)

The Orbital report (page 41) stated that the only evidence provided to the study was:

> *"Toyota Australia did provide some summary data and <u>opinion</u> that their in-house testing indicated that with 50ppm sulfur (compared to 10ppm) there was a 10-20 percent increase in 100,000km emissions. When extrapolated to 160,000km NOx emissions did not exceed the Euro 5 level, but were not sufficiently under to satisfy legislative requirements due to vehicle variability"*

AIP strongly considers that the veracity of these results needs to be tested before the "conclusions" can be accepted. No detail was provided on the methodology or sensitivities and most importantly, there was no indication that the study had been conducted on Australian market fuels. Moreover, AIP and member companies would welcome the opportunity to assess the study and the methods to check its validity because to our knowledge the study has not been released or peer reviewed.

AIP strongly considers that no credible evidence has been presented to support the claim that Euro 6 certified vehicles cannot operate effectively and will not meet Euro 6 emission requirements using current Australian market fuel.

The key conclusions of the Orbital report were stated on page 22 and were only qualified on the basis of the reversibility of sulfur effects of the catalysts and OBD limits. Given subsequent evidence on reversibility and that Australian market fuels for PULP are significantly below the FQSA standard, neither of these qualifications should present any great difficulty to achieving the emission requirements under Euro 5/6. The key is that motor vehicle manufacturers should specify PULP as the required fuel in new Euro 6 certified vehicles.

The key conclusions of the Orbital report (page 22) were:

> *"50ppm sulfur fuel would offer a sufficient reduction in the risks of sulfur-related issues identified for new Euro5/6 vehicles meeting the new Euro 5 and Euro 6 emission standards requirements. The 50ppm sulfur levels is not without challenges, but, in combination with some relaxation of OBD requirements at the Euro 6 stage, may be an acceptable compromise."*
>
> *"Some compromise to real world air quality is anticipated **if in-field reversibility is not demonstrated** while <u>general operability is expected to be unimpaired</u>."* [Emphasis added]

The Orbital report also made some comment on the US EPA Draft Regulatory Impact Analysis: Tier 3 Motor Emission and Fuel Standards (US Tier 3). Orbital noted that a comprehensive review of the report was not possible within the timeframe of the review but stated the justification for proposing 10ppm sulfur petrol in the US was based on:

(1) Significantly lower tailpipe emissions targets than presently regulated, with these being significantly lower than those proposed under Euro 5/6
(2) A long term forecast model of air quality set once the majority of fleet has rolled over to meet the new tailpipe requirements.

SGS catalyst durability study 2013[16]

SGS was commissioned by the American Petroleum Institute (API) to determine if the exhaust emissions effects caused by exposure to 80ppm sulfur petrol were reversible after the vehicle was refuelled with 10ppm. The rationale for the study is that there is a lack of test data on the sensitivity and reversibility of very low emitting vehicles to sulfur in petrol, especially for vehicles aged to full useful life.

[16] SGS Environmental Testing Corporation (June 2013) *Reversibility of Gasoline Sulfur Effects on Exhaust Emission from Late Model Vehicles* American Petroleum Institute

The rationale in the SGS study (page3):

> *"Previous research has shown that sulfur sensitivity and sulfur reversibility are influenced by a number of vehicle operating characteristics (e.g. air/fuel ratio control, catalyst temperatures) and emission control system design configuration and catalyst formulation. In contrast, the emissions of late model vehicles to low sulfur levels is not well understood for very low sulfur levels, and especially for vehicles aged to full useful life."*

The study tested six late model vehicles which were subjected to a three segment reversibility sequence. Four baseline tests were run on 10ppm, three high sulfur exposure tests were run on 80ppm and three tests were run after the vehicle was switched back to 10ppm. The test fuel was a California certification containing 10 percent ethanol. The 80ppm fuel was produced by dosing the test fuel with a representative mix of sulfur compounds. The test vehicles were a 2009 Chevrolet Malibu, 2012 Honda Civic, 2012 Hyundai Sonata, 2012 Audi A3, 2012 Ford Focus and 2012 Toyota Camry. The tests were conducted with aged catalytic converters to the equivalent of 120,000 to 150,000 miles.

The key finding on reversibility in the SGS study (page 2):

> *"For each vehicle tested on 10ppm sulfur fuel, NMOG (non-methane organic gases), NOx, CO, Soot and PN (particulate number) were found to be reversible on 80ppm fuel. There was greater than 95 percent confidence that the differences in mean emissions values measured before and after the high sulfur fuel exposure were not statistically different."*

AIP considers that the SGS study is indicative of the results on reversibility that could be expected in Australia given that the vehicles chosen are representative of the popular models sold in Australia. It is also instructive that these results were conducted on aged equipment and demonstrated that reversibility could be achieved towards the end of the useful life. The SGS study also addresses the caveats in Orbital study on the use of 50ppm around sulfur reversibility and the ability to meet high mileage emission requirements.

US Tier 3 2014[17]

According to the US EPA, "The Tier 3 program is part of a comprehensive approach to reducing the impacts of motor vehicles on air quality and public health. The program considers the vehicle and its fuel as an integrated system, setting new vehicle emissions standards and lowering the sulfur content of gasoline beginning in 2017. The vehicle standards will reduce both tailpipe and evaporative emissions from passenger cars, light-duty trucks, medium-duty passenger vehicles, and some heavy-duty vehicles. The gasoline sulfur standard will enable more stringent vehicle emissions standards and will make emissions control systems more effective."

"Emission reductions from the Tier 3 program will lead to immediate air quality improvements that are critically important for States to attain and maintain the existing health based National Ambient Air Quality Standard (NAAQS). In the absence of additional controls such as the Tier 3 standards, many areas will continue to have air pollution levels that exceed the NAAQS in the future". It is very clear from these statement that the objective of the US tier 3 program is to address urban air quality issues in the US and there is no mention of operability in the objective statements.

AIP has not had an opportunity to undertake a detailed review of the comparability of Euro 6 standards and the US Tier 3 requirements but would note that the vehicle emission standards of each jurisdiction are not strictly comparable because of differences in approval processes and test procedures.

[17] US EPA (March 2014) *Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards Final Rule – Regulatory Impact Analysis* EPA-420-R-14-005

In approval processes, Euro emission standards only apply when the vehicle is produced and the manufacturer has no liability for its performance and continued compliance and emission performance. In the US, surveillance testing, mandatory emissions system warranties and recall campaigns are utilised to ensure that there is ongoing compliance.

In testing procedures, there are significant differences between test methods including drive cycles, distance, speed and cold start performance. However, according to the International Council on Clean Transportation (ICCT), Euro 6 standards are equivalent to the US Tier 2 emission limits[18] and therefore the Tier 3 standards which represent a further tightening of vehicle emission from Tier 2 exceed Euro 6 requirements.

AIP notes that there were significant submissions that disputed the validity of the US EPA analysis and findings.

(2.7) CHANGING FUEL QUALITY STANDARDS IN AUSTRALIA: AN ASSESSMENT OF DISCUSSION PAPER POLICY OPTIONS

The Discussion Paper discusses five policy options or alternatives for changing Australian fuel standards. Each existing fuel standard is made up of a list of parameters, which set the upper and/or lower limit on the substances allowed in that type of fuel. The alternatives identified outline a range of proposed changes to those limits. As noted in the Discussion Paper, *"this list is not exhaustive and you may suggest other possibilities for the Government to consider"*.

This section provides AIP's assessment on the five policy options identified in the Discussion Paper, noting that an alternative and preferred option is recommended by AIP for the Government to consider. The section also provides some important market context for the assessment of any proposed policy changes.

Discussion Paper Policy Options - Changing Fuel Standards

There are two elements at the core of these proposed policy alternatives: changes to substance limits and other parameters for each fuel type (alternatives B, C, D and E), and a phase-out of regular unleaded petrol (ULP) in alternatives B and D. The five policy alternatives are summarised as:

OPTION A: ***Australia's fuel standards remain in effect in their current form (business as usual).***
Petrol standards retained: unleaded petrol (91 RON) with a maximum sulfur limit of 150 ppm; premium unleaded petrol (95 RON) with a maximum sulfur limit of 50 ppm. Diesel standard continues to specify a maximum sulfur limit of 10 ppm and derived cetane number of 51 for diesel containing biodiesel only.

OPTION B: ***Revisions to the fuel standards to align with the recommendations of the Hart Report and to harmonise with European standards***. The key changes proposed under alternative B are:

- In petrol, phasing out unleaded petrol (91 RON) over a specified period of time (e.g. two to five years). Sulfur in premium unleaded petrol (95 RON) would be limited to 10 ppm and a new octane standard for premium unleaded petrol (98 RON) introduced, aromatics limited to 35 percent and in the ethanol used to blend E10, sulfur is limited to 10 ppm and inorganic chloride to 1 ppm.
- In diesel, the derived cetane number of 51 applies also to diesel not containing biodiesel, and polycyclic aromatic hydrocarbons are limited to 8 percent.
- In ethanol E85, sulfur is limited to 10 ppm.

[18] Blumberg K, Posada F (April 2015) *Comparison of US and EU programs to control light-duty vehicle emissions* International Council on Clean Transportation

- A new fuel standard for B20 diesel biodiesel blend is proposed, which would streamline administration and costs for fuel suppliers and for the Department. B20 fuel is primarily used by mining and transport operators.
- Changes proposed to the biodiesel standard are minimal.

Option C: ***Revisions to the fuel standards to align with the recommendations of the Hart report and to harmonise with European standards as per alternative B, except that unleaded petrol (91 RON) is retained but with a lower sulfur limit of 10 ppm.***

Option D: ***Revisions to the fuel standards as per alternative B above, except with stricter parameters (including for cetane levels in diesel) to harmonise with standards recommended by the Worldwide Fuel Charter*** (that specifies the fuel quality required by automobile companies to meet particular emission standards). This alternative includes all the changes to fuel standards detailed under alternative B, with some stricter limits and additional changes for improved engine performance:

- in petrol, olefins are limited to 10 percent, the induction period (which is a measure of the age and eventual degradation of fuel in storage) is increased to 480 minutes and a trace metals limit of 1 ppm is introduced
- in diesel, the derived cetane number and cetane index are set at 55 and polycyclic aromatic hydrocarbons are limited to 2 percent.

OPTION E: ***Staged introduction of world standards from 2020, with a review in 2022 to determine next steps. This alternative proposes a phased-in approach to reduce sulfur in petrol commencing in 2020.*** With the review in 2022, this option is designed to give industry significant lead time to reduce sulfur content in petrol. This alternative also includes revisions to other parameters detailed under alternative B above. Key changes under Option E are:

- Commencing in 2020, sulfur in unleaded petrol (91 RON) is limited to 50 ppm, sulfur in premium unleaded petrol (95 RON) is limited to 25 ppm, and introduction of a new octane standard for premium unleaded petrol (98 RON) with a 10 ppm limit on sulfur.
- These changes will be reviewed in 2022 to determine next steps.
- For premium unleaded petrol (98 RON), the introduction of this alternative is similar to the Worldwide Fuel Charter standards.

Key Market Context for Assessment of Policy Options

In considering all available policy options (including business as usual), it is important to understand the broader market and policy environment, and the impacts of policy change on industry and consumers in particular. The key elements of the market context are discussed below.

Australian oil refineries:

- Australian refineries are an important economic activity in their own right and underpin the competitive advantage of major exporting industries and Australia’s way of life.
- Australian oil refineries are high technology continuous production operations supported by a highly skilled work force.
- Studies have indicated that a large refinery contributes around $1 billion of GDP depending on its size and the refining industry employs around 2,000 highly skilled personnel which can significantly expand (double) during regular major maintenance periods (“turnarounds”).
- Australian refineries currently supply 65 percent of Australia’s petrol demand and this is expected to increase as a result of de-bottlenecking programs and other capacity-building programs.
- The Australian refining industry has gone through an unprecedented period of structural adjustment with the closure of three refineries in the last five years.
- Refinery capacity increases and de-bottlenecking have been very selective and subject to rigorous investment approvals.

- The refinery industry is investing significant capital to ensure ongoing competitiveness and reliability of operations to secure a sustainable future.
- Australian refining is a key source of liquid fuel supply for the Australian economy, supports some localised crude production and adds diversity to the supply mix. Any further reduction of its capacity needs to be carefully considered for impacts on Australian liquid fuel supply security and the impact on downstream industries that rely on refinery petroleum feedstock, such as the petrochemical industry.
- AIP also notes that the proposed introduction of 10ppm in local jurisdictions such as New Zealand comes at a small cost to the local refining industry. This approach is not analogous with the Australian circumstance.

Likely outcomes 10ppm sulfur petrol introduction:
- If the downstream industry is forced to fund the investment to produce 10 ppm petrol it would:
  - Lead to no improvement in operability of the vehicle and minimal improvement of emission performance of the Australian fleet both now and in the future.
  - Fundamentally threaten the financial viability of the Australian refining industry, potentially leading to further refinery closures - adversely affecting supply diversity in the Australian market and hence Australian liquid fuel supply security.
  - Increase the emissions at Australian refineries because of more intensive processing of the fuel to achieve the standard.
  - Impose a price premium on motorists for fuels their vehicles cannot optimally utilise.
- Given the fundamental and negative impacts on the refining industry and motorists, AIP and member companies strongly urge a thorough Regulation Impact Statement process and assessment to determine whether there is a net benefit to the Australian community in introducing 10ppm.

Australian fuel market implications:
- A key quality parameter in petrol is sulfur which has a standard of a maximum of 150 parts per million (ppm) for unleaded petrol (91 RON) ULP and a maximum of 50 ppm for premium unleaded petrol (95 & 98RON) PULP.
- Australian market fuel quality has substantially lower sulfur levels than the maximum standard with 2014-15 average levels in Sydney for ULP of 28 ppm and PULP of 16 ppm, and Melbourne for ULP of 60ppm and PULP of 28ppm.
  - These current market fuel qualities substantially reduce the already small environmental benefits of changing the standard.
  - Since 2001, PULP has grown from 10 percent of the market to 30 percent thereby lowering the sulfur level in the petrol pool and this trend is expected to continue as more vehicles require PULP.
- Total Australian petrol demand is 18 billion litres and has been static to declining over the last 15 years because while the motor vehicle fleet has been increasing the average vehicle kilometres travelled (vkt) have been falling and fuel economy has substantially improved.
- While sulfur is an important fuel parameter there are a range of the other parameters which can potentially affect vehicle environmental performance including octane, oxygenates (e.g. MTBE - methyl tertiary butyl ether which is a ground water contaminant), aromatics and olefins, which would need to be assessed in any review of the fuel standards.

Lead time for changes to Fuel Standards:
- The assessment of the impact of implementing 10ppm sulfur on Australia refineries is a highly technical and complex exercise.
- The time period for Australian refineries to service the requirements of a RIS are substantial and could <u>cost at least $15 million and take 2 years</u> to complete given the threat to viability of the refineries of any proposed changes to fuel standards.
  - Two AIP member companies cannot call on the expertise of international affiliates and will be required to outsource this expertise at considerable expense

- The timeframe for implementation of any changes in fuel standards once a decision has been finalised will be at least a <u>further 5 years</u> because of the significant construction and reconfiguration of the refineries that is required.
    - The work requires considerable planning given it must be undertaken while maintaining a reliable supply of fuel to the Australian market. AIP also notes that the implementation period could be greater given the need to align any work to modify the equipment with each individual refinery's 'turnarounds'. The refineries operate on a continuous 365 day/year basis and only cease production infrequently on a planned schedule (often as long as 5 years) to undertake scheduled shutdown maintenance ('turnarounds') on major sections of the plant.

AIP Assessment of Policy Options

AIP views on the five options identified in the Discussion paper are outlined below, together with a policy alternative (Option F) recommended by AIP and its member companies.

OPTION A:

AIP considers that Option A is the most desirable as it will yield the highest positive community benefit.

While AIP acknowledges that a cost benefit analysis will be undertaken as part of a Regulation Impact Statement (RIS) it would appear that the available evidence suggests that the introduction of 10ppm sulfur petrol will generate the following outcomes.

- There are large capital costs ($979m) and increases in ongoing operating costs (1.1-1.7cpl).
- Motorists will face a price premium of up to 2 cpl.
- Increases in greenhouse gas emissions at the refinery of up to 5 percent.
- There are limited health benefits
- Mandatory vehicle standards can be introduced without changes to fuel standards.
- Refinery viability is threatened potentially putting at risk $1 billion per refinery per annum in economic contributions.
- In the event of refinery closures there will be knock on impacts that will affect specific local communities such as Geelong and to other industries with key links to the refining industry.
- A substantial reduction in Australia's liquid fuel supply security.
- Increased non-compliance with respect to IEA 90 day treaty commitments.

The 2015 FQSA review found there were $100m in health benefits from moving the current standards to 10ppm sulfur petrol. However, this does not take into account the market quality of fuel currently supplied in Australia and if you assume the sulfur response curve for pollutants is linear, then the lower sulfur levels in market fuel would imply avoided health costs **below $30 million**. AIP will work closely with the RIS consultant to ensure that accurate data is supplied and health costs are accurately modelled.

The only apparent barrier to retaining current fuel standards appears to be the introduction of Euro 6C and the impacts and the triggering of On Board Diagnostics (OBD). It is claimed by the vehicle industry that this requires the whole of the gasoline pool to be converted to 10ppm sulfur petrol. These claims need to be fully tested because it will only apply to new vehicles when Euro 6C is introduced and there may be ways of capturing the benefits of Euro6 without introducing the OBD requirements.

AIP also does not support the introduction of a 98 RON standard and the proposal for a MON level of 88 is an error in the discussion paper as the MON level in 98 is 85.

OPTION B:

AIP does not support Option B as it may lead to refinery closures and force existing vehicles to use Premium Unleaded Petrol (PULP) although their vehicles cannot derive the full benefit of the fuel. AIP further observes that as cars requiring 95 RON enter the market place in increasing numbers, the demand for ULP will naturally fall and phase out over time similar to the phase out of Leaded Fuel in the late 1990s.

In terms of the other proposed changes, <u>AIP does not support changes to</u>:

- the derived cetane number because of the lack of operability issues and the impact on refinery competitiveness (see Chapter 6)
- the PAH specification because of the loss of refinery flexibility and the observation that the refineries produce well below the specification on average (see Chapter 6)
- the aromatics specification because of the minimal environmental benefits, the potential introduction of other environmental issues (such as groundwater contamination and increase in volatile organic

compounds) and the link between 35 percent aromatics limit and the 22 percent ether specification in the European specification (see Chapter 6)

However, AIP does support:

- In E10, the limitation of inorganic chlorides to 1ppm and the limit of sulfur to 10ppm
- A change to the current spec of 51 DCN for biodiesel blends up to 5 percent, and a realignment of this back to the diesel spec of 46 minimum (see Chapter 6).
- The creation of biodiesel blend standard for B20, which will obviate the need for further s.13 waivers and allow the retention of the cetane number of 46 (see Chapter 6).

The introduction of 10ppm in 3 years' time cannot be achieved by the industry and will in most likelihood lead to the closure of the Australian refining industry. If the standards are implemented and 2020 is intended timeframe, then the cost will be the closure of the Australian refining industry estimated at around $4 billion per annum.

OPTION C:

AIP does not support Option C for the same reasons as Option B.

OPTION D:

AIP does not support Option D for the same reasons as Option B.

AIP also notes that the fuel specifications in the World Wide Fuels Charter are well in excess of European standards and it will be very difficult to source fuel in the Asian region to those standards.

OPTION E:

AIP does not support Option E because the interim steps do not ameliorate the cost requirement for the refinery to undertake necessary construction.

OPTION F:

AIP has developed an alternative policy option (Option F) which proposes introduction of 10ppm from 1 July 2027. Option F involves changing only the sulfur parameter in petrol. If the Government is convinced it must change fuel standards to achieve the other benefits, then this proposal is designed to ensure it minimises the impact to all stakeholders (see section 2.3).

Option F also proposes an **interim step** that could be of interest to Government to capture some minor environmental benefits before 2027 and involves:

- 80ppm pool average and 120ppm maximum in ULP from 2021 (reported not regulated)
- 40ppm pool average and a 50ppm maximum in PULP from 2021 (reported not regulated)
- No changes to any other parameter.

It is critical to understand that a pool average cannot be regulated under the current FQSA structure and the compliance would need to be assured by regular reporting.

Rationale for the interim solution

The fact that the quality of market fuels is substantially below current standards would seem to suggest that there may be scope for a reduction in standards to lock in the actual current average market quality of fuel. Option E which proposes an interim solution is not desirable as refineries would be required to undertake capital works similar to Option F. Moreover, the proposed levels of sulfur do not satisfy the motor vehicle manufacturers' assertion that 10ppm sulfur petrol is required for all new vehicles.

Consequently, AIP member companies undertook a detailed examination of the possible sulfur levels that could be achieved under an interim solution that would be delivered with minimal cost but ensure that there was consistency across Australia. By definition, this approach limits the proposal to the sulfur levels of the highest sulfur producing refinery in Australia.

In this examination, and also confirmed by the aggregate data presented early in this chapter, there are relatively few production batches that are at very high sulfur levels in the grade but the flexibility this gives the refineries is absolutely critical to their commercial viability. Therefore, the maximum allowable levels for this AIP proposal were only able to be reduced to 120ppm for ULP and not at all for PULP.

There are also issues with how any compliance regime would work under a pool average arrangement. Given that the majority of supply in Australia is sourced from co-mingled terminals, it is impossible to trace the individual molecules to the original owner. The quality of fuel is managed from the original certification documentation when the fuel is manufactured or imported, however, the Fuel Quality Standards Act requires the fuel to be compliant throughout the supply chain to the retail bowser. Therefore, it is impossible to demonstrate compliance under a pool average arrangement for the sulfur parameter.

To overcome this issue, it is proposed that the fuel standard is not altered and compliance is achieved by an annual reporting requirement utilising the certification documentation. Alternatively, if the Government wished to introduce a strict compliance regime, it would need to change the structure of the Fuel Quality Standards Act.

(3) CHANGING AUSTRALIAN FUEL STANDARDS: IMPACTS ON REFINERY COSTS, OPERATION AND VIABILITY

KEY MESSAGES

- The industry analysis and case presented in this Chapter is for the impacts and costs on refineries of implementing 10ppm sulfur petrol and utilises some key simplifying assumptions, in particular, that sulfur is the only parameter considered.
- The costings are based on the AIP proposal to introduce 10ppm sulfur petrol from 1 July 2027 with an interim step as discussed in Chapter 2.
- In the time available for this submission, each AIP member undertook significant investigation and modelling of the solution with optimal construction times, i.e. the construction is synchronised with scheduled maintenance events (“turnarounds”) that occur every 4-6 years.
- It is critical that any changes to fuel standards are coordinated with the scheduled maintenance periods or otherwise substantial costs could be incurred that have not been estimated in this current work.
- The estimates do not include changes to other petrol parameters such as aromatics, Methyl Tertiary Butyl Ether (MTBE) and other oxygenates, octane or olefins but does take account of the changing requirements of the octane pool, i.e. the ongoing switch to Premium Unleaded Petrol (PULP) from Unleaded Petrol (ULP)
- It is absolutely critical that all parameters of the standard are defined before a final construction costs number is calculated for a Regulation Impact Statement (RIS) assessment.
- The AIP estimates are in 2017 dollars and no provision has been made for pre Front End Engineering and Design (FEED) work that must be completed or loss of business and opportunity costs of resources diverted during the construction period (5 years).
- The costs were benchmarked against similar construction projects at other refineries using standard engineering estimation techniques and the cost variances utilised are standard internal practices for each AIP member.
- The resultant costs will be different for each AIP member and depend on the strategy employed to reach the standard, however, each refinery will be required to construct a de-sulfurisation unit, address the loss of octane from the desulfurisation process either through construction or blending or both, and augment infrastructure and utility facilities.
- AIP’s assessment of the likely total capital cost to the Australian refining industry would be $979m which is similar to the advice provided by AIP in its submission to the Ministerial Forum on 8 April 2016.
- Using standard company approaches to construction cost variances the total capital expenditure is likely to range from $703m - $1,408m; however, the qualitative feedback is that it is unlikely to be at the lower end of the estimates.
- There is a considerable range of likely construction costs between the individual refineries that reflects the different refinery configurations and the strategies employed to meet the reduction in sulfur (but the average is just below $250 million).
- Increased operating costs include direct costs (labour, catalyst, materials) and margin costs due to downgrading (octane destruction) of product streams in the process.
- The expected increase in operating costs is $128m - $192m which equates to a cost of 1.1.-1.7 cents per litre.
- This result confirms the previous advice provided by AIP on 8 April 2016 that increased operating costs will likely exceed any price premium for improved quality as discussed further in Chapter 4
- AIP estimates that the increase in refinery emissions will be between 160,000 and 320,000 tonnes pa.
- By way of example, at a $20 per tonne assumed carbon price, this would equate to an additional impost on refineries of between $3.6m and $7.2m per annum.

(3.2) INTRODUCTION

This Chapter outlines AIP's detailed analysis and impact assessment based on input from the Australian refineries of the costs and business impacts of introducing 10ppm sulfur petrol from 1 July 2027, including:

- key costings assumptions
- project overview and assessment
- cost estimates
- refinery viability.

The results presented in this chapter confirm in more detail the previous AIP advice on expected refinery impacts of this policy move.

(3.3) KEY COSTING ASSUMPTIONS

The estimation of refinery costs was undertaken by each refinery, and aggregated by AIP, on the basis of five key simplifying assumptions. These assumptions used by each refinery were determined by AIP based on its own industry and market knowledge in order to facilitate consistency and aggregation across the Australian refining industry.

AIP notes that these assumptions can limit the application of the results but given the wide range of results that have been produced, it is likely to cover many possible contingencies.

1. ***The costings have been based on the AIP proposal to introduce 10ppm sulfur petrol from 1 July 2027.***

The AIP proposal detailed in a letter to Ministers Frydenberg and Fletcher on 17 February 2017 provided for the implementation of 10ppm sulfur in all grades subject to successful negotiation of key caveats that include demonstration of environmental benefits from the existing vehicle fleet (that is, it may not be necessary or desirable to introduce 10ppm sulfur regular unleaded fuel) and no changes to the other parameters in the petrol standard such as olefins and aromatics.

2. ***A fundamental assumption is that the assessment was conducted with only the sulfur parameter changing to 10ppm from 1 July 2027.***

The implications of this assumption are that the costs of changing other parameters have not been assessed. For example, proposed limits of 35 percent for aromatics will be a major constraint on Australian refineries that will require investment and operating cost increases to replace octane caused by the lower standard.

The prohibition of MTBE in Australia means that there would be significant constraints in meeting that standard and there are significant environmental trade-offs (e.g. groundwater contamination, volatile organic compound (VOC) emissions) which are discussed in Chapter 6 of this submission.

In short, AIP and member companies do not support the reductions in the aromatics specification to 35 percent in lieu of having other viable oxygenates as there are no identified operability issues and no evidence of human health or environmental concerns.

If any of the other parameters were to change it would require an increase in the cost estimates.

3. The capital works are synchronised with scheduled maintenance cycles ("turnarounds")

This is an important simplifying assumption because it optimises the capital investment program. If the refinery is forced to implement these changes ahead of the scheduled maintenance period, it wastes expenditure from the previous maintenance cycle and if it is forced to extend maintenance beyond turnaround period, it introduces significant risk that equipment may fail. Therefore, the assumption allows all the additional costs and risks associated with out of sequence turnarounds to not be included in the analysis. In this sense, the estimate is a minimum cost estimate undertaken under optimal timing. If this proved not to be the case then costs would be significantly higher.

The AIP proposal to introduce 10ppm sulfur petrol from 1 July 2027 would mean two turnaround cycles for each refinery but it is likely that some capital expenditure would occur in the first capital cycle to ensure that the main body of work in the second capital cycle is completed efficiently. At this time, AIP member companies have not sought to model this capital expenditure profile.

4. The cost estimates have been developed in 2017 dollars.

No attempt was made to estimate the construction market in 2027 and thereby forecast costs in the actual construction period. These costs estimates have been developed for the direct capital expenditure to produce 10ppm sulfur petrol in all grades from 1 July 2027 based on current conditions. Also the costs for the pre-FEED (Front End Engineering and Design) and loss of business during the construction period were not included. Moreover, the opportunity of resources utilised in the design and construction has also not been estimated where particularly labour is diverted from higher value added tasks. These factors represent real costs to the refining industry and should be acknowledged qualitatively.

5. AIP members utilised internal company engineering estimate variances.

While these variances are broadly comparable in terms of percentages, there are differences in approach by each of the AIP members to establishing the range of costs. This leads to some companies developing a wider range in cost estimates. When these ranges are aggregated across the companies it produces quite a wide range of overall industry cost estimates ($703 million - $1408 million). However, qualitative feedback suggests that the lower costs are not likely to be realised in practice and experience from the Cleaner Fuels Program in the period 2002 - 2006 saw costs go considerably over budget (eg. in some instances 30 percent over budget).

(3.4) PROJECT OVERVIEW AND ASSESSMENT

The broad options that a refinery has to produce 10ppm are:

- Low sulfur feedstock (crude oil)
- Desulfurisation of fluidised catalytic cracker (FCC) feed
- Desulfurisation of fluidised catalytic cracker (FCC) output
- Petrol blending with low sulfur, high octane blend-stock

Low sulfur feedstock/crude oil is insufficient by itself to produce 10ppm sulfur petrol. Further processing of the feedstock is required to achieve 10ppm. Each refinery will have a different pathway to achieving 10ppm sulfur petrol depending on the current configuration, physical site characteristics and market dynamics. For example, the metallurgy of a refinery determines whether it can process high sulfur (sour) crude oils. Typically, the current Australian oil refineries mainly utilise low sulfur (sweet) crude oils.

Based on advice received by AIP, the only possible economically viable option to meet 10ppm sulfur petrol from 1 July 2027 is to construct a petrol hydro-desulfurisation unit for FCC output along with utilising crude selection and blending strategies.

While significant modelling and other investigative work was undertaken to produce these estimates, it has to be stressed that the current estimate is still preliminary and no analysis has been completed on the refinery viability as a more detailed engineering and financial assessment needs to be completed for that to occur. Moreover, there are important governance processes, either by Board consideration or internal corporate approvals that require the complete assessment. A more complete assessment would give more accurate numbers including an assessment of the impact on refinery viability.

The proper assessment of the introduction of 10ppm sulfur petrol for the purposes of a Regulatory Impact Statement (RIS) for fuel standards is a complex and expensive exercise for the Australian refineries.

Given that the implementation of 10ppm sulfur petrol will threaten the viability of the Australian refining industry, each refinery must not only assess the technical solutions but also determine whether there are any solutions that will retain economic viability. The results of the economic viability assessments are critical to the RIS because in the event of refinery closure it will add an additional element of costs to a RIS cost benefit assessment.

- The time period for Australian refineries to properly service the requirements of a RIS are substantial and could cost at least $15 million and take 2 years to complete given the resources required for this exercise which will likely need to be outsourced at least in part. Furthermore, because any proposed changes to fuel standards represent a threat to the ongoing viability of the refineries, there will need to be a rigorous cost-benefit study to determine whether the required investment to deliver the identified technical solutions can be economically justified.

- The timeframe for implementation of any changes in fuel standards once a decision has been finalised will be at least a further 5 years because of the significant construction and reconfiguration of the refineries that is required. This work requires considerable planning given it must be undertaken while maintaining a reliable supply of fuel to the Australian market. The implementation period also needs to align any work to modify and install refinery plant and equipment with each individual refinery's 'turnaround' cycle. The refineries operate on a continuous 365 day/year basis and only cease production infrequently on a planned schedule (often as long as 5 years) to undertake scheduled shutdown maintenance ('turnarounds') on major sections of the plant.

It is essential that the scope and objectives of the petrol standards review be clearly defined before undertaking any RIS and it is recognised that all the parameters of the standard will need to be considered. All proposed changes will have an impact on refinery operation, so each will need to be modelled for feasibility and costs.

The initial work required to develop a response to proposed changes is expected to take 2 years to complete and will need to involve the following:

- Consideration of refinery planning aspects to consider the physical and economic impacts, which will use complex mathematical models which will be run on multiple scenarios to identify and optimise the refinery's technical and financial performance
- Alignment of supply aspects to ensure that any proposals are feasible from a distribution perspective, including management of refinery turnaround periods
- Technical assessment of the available options for meeting the proposed fuel specification changes to identify preferred solutions

- Assessment of the refinery financial viability and ability to accommodate the required investment. If closure is a likely outcome, then this needs to ensure that all closure and reconfiguration costs have been appropriately reflected in the analysis.

This will also require a detailed market assessment of the demand outcomes including the likely volume and price movements in different grades of petrol.

The principal outputs from the initial study work will be:

- Identified technical solutions recognising that implementation of 10ppm sulfur petrol will likely also require augmentation of the refinery octane production capability to offset the negative impacts from desulfurisation, and to meet the higher octane demand resulting from implementation of tighter vehicle emissions and fuel efficiency standards
- Quantification of negative impacts on ongoing refinery margin and overall profitability
- Impacts on refinery operating units including utilities supplying electricity, fuel, hydrogen, steam and water to process units
- Capital cost requirements for the refineries from desulfurisation of gasoline streams and augmentation of octane production units (eg. alkylation, isomerisation or platforming units)
- Additional operating costs of the refinery
- Increased energy usage and infrastructure
- Increase in greenhouse gas emissions
- Challenges to construction including land availability, state and local approvals, ongoing environmental licence requirements
- Calculation of refinery shutdown requirements and construction program feasibility
- Consideration of workforce consultation and industrial relations changes
- Viability assessment and the community cost of closure including remediation and loss of economic activity.

Given the scope, size and cost of the likely projects required to be implemented, there will be a significant internal approvals process necessary once the project economics have been established. This is expected to take several months at least to ensure all appropriate Board and/or Shareholder approvals are received.

From the point at which a formal decision has been taken to make the investments in the refinery necessary to meet the required fuel specification changes, it is expected that a further minimum 5 years will be required to fully implement all changes.

Industry benchmarking has suggested that projects of this size ($200m+) require a minimum 3 year implementation timetable, and that is before factors such as the specific complexities of integrating the required works with an operating facility and the need to align works with scheduled turnarounds are taken into account.

The project execution stage is expected to involve the following activities:

- Establishment of the required project engineering resources to manage the complex activities required from a major investment activity.
- Detailed design work on the preferred technical solutions. This will involve drawing in the required technical expertise from outside the organisation to undertake the detailed design on process units and other refinery utilities in conjunction with technical providers offering suitable technologies. This will require a coordinated and integrated approach across multiple refining assets and processes given the high degree of interconnectivity between refining units and systems.
- Tendering of multiple design packages across mechanical, civil, piping, electrical and instrumentation disciplines and integrating the outputs into a coordinated and aligned schedule for implementation.

- Detailed discussions with regulatory authorities to determine the scope and nature of required statutory approvals, and the development of the documentation to enable applications for, and receipt of, all necessary approvals. This will require interface with Local Council, WorkSafe, EPAs, and local fire fighting authorities at a minimum, and may also include other State and Federal authorities including environmental, ports, roads and other infrastructure bodies. Past experience has shown that for complex projects, the approvals phase can take up to 2 years alone.
- Community and other stakeholder engagement to communicate the proposed works, identify any impacts and gain local business and resident support for the project.
- Coordination of works with necessary turnaround activities where this is required to integrate changes to plant and equipment which necessitate refinery units to be shut down for works to be completed. Refinery process units are generally operated on a 4-6 year turnaround cycle, so this will a critical aspect of the overall project coordination. Given the projects will likely need to be undertaken across multiple process units, this will require coordination across multiple turnaround events, further adding to the project complexity. Shutting down units outside of defined maintenance cycles has a major cost and margin impact on the refinery which can run into costs of up to tens of millions of dollars. If the implementation of necessary projects to meet tighter fuel specifications is done outside of the turnaround cycle, then the additional costs need to be factored into the overall assessment of ongoing refinery viability. In the case of Geelong Refinery, the operations support a third party manufacturing business on site (LyondellBasell) so additional shutdowns could severely impact the viability of that business. The same situation applies to the Altona refinery and the Qenos facility although those facilities are not co-located. Please see Chapter 5.
- Coordination of construction works with other site operations to minimise the impact where these can be undertaken whilst maintaining unit operations.
- Alignment and coordination of product supply aspects (e.g. sourcing inputs and managing storage) to manage any periods where refinery production is reduced whilst construction activities are underway. This is essential to ensure a reliable ongoing supply of fuels to the market place.
- Pre-commissioning and commissioning activities which alone can extend to many months for complex projects. This includes detailed product testing requirements to ensure that process units are performing to expected design standards.
- Implementation and bedding in of necessary operational changes to manage new or modified processing units.

These activities will be somewhat different for each refinery depending on the individual configurations and capital investments necessary to meet the required changes. Also importantly, it involves a huge transfer of resources away from efforts targeted at both ongoing efficient operations and other business improvement programmes which are essential to ensure the long-term viability of the refinery operations, so will also involve costs to the business on these fronts.

(3.5) COST ESTIMATES: IMPLEMENTING 10PPM SULFUR IN 2027

While the timing constraints for this submission did not permit a more complete assessment of capital and operating costs as detailed above, there was an assessment undertaken by each refinery, aggregated by AIP, whilst adhering to strict operational procedures in relation to in-confidence material.

- Creation by AIP of a set of common assumptions around oil price, product prices and key differentials, such as sweet/sour crude oil differential, based on AIP’s industry and market knowledge
- Bilateral testing of inconsistency by AIP to ensure that any differences between company estimates were able to be explained.
- Given the commercial-in-confidence nature of the data, confidential aggregation of the figures by AIP
- Great care was taken to not reveal any commercial-in-confidence data and to comply with competition law requirements.

The individual AIP member company approaches to estimating the capital costs included:

- Modelling of production streams to determine the required size of the units
- Utilisation of linear modelling to determine the feasibility of the proposed solutions
- Discussions with the technology vendor to determine price estimate
- US Gulf Coast construction benchmarks with a 30 percent escalation for Australia
- Contingency of up to 50 percent (note experience shows that the contingency is utilised in every project)
- AUD/USD exchange rate of 0.75.

Each AIP member company produced an estimate of the likely capital costs and the industry aggregated cost is $979 million. This estimate is consistent with the $1 billion estimate that was provided in the AIP Submission to the Ministerial Forum on Vehicle Emissions on 8 April 2016. This figure was derived from the 2005 study by McLennan, Magasanik and Associates by indexing their 2005 estimates by the construction cost index.

The range of the capital cost estimates are $703m - $1,408 million although as detailed in Assumption 2, it is considered that:

- each AIP member company used their own internal approaches to engineering variances that mean some of the range estimates are wider than others
- experience shows that the actual costs are unlikely to be at the bottom end of the range, e.g. in the introduction of the Cleaner Fuels Program between 2002 and 2006 there were significant cost overruns from those estimated for those changes to fuel standards.

There is quite a marked difference between capital cost estimates for different AIP member companies that can be explained by:

- strategies employed to meet the new specification and the extent of the reliance on crude selection and blending strategies
- current and expected feedstocks
- market and expected demand patterns for the refinery production
- different configurations of the existing refinery equipment
- the capacity of the new units
- the requirements for augmentation of utilities: hydrogen, water, steam etc
- the currently available area within the plant and the requirement for earthworks for the new units.

While the average capital expenditure for the Australian refinery sector to meet the 10ppm requirement is just below $250m per refinery, there are refineries that have capital costs above the average and other refineries that are commensurately lower. Clearly, the refineries that are required to spend a greater amount of capital face a greater threat to refinery viability.

Operating costs were also estimated and as with capital expenditure there was a fairly large range of results mainly caused by margin loss. Operating costs were estimated for direct costs (which include the costs of operating the new units) and includes labour, consumables (catalysts), energy, hydrogen and water. These costs ranged from $9-14 million per annum for each refinery with a volume weighted average costs of $11 million per annum. As could be expected, these costs are fairly similar across the industry and would be expected to vary with the capacity of the unit.

The other operating cost effects are margin loss which was an average of $22 million per annum and relates to the downgrading of product because of the impact of the desulfurisation process on reducing octane levels. There is significantly greater variance across the industry largely because the strategies utilised to meet the 10ppm sulfur standard differ. At its simplest, the higher operating cost companies are using blending and crude selection strategies to a greater extent than the lower operating cost competitors hence the significantly higher impact on margin costs for some companies.

The aggregated increase in operating costs range from 1.1 cpl - 1.7 cpl. This level of increase confirms the statements in the AIP submission of 8 April 2016 that any price premium from improving the quality of fuel would not be sufficient to break even.

(3.6) REFINERY VIABILITY

There has been no attempt by AIP member companies to assess refinery viability as there is not sufficient detail in these assessments to enable this to occur, as detailed in the previous discussion around the pre-FEED process.

However, some broad observations can be made about the significance of this analysis to refinery viability that includes:

- it has been confirmed that refineries will require a significant investment that will largely be spent on local employment, services, and contractors
- the investment is just to stay in business and will not improve profitability
- if government accepted the timeframes and expenditure levels in the foregoing analysis, and assuming that a decision is made in 2017, then the pre-FEED process and construction time would mean that it is not possible to meet the next turnarounds scheduled for 2020-2022
- a typical turnaround costs between \$100m-\$200m, so if refineries were forced to comply with 10ppm sulfur petrol at the next turnaround scheduled for 2020-2022, then individual refineries would be required to source \$300m-\$500m in cash to fund these projects in a relatively short time frame and potentially not have adequate time to fully resource and assess a project of this scale
- a comprehensive forward assessment on the outlook for refinery margins is required, coupled with a need to secure Board/Shareholder approval for the necessary investment.

(3.7) REFINERY GREENHOUSE EMISSIONS

Refineries are emission intensive trade exposed (EITE) operations. This has been repeatedly recognized through multiple Government processes over a decade or more. Furthermore, the inherent nature of the refining industry is that refineries can be subject to large variations in emissions levels over the business cycle and this variation must be recognised as business as usual.

Unfortunately, while there has been much debate about the relative emission benefits from vehicles from a move to 10ppm sulfur fuel, little consideration has been given to the greenhouse gas emission implications at the refineries.

Refinery investments to meet tighter mandatory fuel quality standards, or to meet tighter mandatory refinery air quality emissions standards, involves installation of new equipment and further processing of refinery inputs. This investment, while increasing onsite refinery emissions, would not result in the production of additional quantities of fuel outputs. AIP estimates that the requirement to install new equipment to meet the 10ppm specification could increase individual refinery emissions by somewhere between 5 and 10 percent above existing baselines, depending on the technology required at the refinery to meet a 10ppm sulfur specification.

This increase in refinery emissions needs to be included in the Regulatory Impact Statement. AIP estimates that the increase in emissions will be between 160,000 and 320,000 tonnes per annum. At a \$20 per tonne carbon price, this would equate to an additional impost on refineries of between \$3.6m and \$7.2m per annum.

Refineries also have little to no alternatives to offset these large resultant increased emissions through other abatement opportunities:

- oil refineries are highly energy intensive with 90 percent of costs being crude oil and energy costs and therefore already have a strong incentive to be efficient – most, if not all, low cost abatement and energy efficiency opportunities have already been undertaken
- the capital stock for Australian refiners is fixed and emission reductions are associated with large scale investment programs that are unlikely to minimise energy use
- with challenged financial performance, there is limited opportunity for large investments programs to reduce emissions
- Australian oil refiners may have relatively small scale projects, such as butane capture and utilisation, and improvements in boiler efficiency which could be developed on a project basis and bid into the Emission Reduction Fund (ERF):
  - for these smaller projects, there would need to be lower transaction costs for bidding of these projects to justify the preparation of bids and potential co-funding
  - refiners have, to date, been unable to secure low cost abatement opportunities through the ERF.

This paradigm has clear implications for refinery baselines under the Government's Safeguard Mechanism. Under the current rules, there is no provision or process for dealing with such circumstances where Government imposes a regulation for purposes other than in terms of either the significant new investment provisions or the best practice baselines. These provisions would not provide for offsetting the increased emissions associated with installing desulfurisation units as:

- the scale of investment, and associated emissions, while significant, would not trigger the significant expansion provisions
- if new equipment is added to the refinery, it will be extremely difficult to determine best practice or state of the art capability as this assessment is very dependent on the unique design of each refinery (as evidenced by the extremely complex assessments required under current EU climate change policies relating to refineries)

In short, there are no other provisions to allow for adjusted baselines as a consequence of implementing a new Government policy.

AIP repeatedly raised the issue of the potential impact of government policy (either Federal or State) on emission baselines during the consultations on the ERF and the Safeguard Mechanism. Indeed, AIP specifically identified the implications of a change in fuel standards and sought to have included explicit statements in the Safeguard Rules to deal with such situations. This was proposed from a pragmatic point of view and would not have weakened the mechanism, nor the Government's Commitment to meeting its climate change objectives. Unfortunately, such provisions were not included in the final rules.

The Australian oil refining sector is under significant commercial pressure and any further costs pose a significant risk to its ongoing economic viability. Consequently, the Safeguards Mechanism should not now, or in the future, expose Australian refiners to additional costs nor expose them to costs not faced by competitor refiners in other countries.

AIP is strongly of the view that mandatory requirements of government, such as the proposal for 10ppm sulfur, should constitute unequivocal grounds for a full adjustment to the emissions baseline of each refinery. Similarly, other policies that utilise EITE provisions such as the Renewable Energy Target, would require adjustments to baselines and methodologies.

(4)CHANGING AUSTRALIAN FUEL STANDARDS: IMPACT ON THE FUELS MARKET & CONSUMERS

KEY MESSAGES

- According to the ACCC, Australian prices are set by Import Parity Price (IPP) and are therefore a result of the supply and demand in the Asian region.
- Australia specification fuel (known as Oz spec) attracts a quality premium because the Australian regulated specification is different to other regional standards, largely because of the prohibition of MTBE which has implications for octane levels.
- AIP commissioned Facts Global Energy (FGE) to undertake a price premium assessment of Australian specification 10ppm sulfur petrol, in particular to gain some insight on the drivers of the supply and demand in the Asian region.
- Currently the 10ppm market is oversupplied which explains why Australian companies are able to source low sulfur material to meet Australian PULP demand. FGE assesses this situation will continue until 2025 which underpins the continuation of low sulfur imports into the Australian market.
- At an assumed AUD/USD exchange rate of 75 cents, the estimated price premium is **0.6 cents cpl in 2017 growing to 1.75 cents cpl in 2027.**
- AIP and member companies consider that with a continuing ban on MTBE, the price premium for Oz spec is likely to be higher than that assessed by FGE. In this sense, these FGE estimates could be considered as being conservative.

(4.2) INTRODUCTION

This Chapter outlines the findings from an independent assessment by Facts Global Energy (FGE) of the price premium forecast to be incurred for Australian specification 10ppm sulfur gasoline in Asia, for the purposes of the cost benefit analysis in the Government's Regulation Impact Statement.

This independent FGE assessment has examined the current Australian gasoline market (including demand by grade), import forecasts into Australia under different scenarios, current supply of Australian spec fuel (150ppm ULP, 50ppm PULP and 10ppm) in the Asian region, and supply forecasts for Australian spec 10ppm gasoline in the period 2020-2027 incorporating firm upgrades of regional refineries.

From this analysis, a price premium for Australian specification 10ppm sulfur gasoline under the different scenarios is developed by FGE.

(4.3) BACKGROUND: AUSTRALIAN FUEL PRICES

Crude oil and petroleum products (e.g. petrol, diesel) are bought and sold in their own markets.

As they are different products – with their own unique physical characteristics, uses, and demand and supply factors – they are priced and traded separately. Different crude oils will also be priced differently for the same reasons.

The market for different crude oils and petroleum products is also regionally based.

Prices in regional markets reflect the supply and demand balance in each market as well as the relative quality of each commodity. There are also linkages and transactions between regional markets to balance global demand and supply.

Pricing of crude oil and petroleum products in regional markets is highly transparent, through the use and extensive publication of 'markers' or price benchmarks. 'Markers' are commonly traded crude oils or petroleum products of a similar quality.

Crude oil and petroleum products are sold through a variety of 'term contract' arrangements and in 'spot' transactions.

Generally, these transactions are based on a formula approach where a marker is used as the base, and then a quality differential is added for petroleum products (premium/discount for fuel quality standards) and a market premium/discount is added for the crude being purchased. The marker or price benchmark used in contracts for specific crude oils or petroleum product sales may change over time and between transactions, depending on market conditions and individual negotiations between the buyer and seller.

Australia's regional market for petroleum products is the Asia-Pacific market, and the trading centre for this market is located in Singapore. The Singapore prices for fuel are the key pricing benchmarks for Australia.

Australian refiners price their fuel to be competitive with fuel imports from Asia - called 'import parity pricing'.

- Import Parity Pricing (IPP) is the 'landed cost' of refined fuel to Australia and includes: the international price for refined fuel (e.g. MOPS95 Petrol), the 'quality premium' for specific Australian fuel standards, freight, exchange rate, wharfage, insurance and loss.
- If Australia's fuel prices were below Singapore prices, Australian suppliers would have no commercial incentive to import to Australia (because fuel sales would be at a loss here); rather, Australian refiners would have an incentive to export production and receive a higher world price.
- Australia specification fuel (known as Oz spec) attracts a quality premium because the Australian regulated specification is different to other regional standards, largely because of the prohibition of MTBE which has implications for octane levels.

According to the ACCC, Australian fuel prices are closely linked to Singapore prices through Import Parity Pricing (IPP):

- *IPP plays a central role in determining fuel price outcomes for petrol and diesel in Australia.*
- *IPP forms the basis for the wholesale prices charged by major fuel suppliers and consequently, changes in the IPP flow through to changes in Australian wholesale and retail prices.*
- *The ACCC considers that the use of IPP-based pricing in Australia is appropriate with imports continuing to be the marginal source of supply of refined fuel.*

(4.4) PRICE PREMIUM FOR AUSTRALIAN PETROL

Each petrol grade (octane ratings 91, 95, 98) has a separate but interrelated market in the Asian region, with pricing a function of supply and demand in the market.

AIP commissioned Facts Global Energy (FGE) to undertake a price premium assessment of Australian specification 10ppm sulfur petrol, in particular to gain some insight on the drivers of the supply and demand in the Asian region.

The report is commercial-in-confidence to protect the intellectual property of FGE but the following section draws heavily from that work and required the express permission of FGE to reference the work.

The FGE assessment used Australian specification fuel (Oz spec) and assumed that 10ppm sulfur would be introduced to Australia in 2022 to assess the impact on price. Refineries in the region are specifically producing Oz spec for the Australian market and prohibition of MTBE means that the octane must be sourced from another component such as relatively higher priced alkylate or isomerate.

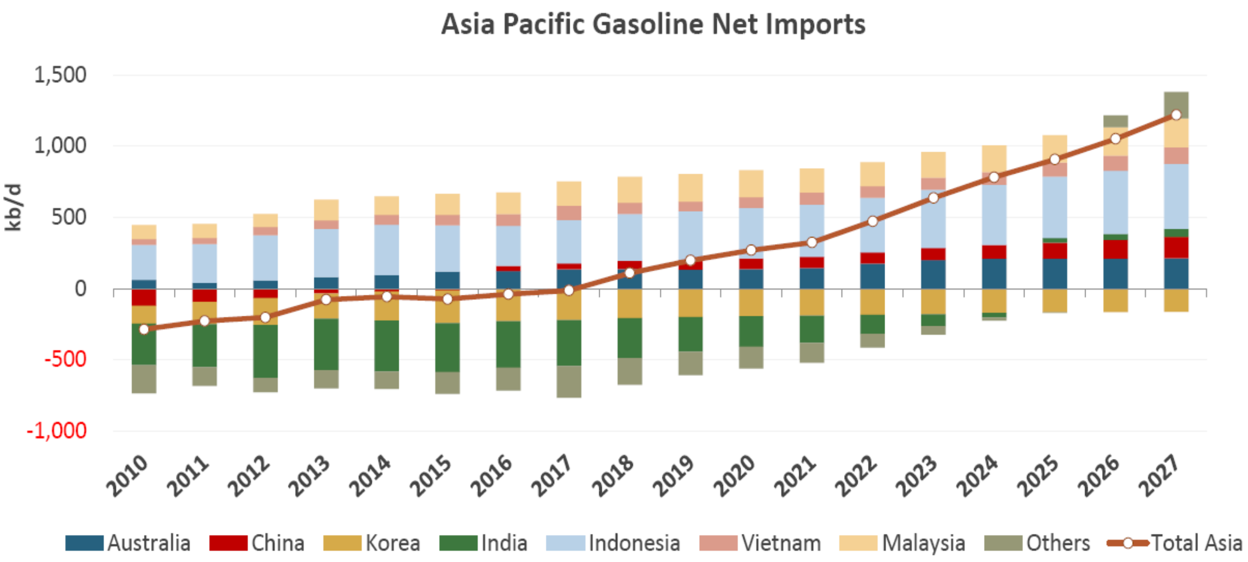
In order to assess the sensitivity of price to different levels of Australian demand, 4 cases were considered.
1. No refinery closures
2. Two refinery closures in 2022
3. One closure in 2022. One closure in 2025
4. Two refinery closures in 2025.

Refinery closures increase the call of Australian demand on regional supplies of 10ppm and thereby affect price.

In order to build the model, FGE had to consider the likely demand and supply scenarios in the region.

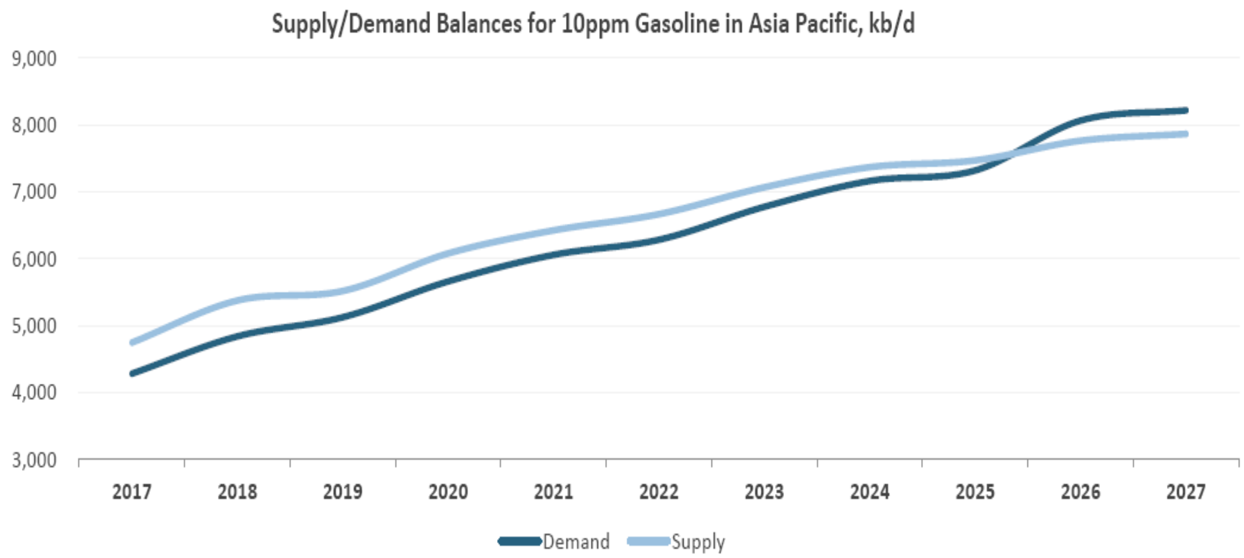
- The main suppliers in the Asian region are Singapore, India, China, Taiwan, Japan and South Korea all of which have a domestic 10ppm standard or have the refinery capability to produce 10ppm standard petrol.
- The major net demand centres are Indonesia, Australia, Malaysia and the Philippines.

There are number of market developments that will not only affect the overall supply balance but will affect the balance between grades. Firstly, because of strong growth and limited refinery additions the region will go to a supply deficit from 2017 and this deficit will continue to grow until 2027. It should be noted that diesel is over supplied in the Asian market making the overall supply balance of petroleum products over supplied.



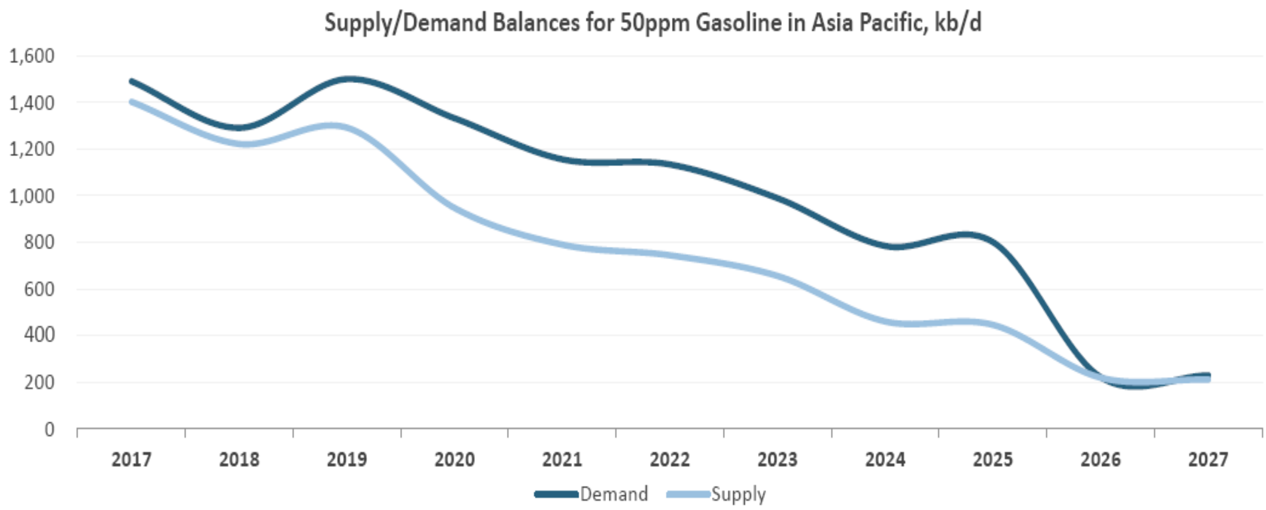
Source: Facts Global Energy, March 2017

The demand countries will implement a 10ppm standard at different times e.g. Malaysia 2026, Thailand 2023, Philippines 2026, which will increase the demand for 10ppm and reduce the demand for 50ppm as it is phased out. Currently the 10ppm market is oversupplied which explains why Australian companies are able to source low sulfur material to meet Australian PULP demand. FGE assesses this situation will continue until 2025 which underpins the continuation of low sulfur imports into the Australian market.



Source: Facts Global Energy 2017

In comparison the 50ppm market is undersupplied but as mentioned it will come into balance as that quality of product is phased out in the region.



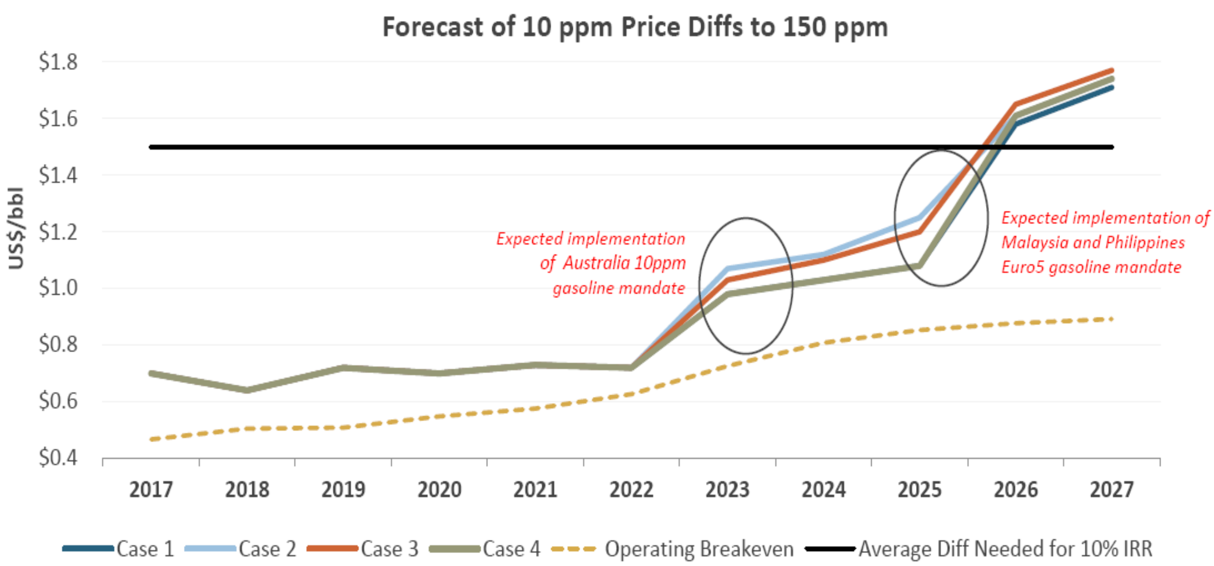
Source: Facts Global Energy 2017

Using these supply and demand balances, FGE then estimated the price premium using the above scenarios. FGE also calculated the price premium that would be required to generate a 10 percent internal rate of the return.

Driven by growing supply deficit, there is an increasing price premium for 10ppm out to 2027. At an assumed AUD/USD exchange rate of 75 cents, the estimated price premium is **0.6 cents cpl in 2017 growing to 1.75 cents cpl in 2027.**

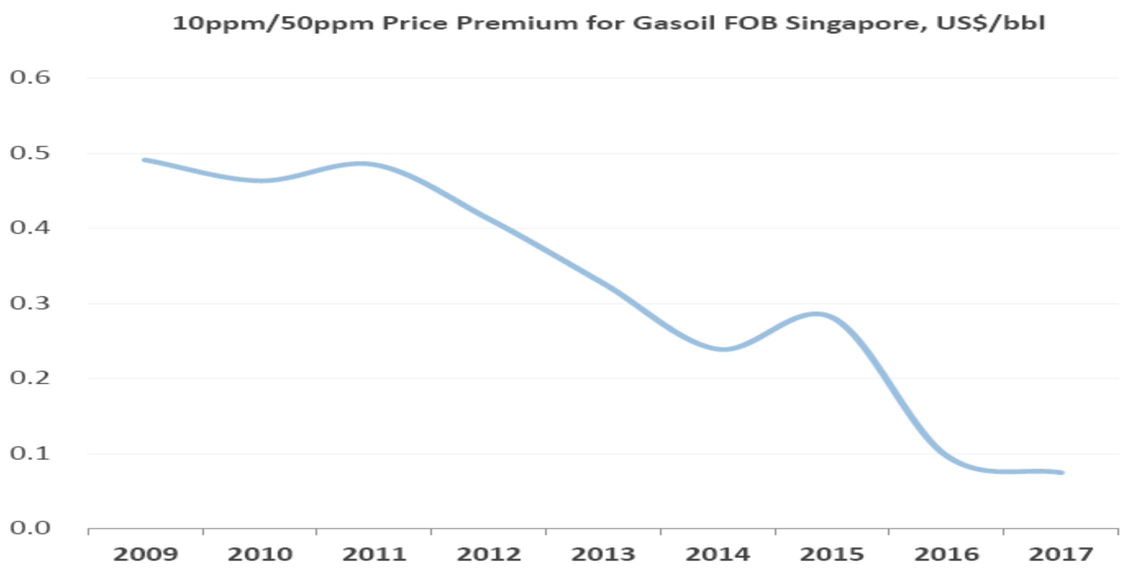
It is noteworthy that the closure of Australian refineries has a relatively small impact on the price premium which is to be expected given the relatively small Australian demand in the Asian region.

It is also important to note that a price premium will not generate an adequate return until 2026 in the FGE modelling.



Source: Facts Global Energy 2017

This result is different to the experience of price premiums when other fuel standards have been introduced. That experience has been the price premium spikes when the standard is first introduced and then is competed away over time. This pattern was seen in the 10ppm diesel market as per the following chart.



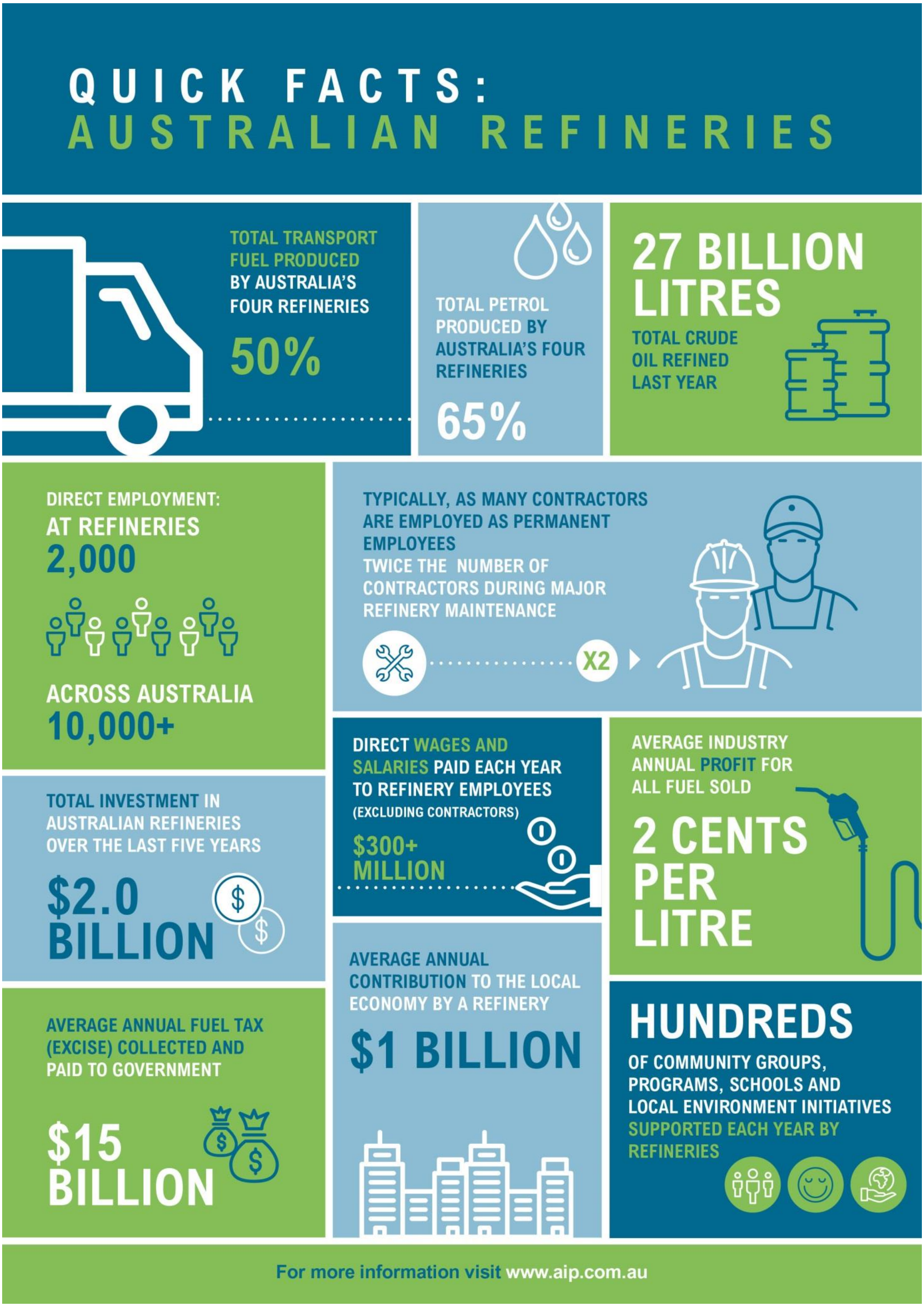
Source: Facts Global Energy 2017

While AIP and member companies consider this work to have been conducted at a high level and indicative of the regional market predictions, we also consider that the work did not take enough account of Oz spec premium and role of MTBE and other oxygenates in affecting the costs required to comply with proposed changes to the Australian Fuel Quality Standards. AIP and member companies consider that with a continuing ban on MTBE, the price premium for Oz spec is likely to be higher than that assessed by FGE. In this sense, these FGE estimates could be considered as being conservative.

(5)AUSTRALIAN REFINERIES: ECONOMIC AND COMMUNITY IMPACTS

KEY MESSAGES

- Australian refineries have been very long standing participants in the local market as the major transport fuel suppliers, with all current refineries being operational for over 60 years.
- The Australian refineries refine about 27 billion litres of crude oil a year (including 7 billion litres of local crude and condensate) into the high value products needed by industry and consumers.
- In 2016, the refineries produced 26 billion litres of refined products, with petrol and diesel accounting for approximately 80 percent of this production.
- From this refinery production, the four Australian refineries currently supply around 50 percent of Australia's total liquid fuel needs, and around 65 percent of petrol consumed in our market.
- Other Australian industries are positively impacted by refineries which provide key inputs to their own activities. Approximately 65 percent of the total value of Australian liquid fuel consumption is in the transport, mining, construction, agriculture and manufacturing industries.
- Total new capital investment in the refining industry was $2 billion over the last 5 years.
- As a high-tech industry, the refining sector has highly skilled workforces with an even mix between direct employees and contractors whose numbers can double during major turnaround work.
- Australian refining companies directly employ 2,000 highly skilled workers (FTEs) at their refineries, and over 10,000 employees nationally. Their workforce is significantly higher when including contractors.
- The Australian refineries also spend hundreds of millions each year purchasing goods and services in their local area and State, contributing to significant jobs and business opportunities.
- The refineries also make a very significant contribution to government revenue, including collecting and paying around $15 billion in fuel excise to the Federal Government from fuel sales in our market.
- As a result of these direct economic benefits, the refining industry's contribution to GDP/GSP is significant and comparable to other important Australian industries, and the presence of a refinery leads to higher private consumption (economic welfare) and business investment.
- Independent economic modelling has found that an Australian refinery contributes around $1 billion in economic activity on average to the local economy, including the direct impact of refinery value added and flow-on impacts to other sectors.
- However, such economic modelling does not capture the key positive externalities and indirect benefits generated by the refining industry which are also economically important, including contributing to the reliability and security of fuel supply, sharing inputs with other industries, innovation, technology and knowledge spillovers, and community development and investment activities.
- *Reliability & Security of Supply*: The domestic refining capacity contributes to the overall health of the Australian economy through its contributions to the level of fuel supply reliability and flexibility. This is important for efficient production and mobility of labour and other products. Supply security is enhanced in Australia through the availability of both domestically refined and imported fuels from a wide diversity of supply sources.
- *Input Sharing*: The refining industry benefits other sectors through increasing demand for certain inputs shared with other industries (e.g. engineering services, chemicals, electronic equipment and mechanical components); this assists these sectors achieve economies of scale and benefit from lower costs in their supply chains (e.g. petrochemicals, plastics and heavy industry/manufacturing sectors).
- *Innovation & Spillovers*: As a high-tech industry, the refining industry benefits the economy through innovation, technology and knowledge spillovers occurring when these are transferred to other sectors (inc. through the mobile contractor workforce). Major technological investments made by the refining industry include improvements in safety, environmental management, new product development, and production improvements and de-bottlenecking. This stimulates innovation and technological improvements in other sectors, without them having to bear the full costs.
- *Community Development & Investment:* Australian refineries actively participate in numerous community development activities and groups to enhance the education, environment and health outcomes of the local area (including grants, donations, volunteer work, and sponsorship). These can be expected to have wider economic benefits like higher GDP and consumer living standards.


QUICK FACTS:
AUSTRALIAN REFINERIES
TOTAL TRANSPORT FUEL PRODUCED BY AUSTRALIA'S FOUR REFINERIES
50%
TOTAL PETROL PRODUCED BY AUSTRALIA'S FOUR REFINERIES
65%
27 BILLION LITRES
TOTAL CRUDE OIL REFINED LAST YEAR
DIRECT EMPLOYMENT:
AT REFINERIES
2,000
ACROSS AUSTRALIA
10,000+
TYPICALLY, AS MANY CONTRACTORS ARE EMPLOYED AS PERMANENT EMPLOYEES
TWICE THE NUMBER OF CONTRACTORS DURING MAJOR REFINERY MAINTENANCE
X2
TOTAL INVESTMENT IN AUSTRALIAN REFINERIES OVER THE LAST FIVE YEARS
$2.0 BILLION
DIRECT WAGES AND SALARIES PAID EACH YEAR TO REFINERY EMPLOYEES
(EXCLUDING CONTRACTORS)
$300+ MILLION
AVERAGE INDUSTRY ANNUAL PROFIT FOR ALL FUEL SOLD
2 CENTS PER LITRE
AVERAGE ANNUAL FUEL TAX (EXCISE) COLLECTED AND PAID TO GOVERNMENT
$15 BILLION
AVERAGE ANNUAL CONTRIBUTION TO THE LOCAL ECONOMY BY A REFINERY
$1 BILLION
HUNDREDS
OF COMMUNITY GROUPS, PROGRAMS, SCHOOLS AND LOCAL ENVIRONMENT INITIATIVES SUPPORTED EACH YEAR BY REFINERIES
For more information visit www.aip.com.au

(5.2) INTRODUCTION

Australian refineries have been very long standing participants in the domestic market as the major transport fuel suppliers to the market, with all current refineries being operational for over 60 years.

The Australian refineries make a very significant positive contribution to the Australian economy, employment and communities, providing direct and indirect economic benefits from their own activities and underpinning the competitiveness of key Australian export industries.

This chapter outlines these direct and indirect contributions for the refining sector as a whole, including:
- Direct Economic Contribution
- Indirect Economic Benefits
- Local Community Development and Investment

The Appendix also provides a factsheet on these economic and community contributions at an individual refinery level.

(5.3) DIRECT ECONOMIC CONTRIBUTION OF THE REFINING INDUSTRY

Each refinery provides significant economic benefits to the local and State economy where it is located, and also contributes to fuel supply security for Australia as a whole through supply diversity and flexibility.

The economic impact of each refinery includes:
- the economic benefit of value adding (ie refining petroleum products)
- the impact on industries that source inputs from the refinery or that provide products/services to it
- financial impacts (new capital investment and profits)
- taxes that the refinery pays to the Commonwealth and State Governments and local council rates
- the economic benefit of employment - demand for qualified personnel and providing apprenticeships and other forms of on the job training.

These direct economic impacts are summarized below and discussed in detail below.

AUSTRALIAN REFINERIES: KEY DIRECT ECONOMIC BENEFITS	**2015**	**2016**
Refinery Production (Value Add)		
Total Petroleum Products (million litres)	24,194	25,722
Total Petrol products (million lites)	10,818	11,653
New Capital Investment		
Refinery Investment ($ million)	$308	$389
▪ Total for the Last 5 Years ($million)	n/a	$2,050
Direct Employment		
Refinery Employees (FTE)	2,048	1,966
Australia – Total Employment (FTE)	10,669	10,282
Direct Wages & Salaries		
Refinery Employees ($million)	$323	$303

Refinery Value Adding

Petroleum refineries process crude oil, condensate and intermediate feedstocks to produce liquid fuels for distribution. The fuel mix produced at a refinery depends on the configuration of the refinery (the equipment) and the chemical composition of crude oils and other inputs that are used.

The production process itself involves choosing the right mix of crude oils, and then distilling them to separate the different components. Once separated, each component then goes through different treatments, before the intermediate outputs are blended. The process corrects the quality, quantity and timing of different products so that the outputs are produced close to the proportions required by market demand, and are fit for industry and household use. Sulfur and benzene are also largely removed from petrol and sulfur from diesel to meet Australia's current cleaner fuels standards.

Like any other industry, production at refineries is the result of a complex optimisation exercise given the prevailing market demand conditions. Refineries use sophisticated decision making tools to devise the best product mix. They take into account constraints stemming from the availability of different types of crude oil, storage capacity, refining technology, global prices for crude oil and finished petroleum products, government regulations and historical investments.

The Australian refineries currently refine about 27 billion litres of crude oil a year (including 7 billion litres of local crude and condensate) into the high value products needed by industry and consumers.

In 2016, the refineries produced around 26 billion litres of refined products, with petrol and diesel accounting for approximately 80 percent of this production.

From this refinery production, the four Australian refineries currently supply around 50 percent of Australia's total liquid fuel needs, and around 65 percent of petrol consumed in our market.

See **Chapter 1** for more detail on the refining sector and the trends in the production and consumption of liquid fuels in Australia. This includes petroleum demand at a jurisdictional level where refineries are located.

Intrinsic Industry Linkages

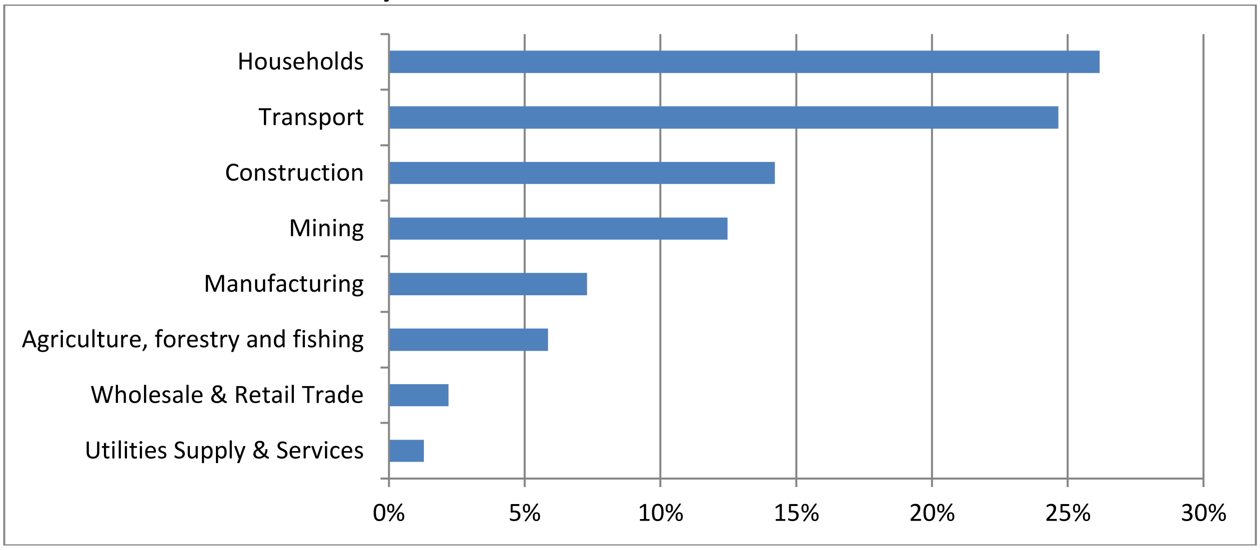
Many industries use petroleum products, and for some industries they make up a large share of intermediate input costs. This means that the petroleum refining industry's products have intrinsic links with the rest of the Australian economy.

The Chart below shows the use of petroleum products in industries where refinery products are particularly important inputs. Use in each industry is reported as a share of total use of petroleum products in Australia. Based on the latest available ABS data, industries account for 74 percent of domestic petroleum product use and households account for 26 percent – making them the largest fuel user group in Australia.

The five major industrial users of petroleum products include the transport, construction, mining, manufacturing and agriculture industries, which make up 64 percent of petroleum product use in Australia. Transport is the largest industry user of petroleum products, making up around 25 percent of total Australian use.

Some outputs from these industries are, in turn, important inputs for other Australian industries. Therefore, any shocks (such as the closure of a refinery) to the petroleum refining sector will flow though all sectors of the economy via links with the agriculture, manufacturing, mining and transport industries.

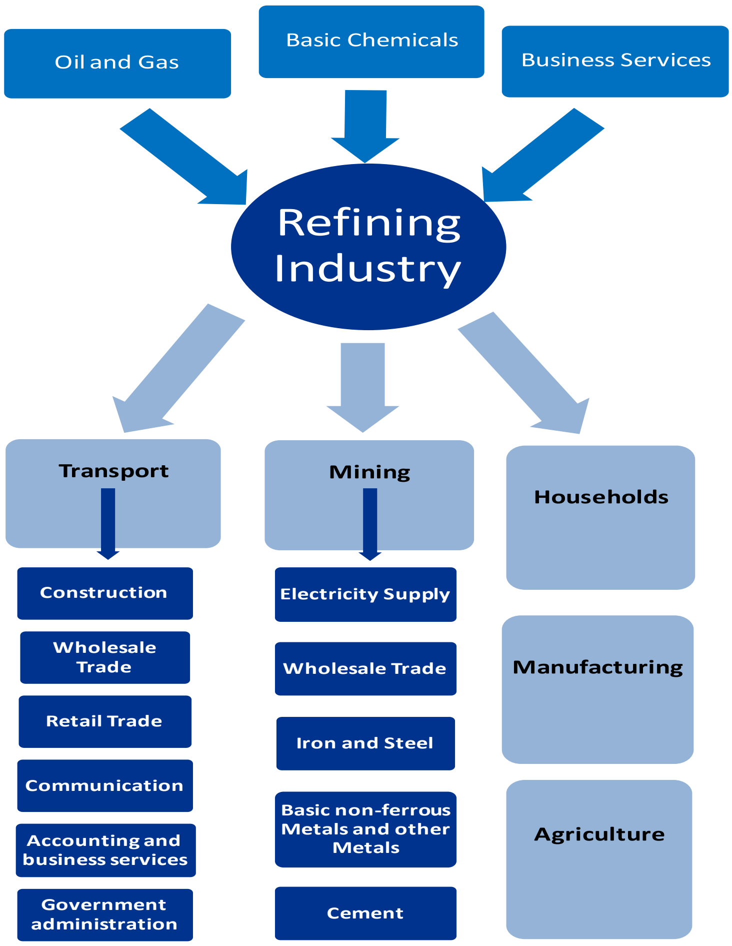
Use of Refinery Products as a Share of Total Australian Use: 2013-14



Source: ABS, Australian National Accounts: Input-Output Tables Cat No 5209.0.55.001 (latest edition).
NOTE: Manufacturing use excludes that used by the petroleum industry itself.

The Figure below presents a simplified picture of the relationship between the refining industry and the rest of the Australian economy. It shows that the refining industry is an important input for other industries which themselves play an important role in the economy. Case Study 1 provides a key example.

The Refining Industry and the Australian Economy



CASE STUDY 1

Intrinsic Industry Links to the Refining Industry – The Chemicals Manufacturing Industry

Businesses in the chemicals industry produce a wide range of products from basic chemicals such as acids and ethylene to synthetic resins, polyethylene, polypropylene and synthetic rubber. These are mainly inputs to other chemical manufacturing processes while products such as polyethylene and polypropylene are used to produce products that flow to end markets including packaging, building and construction, electrical and electronics and transportation.

The industry is characterized by larger industry players located in Victoria and New South Wales plus a number of smaller players focused on niche markets. Victoria hosts the largest share of chemical businesses and historically offered the most favourable location for feedstock and customers.

There are several businesses whose operations are linked to the Altona and Geelong refineries. They include chemical and petrochemical plants that rely on refineries for supply of ethane and refinery grade propylene (RGP) and businesses that provide professional, technical and operations support to the refinery. However, there are two particular chemicals companies which would be particularly impacted by absence of a refining presence in Victoria – namely, LyondellBasell and Qenos which rely on local refinery feedstock.

LyondellBasell

LyondellBasell is one of the world's largest polymers, petrochemical and fuel companies in the world and is the sole manufacturer of polypropylene in Australia. LyondellBasell obtains RGP (polypropylene feedstocks) from both the Geelong and Altona refineries for its plant at Geelong.

From these refinery feedstocks it:

- extracts propane, which it returns to the refineries for marketing as Liquefied Petroleum Gas (LPG)
- produces around 130,000 tonnes of polypropylene per year which is sold to manufacturers in Australia, New Zealand, South East Asia, North Asia, Indochina and India.

It is unlikely to be economic for LyondellBasell to source propylene as feedstock from other refineries in Australia or overseas due to high transport costs. Therefore, it is very likely that, in the absence of refinery presence in Victoria, the LyondellBasell plant at Geelong would not exist. This is consistent with the fact that LyondellBasell closed its plant at Clyde in NSW following the refinery closures there.

Qenos

Qenos Holdings Pty Ltd (Qenos) is the only producer of polyethylene. At its Altona plant, Qenos manufactures olefins, plastics and resins, dominated by high-density polyethylene (HDPE).
In 2013, Qenos completed a significant expansion and modernisation program to expand its Altona facilities. This increased its HDPE capacity by 20 percent.

While Qenos sources most of its ethane directly from Bass Strait, this is augmented with propane and butane from the Altona refinery over the summer months owing to constraints in supply from Bass Strait. In summer, the Altona refinery provides a significant contribution to Qenos' feedstock requirements.

If the Altona refinery were absent, Qenos might be able to obtain feedstock from the Viva Energy refinery at Geelong or from Bass Strait. However, supply from Altona refinery is via pipeline whereas these other sources would likely require investment in truck unloading facilities at Qenos. This would usually involve significantly higher trucking cost versus existing pipeline supply.

In the absence of the Altona refinery, Qenos' business and feedstock operations would become significantly more complex, and additional complexity in feedstock and supply logistics typically involves higher costs.

Financial Benefits - Refinery Capital Investment & Profits

Due to the capital intensive nature of petroleum refining, the industry routinely requires large and ongoing capital investment in plant and equipment to continue safe and reliable operations.

Over the last 5 years, the total new capital investment in Australian refineries was over **$2 billion**. This represents an average annual investment of **$400 million** across the four refineries, which is consistent with the total refinery investment of $389 million in 2016. In simple terms, the average annual investment per refinery is in the range of $50-$150million. Case Study 8 highlights the nature of these investments, as well as R&D initiatives, for one refinery.

In comparison to this significant refinery investment over the past 5 years, the total profit on refinery activities was also **$2 billion**. So, the profits made over this period were reinvested back into these key facilities (i.e. refinery investment was 100 percent of profits).

This reinvestment program is seeking to maintain the competitiveness of Australian refineries through productivity improvements, energy and process efficiency measures and technological innovation. The future investment program will be tested, as it always is, against the potential for greater returns through refinery investments in other countries and through non-refinery investments.

Employment Benefits - Investment in people and jobs

As an advanced technology industry, refineries have highly skilled workforces.

In 2016, workers directly employed by the Australian refineries stood at around **2,000 persons**. This compares with total direct employment for AIP member companies across all their Australian operations was more than **10,000 persons** in 2016.

Actual labour use in the refineries **is substantially larger than this direct employment**, because the refining sector also employs a significant number of contractors on a non-permanent basis and which varies throughout the year, and also year-to-year depending on major maintenance cycles.

During normal periods of operation, refineries employ almost as many contractors as direct permanent employees, implying that refinery employment levels could be as much as twice as large during normal periods of operation. During these periods, the main tasks of contractors include maintenance, engineering, inspection, water treatment and security. However, compared to normal periods of operation, the number of contractors could as much as double during periods when some production units are shut down to allow for major upgrade and maintenance programs (called “turnarounds”, which occur every 4-6 years). Case Study 2 highlights the common trends in contractor employment.

The Australian refineries paid wages and salaries to their direct refinery employees totaling **$303 million** in 2016, similar to the previous year. Total wages and salaries paid are significantly higher when including contractor wages.

Refineries employ skilled labour, such as process control and risk engineers and highly skilled trades people and thus have to compete with many other employers who employ workers with similar skills. As with the rest of the economy, the availability of workers to the refining sector tends to exhibit cyclical patterns. During the lengthy period of Australian economic growth, supply shortages in all types of refinery roles have arisen, and refineries have continued to be challenged in finding sufficient expert workers. To help address skill shortages, the Australian refineries are strong supporters of local apprenticeship, trainee and tertiary internship programs, and they employ a large number of apprentices across a range of trades – see Case Study 3 and Case Study 4.

CASE STUDY 2

Contractor Employment & Major Maintenance Turnarounds – Kwinana Refinery (WA)

BP Kwinana Refinery first started operations in 1955 and was the very first industrial facility to be built in Western Australia – chemical plants and other facilities were developed around the site.

For over 60 years, the refinery has contributed to the WA economy both directly and indirectly, through providing jobs, economic activity, taxes and support for community activities. In steady state operations, the refinery employs approximately 700 people.

In early 2017 the refinery, the largest oil refinery in Australia, will invest approximately $80 million in their largest ever maintenance activity to upgrade the facility. During the six-to-eight week turnaround up to 1,800 additional people will join the refinery team.

This will provide an additional boost to the local economy, with an influx of workers visiting the area daily and benefits for local businesses through the supply chain.

By undertaking turnarounds, BP has the opportunity to inspect, clean and maintain the refinery kit and make targeted investments to continue to operate the refinery safely and at its best.

CASE STUDY 3

Traineeship Programs: Investing in our future workforce, now - Altona Refinery (VIC)

Around 400 people work at the Altona Refinery. Like many businesses in Australia, the Altona Refinery is facing the challenges of an aging workforce.

Since 2007 an *operator traineeship program* has been the key to the refinery's strategy for sustaining a top-class operator workforce into the future.

So far, Mobil has employed 35 full-time, permanent operators for Altona Refinery through this program.

The refinery plans to continue this program into the foreseeable future as part of the company's commitment to ongoing operations.

CASE STUDY 4

Apprenticeships and Internships– Geelong Refinery (VIC)

The Geelong Refinery is a strong supporter of local apprenticeship and tertiary internship programs.

The refinery currently employs 12 apprentices (four mechanical fitting and eight electrical and instrument dual trades). Of these young people, seven were referred by Northern Futures, one of the refinery's community partners whose aim is to create employment opportunities for local Corio and Norlane residents. Two have come to the refinery from Alcoa and one apprentice recently won Gold at the 2016 World Skills championship.

The refinery continues to support CareerTrackers - a national non-profit organisation that creates internship opportunities for Indigenous university students. A 2017 refinery intern, Jack MacCauley, recently won the Project Excellence Award presented at a gala dinner in Sydney.

The refinery supports local social enterprises such as Karingal to run the café and to carry out ground maintenance work around the refinery. Karingal provides employment opportunities for people with a disability.

Contribution to government revenue

AIP member companies recognise that the taxes they pay, and collect and pay, form a significant part of their economic contribution to Australia and to the States where they operate.

The business activities of the refineries, and the broader liquid fuels supply chain, generate a significant amount and variety of taxes in Australia.

The refining companies in Australia:

- pay corporate income taxes, royalties and stamp duties
- collect and pay employee taxes, GST and fuel excise tax
- pay land tax and local council rates, licenses and charges.

Case Study 5 provides a snapshot of the variety and value of these taxes for one refining company across all their business operations including refining.

In 2016, the Australian refining companies collected and paid around **$15 billion** in fuel excise. On average, around **$290 million a week** in fuel excise is collected and paid to the Australian Government by all the refining companies, making them amongst the largest corporate tax collectors in Australia.
The bulk fuel terminals (refinery, import and marketing terminals) of AIP member companies constitute the bonded warehouses at which fuel excise is collected. The fuel excise on petrol and diesel is 40.1 cents per litre, aviation fuel 3.6 cents per litre, LPG 13.1 cents per litre and ethanol 2.6 cents per litre.

Around $5-6 million per annum is paid in *local government rates and charges* for just refinery related activities.

CASE STUDY 5

Tax Profile for 2013 and 2014 – Caltex Australia (all operations)

Taxes Paid	2013 ($)	2014 ($)
Excise	4,846,208,078	5,119,861,548
GST paid	4,427,442,379	4,411,347,563
GST Input tax credits claimed	-3,166,309,756	-3,143,455,865
Income Tax Paid	106,808,670	98,908,770
Customs duty	27,975,026	57,218,651
PAYG Withholding	116,428,846	119,350,165
Payroll Tax	25,468,440	21,593,345
Land Tax	14,832,189	14,384,772
Council Rates	9,886,648	11,232,355
Licences	2,636,438	2,556,490
FBT	2,436,748	1,924,133
Water Rates	2,191,341	2,587,963
Freight Tax	737,644	897,398
Royalty and Interest withholding tax	151,782	352,139
Stamp duty	72,364	5,044,753
Fuel Tax Credits	-7,803,894	-9,285,296
	6,409,162,942	6,714,518,884

Local Business Benefits: a major purchaser of local products and services

Australian refineries are an integral part of their local industrial areas, communities and State economies, and are a major consumer of many locally produced goods and services.

All Australian refineries support local procurement where it is competitive and high quality.

A typical third party spend by a refinery is $100-$200 million per year, to many hundreds of good and services providers and with the vast majority being Australian companies.

CASE STUDY 6

Australian Refineries – Major consumers of locally produced goods and services.

Geelong Refinery (VIC) – Viva Energy Australia
The Geelong refinery's annual third party spend exceeds $160 million and more than 90 percent of this is with Australian companies. Around half of these companies have head offices or branches in the Geelong region.

Kwinana Refinery (WA) – BP Australia
BP Australia purchases goods and services worth around $180 million per annum in Western Australia.

Altona Refinery (VIC) – Mobil Australia
On average, Mobil spends over $100 million each year on goods and services to support Altona Refinery's operation, with the majority of these being sourced from local suppliers.

Lytton Refinery (QLD) – Caltex Australia
Caltex Australia paid over $100 million to 626 suppliers across all their operations in 2014, including refineries.

Research & Development

As refineries are complex manufacturing facilities, each year they directly invest in research and development projects to improve their manufacturing processes, energy use, waste management and environmental outcomes. In a number of instances, the outcomes of many refinery projects are highly successful and are often pioneering. See the Case Study 7 and the Section 3 on Indirect Economic Benefits including innovation for more explanation.

CASE STUDY 7

Investment in Refinery Initiatives & Infrastructure – Geelong Refinery

Geelong Refinery is known to be a complex hydrocarbon processing facility and each year invests in research and development projects to improve its manufacturing process. Outcomes of many projects have been hugely successful and are legitimately pioneering in the industry. For example, Geelong is the first refinery in Australia to use an Electromagnetic Acoustic Transducer (EMAT) that allows the refinery to better scan and detect pipe corrosion. In recent times the refinery has embarked on a number of large scale R&D projects notably:

Extending the operating envelope of crude processing capability within Geelong Refinery.
The refinery has spent $5m developing new knowledge in the design and implementation of refining procedures for new crudes with unusual chemical or physical properties. The goal is to extend the operating envelope of the Geelong refinery to enable the facility to more readily accept the supply of new crudes and residue feeds, each with a particular set of challenging properties, outside the bounds of the existing operating envelope of the plant.

Development of steam control & isolation systems to protect a Residue Catalytic Cracking Unit (RCCU)
A further $2.5 million has been spent to enable the RCCU to be self-sustaining for steam that is used during the process of cracking of long molecular chain hydrocarbons into shorter chain, more valuable products including LPG, gasoline, propylene and fuel oils. Isolating the steam control system enables the RCCU to be unaffected by smaller (and less costly) trips in the refinery process.

Creation of a new bitumen testing analysis process
The refinery has developed an alternative laboratory test method using a Near Infra-Red (NIR) instrument to determine the durability of bitumen. This NIR application is new and has never been used in other refineries. It has reduced bitumen analysis from two weeks to two hours and allows the refinery to test the product at the refinery rather than relying on an external Laboratory. As a result, the refinery can closely monitor the manufacturing process, to yield consistent, high grade locally made bitumen for Victorian roads.

Production Improvements
Geelong Refinery is building:

- A large crude tank (100ML) at a cost of $40-50 million that will increase storage capacity by more than 40 percent.
- A $23 million pumping station between the refinery and the Newport terminal to increase pipeline capacity and move more production to the main distribution centre (keeping trucks off the roads).
- A Bitumen tank and gantry at Geelong at a cost of $30 million.
- The refinery can now concurrently berth two large crude / feedstock vessels.

Overall Economic Contribution (GDP/GSP)

Based on the direct economic impacts and benefits noted above, the Australian refining industry is a significant contributor to the Australian economy providing economic benefits from its own activities and underpinning the competitiveness of key Australian industries, including export sectors.

However, quantifying the total impact that any large facility like a refinery has on the economy is a complex analysis. To quantify the economic contribution of a refinery, a range of economic analysis tools can be utilized, but the most common methods are input-output models and computable general equilibrium (CGE) modelling.

CGE models are used to compare economic performance and consequences for the local economy with or without the presence of a refinery.

These economic models typically seek to capture the full range of refinery contributions including:

- broad impacts across the state and national economies, including price and exchange rate impacts
- the economic benefit of value adding (i.e. refining petroleum products) and employment
- contributions to the economy through their links with other industries
- impacts on households (private consumption) as major consumers of refinery products.

A range of domestic and international modelling and research consistently indicates that the local economy where a refinery is located performs substantially better on all economic measures.

Independent economic modelling by KPMG Econtech found that the Australian refining industry contributes a total of **0.5 percent of GDP or $6.2 billion** in 2007-08 terms (noting there were 7 operational refineries in Australia at the time of this modelling).

This modelling estimates that the presence of the refining industry allows:

- **private consumption** to be 0.6 percent higher than would be the case if there were no refining industry
- **business investment** to be 3.4 percent higher because of the investment that the refining and other sectors are making to maintain their stock of physical assets.

This total refinery contribution to GDP is twice the contribution of the forestry and fishing industries and two-thirds of the contribution of the textiles, clothing and footwear industries. This contribution must also be considered against the background of **total industry turnover (revenue) of $80-90 billion** per year.

This total refinery contribution is the sum of the industry's direct contribution to GDP, 0.2 percent of GDP ($2.4 billion in 2007-08), plus the industry's flow-on contribution including the additional activity that the industry supports in other areas of the economy.

- The latest available ABS data specifically for the 'Petroleum Refining & Petroleum Fuel Manufacturing' sector (ANZSIC CLASS 1701), estimated that the refining industry directly accounted for 0.2 percent of GDP (or $2.2 billion) in 2006-07.
- This estimate, now a decade old, aligns with the direct economic contribution modelled, but does not include the flow on impacts to other industries that is central to economic modelling of total refining industry contribution.

At a single refinery level, the KPMG modelling found that an Australian refinery on average contributes around $1 billion in economic activity to the local economy, including the direct impact of refinery value added plus the flow-on impacts to other industries.

Importantly, economic modelling does not capture the positive benefits and externalities created by the refining industry that are not easily quantifiable, and this is discussed further in Sections 5.4 and 5.5 below.

Foregone benefits and costs of Refinery Closure

As outlined above, the refining industry's economic contribution is modelled by estimating the likely impacts of reducing the size of the industry. That is, by modelling the economic impact of refinery closure (i.e. what happens to the State and National economies if a refinery closes).

As a result, the findings noted above apply directly to what would be the economic benefits forgone if a refinery closed – namely, around $1 billion on average in lost economic activity per annum to the local economy, including losing the direct impact of refinery value added plus the flow on impacts to other industries.

Importantly, there are also a number of costs associated with closing a refinery in Australia, which means that the decision to cease operations does not occur without significant pressure to do so.

The costs to any one refinery of ceasing production and leaving the industry are very high.

The capital-intensive nature of the industry means that a high level of associated investment and sunk costs are involved, and any refinery leaving the industry would forego the value of their existing assets.

Moreover, a refinery exiting the Australian industry would also face significant site remediation costs.

In addition, there are substantial costs with any conversion of a refinery into an import terminal. For example, based on public statements by Caltex Australia Limited, the total cost of converting the Kurnell refinery into an import terminal was approx. $270 million.

There are also opportunity costs of leaving the industry. When one refiner leaves the industry, there may be opportunity for other refiners to gain by expanding their market share. This creates an incentive for each refinery to wait until others exit.

(5.4) INDIRECT ECONOMIC BENEFITS AND POSITIVE EXTERNALITIES

This section highlights a number of benefits that the Australian refining industry adds to the Australian economy. In addition to the output impacts and direct economic benefits identified above, the industry also produces positive externalities and benefits that are often not taken into account.

These indirect benefits include:

- **contributing to the security of fuel supply**
- **sharing inputs with other industries**
- **innovation, technology and knowledge spillovers**
- **community investment and development activities (discussed in Section 4)**

Although they have not been captured in the economic modelling above, these contributions are economically important.

Security of Supply

The domestic refining capacity contributes to the overall health of the Australian economy through its contributions of fuel supply reliability, flexibility and security, combined with the infrastructure and expertise to deliver fuel products to the market.

Stability and reliability in the supply of liquid fuels is important to the Australian economy. The domestic economy is dependent on a reliable supply of petroleum products, and disruptions to the supply chain affect the ability of business and consumers to access goods and services.

Australia is fortunate to have a high level of liquid fuels supply security and reliability, a view supported by comprehensive government and independent reviews over many years.

Key reviews include the National Energy Security Assessments (NESA) and Liquid Fuel Vulnerability Assessments since 2008, Australian Government Energy White Papers in 2004 and 2012, and the 2013 Report of the Parliamentary Inquiry into Australia's Oil Refining Industry.

These Government reports confirm that Australian liquid fuels supply is highly secure, competitively priced and reliable because of:

- a diversity of supply sources for oil and petroleum products, including domestic and imported sources
- **a domestic refining capability providing multiple supply options and the ability to convert domestic and imported crude oil into useable products**
- established and effective integration into the rapidly growing Asian fuels market
- a flexible, resilient and reliable supply chain, including a significant volume of stock on the water owned by Australian companies which can be moved where needed most
- actual and planned import, storage and distribution infrastructure able to meet growth in fuel demand
- a strong record of efficient and reliable supply and supply chain management by industry
- robust risk and emergency management by industry and government.

In particular, the combination of both domestically produced fuels from different Australian refineries, and a variety of imported sources of fuel, diversifies supply options and thereby enhances supply security for liquid fuels in Australia. For example, any crude oil disruption risks are spread between domestic and imported crudes, as well as between crude oils from a variety of different sources.

This supply security and reliability has benefits for Australian industries and households, allowing efficient production and mobility of labour and other products. In particular, since fuels are important inputs for the transport, mining, manufacturing and agriculture sectors, supply reliability is important to these industries.

Australia is well serviced by a reliable and diverse supply chain that delivers a high level of reliability by global standards. The supply chain includes crude oil and petroleum product shipments into and around Australia, refinery throughput, bulk fuel storage tanks, extensive terminal and distribution networks, thousands of retail outlets, and substantial fuel storage facilities of major fuel users.

As a key part of this supply chain, refineries are located in urban and industrial centres across Australia. The geographical dispersion of the refineries means the industry is well placed to supply liquid fuels to all Australians. The product is delivered to domestic end users by pipeline or road. The refineries are often located close to port facilities, thereby minimising freight costs. The transport network established by refineries also means that any disruption to supply can be overcome by sourcing fuel from other refineries or importers. The geographical dispersion of refineries benefits Australia because industry and consumers in all areas of Australia have access to liquid fuels.

Australia's refineries also contribute to the reliability of fuel supplies through their holding of reserves of crude oil, ready for production. The stock levels are chosen to accommodate short term fluctuations in demand and are based on commercial considerations. Refineries have some capacity (and a range of in-refinery technical options) to increase their levels of production in response to a short-term supply disruption. This may allow refineries to respond more quickly to a disruption than relying solely on imports.

There are also strong business pressures on refiners to maintain resilient and efficient supply chains, since this is essential to minimise costs, and to maintain or increase sales through a reputation for reliable supply. As well as a focus on reputation for reliable supply, the established national and international networks of the Australian refining industry enhances the ability of the Australian refining industry to smoothly manage any supply disruptions that might occur.

Overall, the presence of a robust local refining industry provides a valuable complement to regular import supply as part of the reliable, mature and diverse fuel supply networks in Australia, and provides supply flexibility options.

Input Sharing

The domestic refining industry may also benefit other sectors through adding to the demand for certain inputs. By increasing the demand for inputs which are shared with other industries, the refining industry assists downstream industries in achieving economies of scale. When economies of scale are achieved, all industries that share these inputs benefit from lower costs in the industry supply chains.

Related industries tend to congregate around refineries to take advantage of the inputs available from the companies established to service the refinery. This tendency for related industries to cluster in one area and support each other is known as external economies of scale or agglomeration economies. This type of spillover from the refining industry is difficult to measure, but makes an important contribution to many industries in the Australian economy.

Industries that benefits from sharing inputs with the refining industries include petrochemical industries, plastics and other heavy industry such as steel manufacturing. Manufacturing sectors such as food processing that also consume similar products to the refining industry benefit from reduced costs for commonly consumed products. These industries benefit as they share inputs used by the refining industry. Inputs utilised by the refining industry and other sectors include engineering services, chemicals, electronic equipment and mechanical components.

To illustrate input sharing, an example concerning the use of specialised labour in the refining industry will be used. The refining industry demands a large amount of contracted labour, particularly during major maintenance periods when parts of the refinery are closed.

The maintenance requires specialised skills provided by contractors, and these skills are demanded not only by the refining industry, but also by other sectors. For example, many sectors, including the refining industry, would contract an engineer to perform a stress test. By contributing to the demand for this input, the refining industry aids in lowering the costs for all sectors located in the same area and using engineering contractors.

The refinery industry utilises a wide range of contract services including maintenance services, inspection engineering and water treatment. The refining industry may make up a large portion of such a contract firm's demand, and create the base demand that allows that firm to exist. Importantly, that contracting firm will also service industries other than the petroleum refining industry, and in so doing, add to other industries' productive capacities.

The potential for innovation, technology and knowledge spillovers is another force behind the agglomeration of industry.

Innovation, Technology and Expertise Spill Overs

The Australian refining industry benefits the domestic economy through innovation, technology and knowledge spillovers. The spillover effect occurs when knowledge and technologies are transferred from the refining industry to other sectors. The effect has the benefit of stimulating innovation and technological improvements in other sectors, without them having to bear the full costs.

Innovation and technological change depend on new knowledge more than most other economic activities. Merely developing and using technology and knowledge does not constitute a contribution to the Australian economy. This is because the refining industry is able to capture the full benefit of any know-how that they develop though reduced costs or increased profits. However, if the technology and knowledge originating in the refining industry is transferred to other sectors of the Australian economy, then the receiving industry gains the benefit of the technology or knowledge without having to pay for the costs of its development.

Technology and knowledge spillovers can benefit industries outside the refineries. These spillovers can occur through three main avenues:

- The workforce may move between industries, taking with them knowledge developed in the refining industry.
- Communication between the members of different industries may facilitate the transfer of ideas.
- Other firms or industries may observe the practices of refineries and adapt the technologies for use in their own industry.

Petroleum refining is a highly capital-intensive and technologically advanced industry. It is continuously developing new technologies to improve performance. The knowledge and technology developed in the refining industry gives it the ability to contribute to the skills of the Australian workforce and the productive capacity of other industries. The most important means through which technology or knowledge can be transferred to other industries is the movement of its workforce. When employees leave the refining sector, they take their skills to industries such as mining and chemical (such as petro-chemical) industries.

The highly technological nature of the refining industry provides a challenging environment for engineers, software developers and other technicians to enhance their skills. Training and development activities undertaken by the industry include apprenticeships, traineeships, and training in higher-level technical skills. Some domestic refineries pay for their employees to complete formal qualifications, adding to the skills of the workers in the industry. These labour skills are provided by the refining industry, but the knowledge can be transferred into other sectors when the skilled workers change occupation.
As discussed in Section 2, a large proportion of workers in the industry are contract workers. These workers are inherently mobile and therefore facilitate the transfer of innovations between industries. The refinery training programs often extend to contract workers, and the skills they learn in the refining sector can be utilised in other industries.

As might be expected, the turnover of skilled engineers tends to be higher than for other types of workers, due to high demands in recent years and the relatively broad nature of engineering skills. For example, during the mining boom that recently occurred in Australia, many highly skilled workers left the refining industry to take part in the expansion of the mining sector, where their skills are directly applicable.

An example of technology transfer through the use of contractors is outlined in Case Study 8.

CASE STUDY 8

Technology Transfer through Contractors – Altona Refinery

A new method for cleaning tanks was developed at the Mobil Altona refinery in conjunction with contract workers from Saunders International, a specialist tankage contractor. The new technology allowed the tanks to be cleaned more effectively and with greater speed, which is important to the efficient running of the refinery. This new technology would also be useful for other industries, including the chemical complex and petrochemical manufacturing plants in Altona.

The involvement of contractors in developing this technology meant that the method was readily transferred to other industries and refineries. Saunders International works with a number of different industries, including water supply, chemical manufacturing and mining industries. As the workers from Saunders International move between industries and businesses, they take the method developed at Mobil Altona with them. Mobil Altona also shared the technology with other ExxonMobil refineries around the world, which would then be able to become points from which technology transfer could again occur.

Around the world, refineries use similar technologies that are adapted for the domestic demand and supply conditions. The Australian refining industry utilises technologies adapted from parent company applications or those purchased elsewhere as best practice. In doing so, the industry acts as a point at which new technologies can enter Australia.

Applying any new technology to the industry invariably requires innovative techniques to enable the technology to operate under domestic conditions.

The refining industry invests directly in technological innovation which can benefit industries with similar production processes. Major technological advancements made by the refining industry include improvements in safety standards, environmental impacts, cleaner fuels production and in the de-bottlenecking of production processes. Although these innovations seem to have applications mainly focused on the refining industry, industries including petrochemicals, plastics, steel manufacturing, and food processing can benefit from these technology spillovers.

(5.5) LOCAL COMMUNITY DEVELOPMENT AND INVESTMENT

Many Australian refineries also make contributions outside the economic sphere, through community development activities. These activities benefit the refinery and the community in which the refinery operates. These activities include interaction with community groups seeking to enhance the education, environment and health outcomes of the local area. Refineries make contributions to community development through grants, donations, volunteer work, and sponsorship of community programs.

The projects and production facilities of domestic refineries can affect communities in numerous ways, both positively and negatively. It is in each refinery's self-interest to manage their facility in a way that achieves corporate sustainability. Corporate sustainability is an evolving management paradigm that incorporates societal goals into the traditional growth and profit maximisation model.

Under this paradigm, companies incorporate the idea that community development activities can have benefits to the refineries including better risk management, cost savings and management of intangible assets such as brand and human capital.

By contributing to a community's economic and social development through the idea of corporate sustainability, a refinery not only derives benefits in terms of enhanced reputation and community acceptance, but it also creates positive externalities for the community which flow through to wider economic benefits, such as higher GDP and consumer living standards.

Corporate sustainability is a concept taken on by the refining industry, which is involved in numerous community development activities. The socio economic benefits gained through community development activities are expected to benefit the Australian economy in the long run.
The Case Studies below highlight a small selection of these activities.

CASE STUDY 9

Community Initiatives and Investments – Viva Energy Australia

Viva Energy is spending about $3m to fund a national community program that supports a range of local and national initiatives focusing on mental health and substance abuse including headspace National Youth Mental Health Foundation.

Viva Energy's support for headspace specifically funds Mental Health Role Models to enable up to 70 members of headspace Youth Reference Groups from Geelong and Sunshine (VIC), Parramatta (NSW) and Nundah (QLD) to be up-skilled through formal training in a range of disciplines to help them share their stories locally and help others.

Viva Energy's wider community support program includes:

- A partnership with Northern Futures (Geelong) – to assist community members most at risk of becoming, or remaining, jobless in Geelong's northern suburbs. The Viva Energy Role Model Scholarship Program will subsidise participants undertaking a Certificate I, II or III training course, including associated expenses such as transport and meals;
- Annual grants to benefit the communities of Clyde and Gore Bay (NSW), Pinkenba (QLD), Geelong and Newport (VIC);
- Support for projects to reduce substance abuse, especially within Indigenous communities. Viva Energy is the manufacturer and supplier of Low Aromatic Fuel to support the Federal Government's Petrol Sniffing Prevention Program in the northern half of Australia; and,
- Support for employee fundraising – either through workplace giving or team fundraising – by matching dollar-for-dollar money raised.

CASE STUDY 10

School Maths & Science Programs: Bright Future Grants – Mobil

Mobil is helping to inspire a new generation of engineers and scientists by investing over $95,000 into local schools and kindergartens. Through the 2016 Bright Future Grants program, 33 schools and kindergartens near the Mobil Altona Refinery and the Mobil Yarraville Terminal have each received grants of up to $4,000 for maths and science resources and projects.

"Scientists and engineers are critical for addressing the challenges of 21st century life. That's why we invest in education programs that focus on inspiring kids to pursue careers in science, technology, engineering and mathematics," said Andrew Warrell, Altona Refinery Manager.

"*From medicine to energy development to computing and engineering, we are supporting the development of a passionate and highly skilled workforce that will help solve problems and create new opportunities into the future."*

The grants will enable local kindergartens, primary and secondary schools to bolster their maths and science programs and resources; from purchasing new technology such as iPads, smartboard software and robotics kits, to funding outdoor programs to teach students about sustainability, such as a pedal-powered charging station and sustainable garden.

Mobil has a long history of supporting local schools and kindergartens. Since the Bright Future Grants program began in 2009, Mobil has provided over $580,000 to local schools and kindergartens to support maths and science education.

CASE STUDY 11

Commitment to Indigenous Communities – BP Australia

BP's commitment to Indigenous communities has been largely formalised through their Reconciliation Action Plan (RAP). The 2014 RAP focused on four areas: improving cultural awareness; developing supplier diversity; pathways to employment; and continuing to supply Opal Fuel. In 2017, BP plans to launch their third RAP

BP is also proud of its two-year partnership with Melbourne Business School – an investment of $100,000 is supporting the MURRA Indigenous Business Masterclass program over 2016 and 2017. Each year the MURRA program provides 20 to 30 Indigenous business leaders with an opportunity to participate in three intensive, four-day modules over a single year, focusing on developing leadership, strategy, business acumen and negotiation capabilities.

BP developed Opal low-aromatic fuel to help tackle petrol sniffing. After consultation with 10 Aboriginal and Torres Strait Islander communities across Central Australia, Opal was introduced in 2005 into 37 remote communities. Low-aromatic fuel is now available in over 125 remote communities and BP is a proud supplier of the fuel in a number of areas, including South Australia, Central Australia and the Western Australia Goldfields region. Since its inception, low-aromatic fuel has reduced the incidence of petrol sniffing by up to 88 percent in affected communities.

CASE STUDY 12

Commitment to the Refinery's Local Community– Caltex Australia

Caltex invests $120,000 to over 60 community groups and organisations within a 10km radius of the refinery. Examples of some of the key initiatives and community support include:

- environmental projects such as tree plantings, marine study programs and revegetation of areas
- support for 17 local schools and colleges around the refinery, including a science and engineering program at Iona College
- continued support of the Queensland Living History "History Alive" event at Fort Lytton and an ongoing partnership with Fort Lytton National Park to restore and rebuild historical buildings
- the major sponsor of WINNAM Aboriginal and Torres Strait Islander corporation NAIDOC day and their 25 years in the local area celebrations
- supporting the Wynnum Rugby Union Club juniors for the 16 years, along with the Wynnum Seagulls Junior Rugby League and the Wynnum Manly cricket club
- support for the Volunteer Coast Guard, a Business Women's group, and various youth, community, educational, charity and homeless support initiatives.

(5.6) AUSTRALIAN REFINERY FACTSHEETS

Geelong Refinery (VIC) – Viva Energy Australia

Lytton Refinery (QLD) – Caltex Australia

Altona Refinery (VIC) – Mobil Oil Australia

Kwinana Refinery (WA) – BP Australia

Viva Energy Australia
Investing in sustainable Australian refining

Viva Energy Australia was launched following the purchase of Shell's Australian downstream business (excluding aviation) in 2014. Viva Energy is a brand new Australian company with the benefit of 110 years of operation and local experience.

The exclusive licensee of Shell products in Australia, Viva Energy's mission is to keep local industry moving.

Viva Energy supplies around one quarter of Australia's petroleum products and the business comprises the Geelong Refinery and a market leading retail network of 920+ sites.
In addition Viva Energy runs bulk fuels, bitumen, marine, chemicals and lubricants businesses supported by more than 20 terminals across the country.

1,500 highly skilled and trained people choose to work for Viva Energy nationally. It is this workforce who will deliver Viva Energy's plans to invest $1 billion over its first five years of operation in order to help build Australia's energy future.

Over three years Viva Energy will provide up to $3 million of funding to Jigsaw, its national community program, with the goal of facilitating positive social change through committed, ongoing effort. Jigsaw supports a range of programs and initiatives focussing on mental health and substance abuse, both nationally and in the areas in which Viva Energy operates.

Geelong Refinery

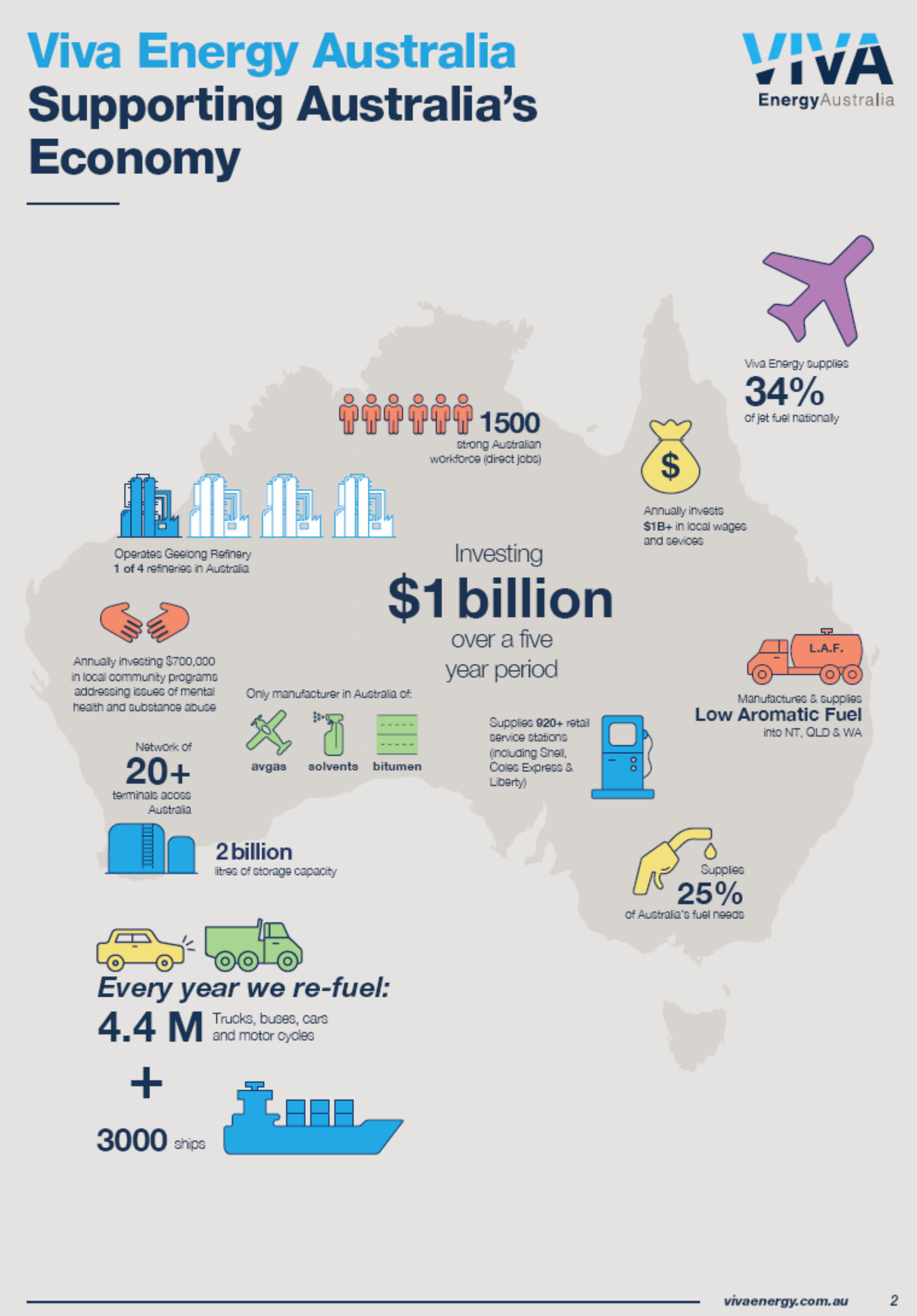
Built in 1954, the Geelong Refinery has been an integral part of the Geelong community for over 60 years. It is a key driver of Victoria's economy, supplying more than half of the State's fuel requirements, employing about 700 people and spending more than $200 million each year in wages and services.

Situated on 120 hectares of land adjacent to Coria Bay, the refinery has direct access to Geelong Port, which it is a major user of. It also operates two fuel pipelines to deliver fuel to Melbourne from where deliveries to customers are made.

The Geelong Refinery has a capacity to refine 120,000 barrels of oil per day to produce petrol, diesel, jet fuel, bitumen, LPG, propylene, solvents and avgas. Crude oils and feedstock for the refinery come from a variety of sources including locally from Bass Strait, the Otways and the Cooper Basin as well as internationally from Asia, the Middle East and occasionally West Africa. Fuel manufactured at Geelong can be bought through the Shell Coles Express network as well as Shell and Liberty branded service stations across Australia. Low aromatic fuel is also produced in support of the federal government's petrol sniffing prevention program.

Recycling practices at the Geelong Refinery are world class. Waste water is treated and reused within the refinery, hydrocarbon waste is converted to compost and spent catalyst used in the refining process is sent interstate and used in the manufacture of cement.

To ensure Geelong Refinery's international competiveness and sustainability, $350 million is being invested into the refinery over a five year period. This investment includes projects aimed at improving reliability as well as growth. A sustainable refinery is good news for current employees, future employment opportunities, apprentices, local Geelong communities and the Australian economy.



Viva Energy Australia
Supporting Australia's Economy
VIVA EnergyAustralia
Viva Energy supplies
34%
of jet fuel nationally
1500
strong Australian workforce (direct jobs)
$
Annually invests
$1B+ in local wages and sevices
Operates Geelong Refinery
1 of 4 refineries in Australia
Investing
$1 billion
over a five year period
Annually investing $700,000 in local community programs addressing issues of mental health and substance abuse
L.A.F.
Manufactures & supplies
Low Aromatic Fuel
into NT, QLD & WA
Only manufacturer in Australia of:
avgas
solvents
bitumen
Supplies 920+ retail service stations (including Shell, Coles Express & Liberty)
Network of
20+
terminals acoss Australia
2 billion
litres of storage capacity
Supplies
25%
of Australia's fuel needs
Every year we re-fuel:
4.4 M Trucks, buses, cars and motor cycles
+
3000 ships
vivaenergy.com.au
2

REFINING

A key part of Caltex's national supply chain

CALTEX

CALTEX AUSTRALIA

With a commitment to Australia tracing back to 1900, Caltex is an Australian company that has grown to become the nation's outright leader in transport fuels. Caltex supplies one-third of all Australia's transport fuels and is unique in this market for being the only major brand listed on the Australian Securities Exchange.

Caltex has continually changed and adapted our business model to meet our customers' ever evolving needs. In 2014, Caltex's Kurnell refinery in Sydney was shut down and converted into Australia's largest fuels import terminal. At the same time, Caltex has been investing heavily in its Lytton (Brisbane) refinery, which has led to operational improvements and record production levels.

Lytton refinery is an important part of Caltex's supply chain which also includes product and crude oil imports, and a national network of terminals, depots, airport operations, logistics fleet and retail sites.

Caltex remains committed to continuing to adapt and improve its supply chain to maintain reliable, secure and competitive quality fuel supply to its customers at a time of rapid change in the transport fuels industry.

LYTTON REFINERY

In 2015, the Caltex refinery at Lytton achieved 50 years of operation.

The Lytton oil refinery was built by Ampol at a cost of around $42 million. Construction commenced in 1963, and by July 1965, the Lytton refinery was operational.

Lytton was Queensland's first refinery and the first refinery in Australia to be owned by an Australian company and financed entirely on Australian capital.

Today Lytton refinery has a capacity of 112,000 barrels per day, enough to fuel almost 8,000 petrol and diesel cars for a year.

Lytton refinery supplies approximately 90% of the transport fuel needs for South East Queensland. It is one of Queensland's largest manufacturing facilities.

The Lytton refinery is a major contributor to the Queensland economy with production currently valued at around $3.5 billion per annum. The refinery employs 470 people and indirectly supports thousands of jobs and businesses locally and across Australia.

Produced January 2016

Lytton refinery produces fuels to keep Queensland moving

Lytton refinery is a process plant where crude oil is refined into petrol, diesel and jet fuel, as well as smaller amounts of fuel oil, LPG and chemicals, such as nonene.

The refinery produces:

▸ Premium unleaded petrol	10-15%
▸ Unleaded petrol	30-35%
▸ Diesel	40-45%
▸ Jet fuel	10-15%
▸ Other (Fuel oil, LPG, chemicals)	2-3%

Lytton's wharves provides a vital link to the refinery

- Lytton refinery has two wharves, one for receiving shipments of crude oil and the other for exporting shipments of fuel products that the refinery has produced.
- Crude oil ships docking at our wharf contain up to 140,000 tonnes of crude oil. This is equal in volume to around 2 million car fuel tanks.
- Lytton normally receives a cargo of 20,000 - 80,000 tonnes of crude oil every 3-5 days.

Refining is a complex and challenging process

- Crude oil is delivered to the refinery by ship and then pumped into large crude oil tanks.
- The refining process starts with the crude distillation units which heat the crude oil to separate it into its different components. These components are then treated by various other refinery process units to make different products.
- Finished fuel products are stored in product tanks and tested by the refinery laboratory to ensure they meet strict quality standards.
- Fuel products are distributed by pipeline to local distribution terminals including Caltex's Lytton terminal, and to Brisbane airport. Products are also distributed by ship to other Caltex terminals on the east coast including Cairns, Townsville, Mackay, Gladstone and Kurnell. Gases and chemicals are distributed from site by truck.
- On average it takes about two weeks for crude oil received by the refinery to leave the site as finished fuel product.

Caltex invests in Lytton refinery to maintain and improve performance

- Caltex spends approximately $50 million per annum maintaining Lytton refinery and continues to focus on the operational improvement initiatives that commenced in 2012.
- Major Turnaround and Inspection (T&I) maintenance events are conducted at the refinery every five years to help ensure continued safe, reliable operations.

A proud workforce and an employer of choice

- Lytton refinery has a highly skilled and capable workforce of around 300 employees and 170 contractors. The number of contractors can more than double during major maintenance work.
- Jobs at the refinery span operations, reliability and maintenance, engineering, laboratory, finance, procurement, HR, training, health, safety and environment.

Safety is at the heart of our culture

- The safety of our people and our operations is Caltex's number one priority. Safety is fundamental to our culture. It is reflected in Caltex's core value of Care.
- Lytton refinery has strong safety systems and innovative programs that engage everyone on site in working safely.

We are committed to a healthy environment

- Lytton refinery has a world class environmental management system which involves monitoring and reporting on environmental performance, engaging with government agencies and the community, and implementing environmental improvement programs.
- We continually strive to improve our energy efficiency and reduce our emissions.

A good neighbour and an active member of the local community

- Lytton refinery has a long-standing relationship with the local community.
- Throughout its history, the refinery has reached out to the communities around our site to provide information about our operations as well as financial and in-kind assistance for a range of educational, environmental, sporting, cultural and community initiatives.

Altona Refinery

Located 13 kilometres west of Melbourne, Mobil Altona Refinery supplies around half of Victoria's fuel needs. It operates 24 hours a day, 365 days a year and processes crude oil into the full range of petroleum products.

The refinery plays a very important role in Victoria's fuel supply chain and contributes to the local and state economy by providing employment opportunities, supporting suppliers and industrial customers and producing refined fuel products that are essential to everyday life.

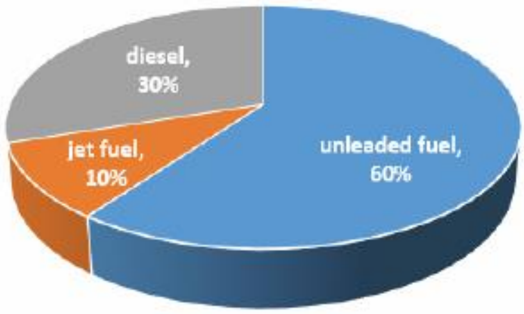
Over the past five years, Mobil has invested more than $370 million on improving the safety, reliability and viability of our refining and distribution facilities in Melbourne's West so that we maintain our position as a major supplier of high-quality and reliable fuels to Victoria into the future.

Altona Refinery — fast facts:

- Commenced operation in 1949
- Produces approximately 13 million litres of refined products per day, enough to fill around 300,000 cars
- Produces a number of refined petroleum products, including unleaded petrol, diesel and jet fuel to supply around half of Victoria's petroleum fuel needs
- Contributes around $270 million to the Victorian economy every year.
- Employs more than 350 people and supports thousands of other jobs
- Investment of more than $370 million in maintenance and other improvements during the last five years.
- Bright Future Grants support maths and science education in local schools and kindergartens
- Supports local environmental projects and community organisations
- Pays over $1million in rates to Hobsons Bay City Council, around $3 million in fees and charges to City West Water and more than $6 million in port fees and wharfage to the Port of Melbourne Corporation every year

Altona Refinery is located just 13 kilometres west of Melbourne

Average refinery production



Mobil

An ExxonMobil Brand

Altona Refinery

Turning Crude Oil Into Essential Products

The Altona Refinery plays an important role in converting crude oil into a range of petroleum fuels that we all rely on.

Imported crude oil arrives via tanker at Gellibrand Wharf and is transported to the refinery by pipeline. Victorian crude oil is also transported to the refinery by pipeline from the Gippsland/Bass Strait oil and gas fields.

At the refinery, the crude oil goes through various processes to become unleaded petrol, diesel, jet fuel and LPG. After processing, refined products are pumped into storage tanks to await distribution. There are almost 100 storage tanks at the Altona Refinery and in its tank farm.

Around 90 percent of products are transported by pipeline from the refinery to Mobil Yarraville terminal and other oil company terminals for distribution by road throughout Victoria and into parts of South Australia and Southern New South Wales. Jet fuel is transported directly from the refinery by pipeline to Somerton, where it is then provided to Melbourne Airport.

The refinery supplies LPG as feedstock to the nearby Altona chemical complex, which produces the raw materials that are used in the manufacture of a multitude of consumer applications and products including dairy bottles, pipelines, wire insulation, sealants and adhesives and other plastics products.

Ensuring safety

Mobil places the highest priority on operating flawlessly in all aspects of our business. One of the key tools in maintaining safe operations is the ExxonMobil Operations Integrity Management System which provides a systematic process to set objectives, measure progress, plan improvements and ensure accountability for results.

The refinery has detailed response plans in case of emergency, including a number of ways to communicate with the local community. We conduct regular emergency drills and liaise closely with local authorities and emergency services.

Victorian Government regulations require that the Altona Refinery be licensed as a Major Hazard Facility because it stores and handles large quantities of hazardous products. In line with this, a detailed Safety Case has been developed, identifying risks associated with potential major incidents and putting in place procedures to ensure these risks are reduced as much as practicable.

Environmental management

Mobil is committed to achieving and maintaining excellence in environmental care throughout our operations. The Altona Refinery operates under an environmental licence issued by the Environment Protection Authority Victoria.

Community Involvement

A Community Liaison Committee, including representatives of Hobsons Bay City Council, local residents and refinery management, meets four times a year and meetings are open to all interested people in the local area.

A newsletter is distributed to over 20,000 households to coincide with the meetings. At the meetings, Mobil reports on the refinery's operations and environmental and safety performance and provides updates on progress achieved to meet targets and initiatives.

Additionally, the Altona Refinery supports a number of community, environmental and education programs in the area by providing funding to local schools and kindergartens and community groups.

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Altona Refinery - fuelling Victoria for the long haul

As the Australian fuel industry goes through a period of significant structural change, Mobil is committed to supporting Altona Refinery's ongoing success.

A number of factors, including external market influences, past investment decisions and the hard work of dedicated and highly-skilled employees, have combined to uniquely position Mobil Altona Refinery as a thriving business that continues to defy Australia's tough manufacturing environment.

Changes to the global crude oil market

Since the Altona Refinery was constructed back in 1949 it has been continuously adapting to changes in technology, consumer needs, economic circumstances and market dynamics. Recent factors, such as the United States shale gas and tight oil revolution, have impacted crude oil trade patterns so that the type of crude oil that suits Altona Refinery is now more readily available and more cost efficient to process.

A cracker of a story

One of the keys to the Altona Refinery's success is the unique design and capability of its Fluidised Catalytic Cracker or FCC, which was installed in 1997. The design of Altona Refinery's particular FCC allows advanced residual cracking. This means the refinery can process much of its heaviest crude oil molecules, maximising the production of high-value products obtained from each barrel of oil. Other Australian refineries have FCCs, however the efficiency gained from the Altona Refinery's FCC model is unique.

Investing in our future workforce, now

Around 350 people work at the Altona Refinery. Like many businesses in Australia, the Altona Refinery is facing the challenges of an aging workforce. Since 2007 an operator traineeship program has been the key to the refinery's strategy for sustaining a top-class operator workforce into the future.

So far, Mobil has employed 35 full-time, permanent operators for Altona Refinery through this program. The refinery plans to continue this program into the foreseeable future as part of our commitment to ongoing operations.

Mobil™

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A leader in safety, efficiency and reliability

During the last five years, Mobil has invested over $370 million in safety, efficiency and reliability improvements, building a strong foundation which will allow the Altona Refinery to capitalise on future opportunities for growth.

Recent investments include upgrading the refinery's IT systems, refurbishing employee facilities and buildings, demolishing redundant buildings to improve the refinery's visual amenity, increasing pipeline and tank integrity programs, improving the crude import facilities at Gellibrand Wharf and working to increase the reliability of the refinery's electricity supply.

Some of the benefits already being realised at Altona Refinery as a result of these prudent investments include being recognised as one of the most reliable ExxonMobil refineries in the world, ongoing improvements to environmental performance and an outstanding safety record.

Kwinana Refinery

Our long history

- We are proud of our long history of over ***60 years*** of operations at Kwinana Refinery.
- It's a tough refining market and we have to be intuitive and efficient in the way we do things in Australia to compete with overseas refiners.
- At Kwinana, we are committed to investing in our 'kit' to ensure we continue to provide secure, reliable and competitively prices fuels.
- We are the largest refinery in the country, providing about 80 percent of fuel to Western Australia, and beyond that to South Australia and Tasmania.

Challenges in refining

- As we've said in our annual Energy Outlook, BP expects to see strong continued demand for energy globally and industrialisation in emerging economies is the main driver of this.
- Energy demand has shifted from west to east and in Asia especially, we've seen the emergence and investment in large scale mega-refineries.
- We are competing with refineries which are two and three times our size – a good example is Jamnagar Refinery in India which has a capacity of 1.2mn barrels of oil per day, processes over 20 types of crude and exports to 26 countries.
- This regional growth in refining capacity and the scale at which it is occurring has put immense pressure on Australian refineries and is why we've seen the industry shrink over the last decade.

Remaining competitive

- Despite these challenges, Kwinana is performing better than ever – operating at close to full capacity and frequently meeting our operational performance targets.
- This consistent strong performance can be put down to our team working incredibly hard over the last few years to optimise refinery operations and become more efficient - we've really pushed ourselves to look long hard at every opportunity.
- We continue to work very closely with BP's own supply teams to buy the right crude oil and feedstocks, and to access customers and markets that buy our products.
- New technology and innovations also mean Kwinana's operations, like BP's other refineries, have become more sophisticated and flexible.
- All improvements, small and large, make a difference – we have even reduced our water usage at the refinery by more than 75 percent, in part by using more high-quality recycled water.
- Refining margins will always be up and down so the key for us is to capitalise on strong refining margins when they are available and still be profitable when the market changes.

Ongoing investment

- Refineries are capital intensive businesses. Over the past decade, the industry in Australia has invested nearly $9½ billion and import infrastructure has also been enhanced significantly.
- BP has just completed its largest ever maintenance activity at Kwinana and employed over 1,800 additional people to support the event.
- By undertaking turnarounds periodically, we have the opportunity to inspect and clean the refinery kit and make targeted investments to continue to run the refinery safely and at its best.

- Albeit in a different sense, we have also invested in our future by agreeing to re-sign our State Agreement with WA State Government
- BP also continues to invest in its broader supply chain in WA - as the primary provider of jet fuel into Perth Airport, with our shipping operations around the state's coastline and through our fast--growing network of BP branded service stations.
- We have committed to invest about $2.3 billion over a five-year period into the growth of our Downstream business across Australia.

Our broader contribution

- Kwinana, WA has a long history as part of the Kwinana and broader Perth community.
- Kwinana Refinery first started operations in 1955 and we were the very first industrial facility to be built in Western Australia – chemical plants and other facilities were developed around it.
- For over 60 years, we have contributed to the WA economy both directly and indirectly, through providing jobs, economic activity, taxes and support for community activities.
- Kwinana continues to be an important source of employment in the area and we even have multiple generations of the same families among its staff.
- More broadly, across Western Australia, we directly employ some 1,500 people and contributed over $10.25 million in state payroll tax in the 2015 financial year.

(6)OTHER CONSULTATION AND TECHNICAL ISSUES

KEY MESSAGES

- The Department's Discussion Paper also proposes changes to other parameters in petrol and diesel, and also new standards proposals. AIP's position on these proposals includes the following:

Aromatics and Methyl Tertiary Butyl Ether (MTBE) in petrol:

- AIP does not support a change to the aromatics standard in petrol because a central and critical guiding principle for fuel quality standards in Australia has been the harmonisation with European standards subject to Australian conditions.
- A key difference between Australian standards is that MTBE is limited to 1 percent (effectively a ban) under the FQSA whereas in Europe total ethers are allowed up to 22 percent. Western Australia considers the risk of MTBE to groundwater so serious it has limited MTBE in fuels to 0.1 percent.

Proposed PULP 98 standard:

- AIP and member companies do not consider that a PULP 98 standard is necessary.
- However, if Government considers that such a standard should be made then the MON level should be retained at 85 as per the current FQSA.

Cetane in diesel:

- AIP strongly supports setting both Cetane Index (CI) and Derived Cetane Number (DCN) for the diesel standard (both mineral diesel and biodiesel blends) at the current 46 minimum.
- Adoption of a 46 minimum cetane will not impose any additional costs upon the petroleum refiners, importers or fuel blenders and we are not aware of any adverse operability issues associated with a DCN of 46 in diesel (whether or not it contains biodiesel), nor have we seen any compelling evidence of environmental benefit. There are, however, significant costs associated with implementing a 51 cetane.

PAH in diesel:

- AIP member companies believe there would be negligible environmental and operability benefits of reducing the PAH limit based on available evidence.
- Tightening PAH spec to 8 percent max would substantially constrain refinery flexibility and threaten refinery viability. Most domestic refineries would likely need investment in expensive high pressure diesel hydrotreater reactors to achieve any substantial reduction in PAH.

Proposed B20 standard:

- AIP supports the development of a B20 fuel quality standard, but AIP's Submission (2012) to the Department of Sustainability, Environment, Water, Population and Communities outlines in detail the proposed B20 test properties and test methods which are appropriate in AIP's view.

Fuel additives for inclusion on the Register of Prohibited Additives

- AIP member companies support, for inclusion on the Register of Prohibited Fuel Additives N-methylaniline (NMA), and tetraethyl lead, but has no opinion at this stage on polychlorinated n-alkanes. The Department should consult with OEMs and additive suppliers on the treatment of methylcyclopentadienyl manganese tricarbonyl (MMT).

(6.2) INTRODUCTION

Chapter 6 covers the AIP position on other parameters in petrol and diesel, and other standards proposals including:

- Aromatics in petrol
- Methyl Tertiary Butyl Ether (MTBE) in petrol
- Proposed PULP 98 standard
- Ethanol
- Cetane in diesel
- PAH in diesel
- Proposed B20 standard
- Register of Prohibited Additives

(6.3) OTHER FUEL STANDARDS PARAMETERS

Aromatics in petrol

AIP and member companies are surmising that the provenance of the proposal to alter the aromatics specification is to harmonise with European fuel quality standards. As detailed in Chapter 2, a central and critical guiding principle for fuel quality standards in Australia has been the harmonisation with European standards subject to Australian conditions. A key difference between Australian standards is that MTBE is limited to 1 percent (effectively a ban) under the Fuel Quality Standards Act (FQSA) whereas in Europe total ethers are allowed up to 22 percent. Western Australia considers the risk of MTBE to groundwater so serious it has limited MTBE in fuels to 0.1 percent.

Other jurisdictions in the Asian region do not limit MTBE at all such as South Korea which is now the major source of petrol imports to Australia and in Japan there is a 7 percent limit. Consequently, there will be a considerable difficulty in sourcing low aromatic, MTBE free material without a significant price premium. Given the considerable difficulties with this aromatics proposal, in developing Option F, AIP and member companies have proposed that there are no changes to other parameters in the petrol standard and therefore, does not consider the costs to refineries.

Aromatics are the highest octane molecules in petrol and are a crucial component of petrol manufacture, particularly the higher octane grades. The primary reasons for imposing maximum aromatics limits relate to possible engine deposit formation and to environmental concerns associated with tailpipe benzene emissions both from benzene present in the fuel and benzene generated by the decomposition of aromatics under combustion conditions during the initial engine start. These concerns are already well-managed by the existing aromatics limits and concerns with benzene generation through combustion cease once the catalyst has warmed up.

In 1994, the United Kingdom Expert Panel on Air Quality Standards stated that "the current average concentrations of benzene to which the general public are exposed in the UK's air present an exceedingly small risk to health …. [and that] … forecast reductions in atmospheric benzene concentrations will reduce this exceedingly small risk further".

In examining this issue, the UK oil industry[19] identified the key mechanisms for reducing benzene as (in order of effectiveness):

- Exhaust tailpipe emissions, through improved catalytic converters
- Petroleum evaporation from fuel system when stationary, through carbon canister traps
- Vapour release during delivery and storage of petrol through vapour recovery, systems

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[19] UKPIA (2003), *Briefing: Benzene in Petrol*

- Vapour release when filling petrol tank, through forecourt vapour recovery systems

It was concluded that while it was not possible to separate out the individual benefits of a particular measure, catalytic converters had significantly improved and would continue to do so and would deliver the air quality benefits standards required by the Expert Panel.

Australia already controls tailpipe benzene emissions via a tight fuel benzene limit and further controls on total aromatics will be prohibitive with little benefit.

As fuel benzene has the largest influence on exhaust benzene emissions and the impact of non-benzene aromatics is 90 percent less[20], controlling fuel benzene is an appropriate approach for managing tailpipe benzene emissions. Australia already substantially reduced the benzene in petrol by 80 percent in 2006 from 5 percent max to 1 percent max and is now at the same level as Europe. The Australian refining industry had to invest approximately $800 million at that time to meet the new benzene limit.

Whilst in Europe there is both a benzene limit and a total aromatics limit, in the USA, there is no aromatics limit and tailpipe emissions are controlled simply via a fuel benzene limit.

The 1996 EPEFE Gasoline Aromatics study indicates a linear relationship between fuel aromatic content and exhaust benzene and concluded that a reduction in aromatics from 50 percent vol to 20 percent vol resulted in a reduction in tailpipe benzene from 7 percent vol to 4 percent vol. Applying this relationship to a reduction in Australian fuel benzene from current 45 percent max to proposed 35 percent max would predict a reduction in tailpipe exhaust benzene of only about 15 percent. AIP has not collected the data for the average aromatics supplied to the Australian market but believes that the actual level of aromatics is well below the current fuel standard. However, the data for one company has shown average aromatic levels as ULP 91 = 28 percent average; PULP 95 = 33 percent average (range 27 to 38), PULP 98 = 36 percent average (range 33 to 42.5). Another company had averages of ULP 91 = 27 percent; PULP 95 = 32 percent; and PULP98 = 36 percent.

In addition, catalyst technology has advanced further since that time and newer three-way catalysts are very effective at removing unburnt hydrocarbons and can be expected to be effective in mitigating the effects of aromatics in fuel (refer the UK Expert Panel on Air Quality Standards referenced above).

Further tightening the aromatics limit to 35 percent max will restrict the availability of premium high octane fuels and increase their cost.

Many of the streams available within a refinery have an octane which is too low for production of high octane petrol on their own. The refineries do produce some good octane low aromatics streams (such as alkylate), but these are of limited availability. Aromatics however have superb octane and Australian refineries rely on of high aromatic streams (usually reformate produced in their gasoline reformer units) for the blending of high octane premium petrols. For example, one aromatic, m-xylene has a blending RON of 145 compared with Australian Super Premium grade petrol of 98 RON.

In Europe, oxygenates such as ethanol, MTBE and ETBE are generally used to assist in achieving octane specifications. These aromatics-free high-octane oxygenates allow Europe to adopt lower aromatics limits. Except in the case of ethanol, these compounds are restricted to 1.0 percent vol maximum in Australia and so are not available to boost octane. Furthermore, in Europe, excess high aromatics streams are typically sold as high-value feedstock to near-by chemicals plants. Unfortunately, this option does not exist in Australia.

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[20] CONCAWE (1996), *The influence of gasoline benzene and aromatics content on benzene exhaust emissions from non-catalyst and catalyst equipped cars - a study of european data (Report no 96/51)*

If aromatics are limited to 35 percent, high octane petrols will most likely need to be produced by importing expensive low-aromatics high-octane blend stocks. Availability of these low-aromatic high-octane stocks in expected to be limited in the Asian region as other countries move to also tighten their fuels standards and are likely to command a price premium.

Sales of higher octane grades are increasing in Australia while the sales of regular grades are declining, and so the requirement for higher octane blending components will continue to increase.

Whilst heavy aromatics have been linked to combustion chamber deposits where the aromatics content exceeds 50 percent vol, this is not applicable for this assessment as Australian petrol has a maximum pool average aromatics content of 42 percent vol.

AIP and member companies are unaware of any reports of engine deposit problems linked to the aromatic content of Australian fuel.

In addition to boosting octane, aromatics also have high energy density and motorists get more kilometres per litre.

This means that petrol blended using aromatics has a higher energy density (energy per litre) than fuels blended with oxygenates and so motorists can go further with higher aromatics petrol for the same litres of petrol purchased than they will for lower-aromatics fuel.

Methyl Tertiary Butyl Ether (MTBE)

As discussed in the previous section, it is important that the Government provide guidance on some parameters because it defines what is achievable for other parameters, for example, aromatics in petrol.

It would appear to be highly unlikely that MTBE would be permitted by State jurisdictions, especially Western Australia and NSW given their reliance on groundwater as a source of potable water.

AIP member companies have never blended MTBE into domestically manufactured fuel because of these sensitivities but we are aware of significant contamination resulting from imports of MTBE by independent importers in the early 2000s.

Proposed PULP 98 standard

AIP and member companies do not consider that a PULP 98 standard is necessary.

The regulatory requirement for premium grade petrol is well defined, including the minimum MON of 85. The numerical difference between RON and MON is recognised as the fuel 'Sensitivity', which is shown in the table below. Vehicles are calibrated on assembly to use a specified RON which is the minimum quoted on the fill cap. The RON value is associated with a MON value which is 10 numbers lower. All commercially available cars run 91RON 81 MON or 95 RON 85 MON

FUEL	ULP	E10	PULP95	PULP 98	EN 228 PULP 97
RON	91	94	95	98	97
MON	81	82	85	85	86
Sensitivity	10	12	10	13	11
Vehicle Octane specification	91	91	95	95	95

Fuel sensitivities of up to 13 octane units is common and there is no evidence that this is an issue for modern spark ignition engines. Petrols above 95 RON have higher sensitivities without issues.

Cars that are designed to use 98 RON and only 98 RON will have additional tuning to enable the vehicle to run with the minimum MON specified in the market for a 98 octane fuel.

The European standard EN 228 of 2012 does have a separate spec for the 97 octane Premium grade ULP grade sold in Europe with a minimum MON of 86. This addresses the presence of a regular 95 RON grade and a Premium 97 RON grade in Europe. Australia already has that with a specification for regular 91 RON and Premium 95 RON which specifies minimum and maximum properties for each fuel.

If the government considers a standard is required then a minimum RON of 98 with all other parameters remaining the same as already specified for premium grades defines all differences required.

AIP notes that the figure quoted in the discussion paper (i.e. a MON of 88) is incorrect.

Ethanol

As noted earlier in this submission, the further desulfurisation of fuels, such as to meet a proposed 10ppm standard, may result in octane reduction in fuel and therefore octane boosting is likely required at the refinery in order to meet the minimum regulatory octane requirements. The discussion paper notes there are a range options available to refiners to achieve this objective, including the use of ethanol in both ULP and PULP.

AIP has consistently opposed fuel market share mandates, such as the State biofuels mandates, and the inclusion of ethanol in premium fuel. AIP is strongly opposed to any proposal that would result in the mandated introduction of another fuel type, such as E12. Moreover, there is a practical barrier to proposals such as E12 as the overwhelmingly majority of cars in Australia other than flex fuel vehicles are restricted to a 10% ethanol by warranty requirements.

A requirement to use additional ethanol for the purpose of fuel octane enhancement boost, is likely to:

- be opposed by motorists (current experience demonstrates strong consumer aversion)
- be difficult to achieve in practice, particularly given:
    - the need to supply sufficient volumes nationally
    - the limited available supply of ethanol feedstock from local manufacturers
    - the barrier to international supply by virtue of the alternative fuel excise concessions
    - a number of vehicles in the Australian fleet are unable to use ethanol blended fuels, and will void manufacturer vehicle warranties above 10 percent ethanol blends
- attract higher costs for refiners than alternative octane enhancement options
- impinge on proprietary fuel formulas in premium grade fuels
- impose additional costs on motorists due to:
    - the inherent lower energy density of ethanol and as such the need to refuel more regularly
    - supply constraints from ethanol manufacturers
    - changes to the excise arrangements that would increase the cost of ethanol blended fuel supply
    - the need to invest in infrastructure and site conversion with costs passed onto the consumer
- introduce greater risks for fuel security and reliability.

There are three producers of fuel-grade ethanol in Australia, one of which is located in New South Wales while the remaining two are located in Queensland. These three producers manufacture ethanol from different feedstocks and are predominantly located in the regions where the feedstock is sourced in order to optimise the total cost of transporting both feedstock and the ethanol that is produced:

- Manildra produces ethanol from wheat starch at a plant located near Nowra, NSW. Manildra is the largest producer of fuel-grade ethanol in Australia, with a capacity of 300 million litres of ethanol per year;
- Wilmar BioEthanol is Australia's largest producer of sugar-based ethanol. Wilmar BioEthanol produces its ethanol by fermenting molasses, a by-product of sugar production. The plant is located in Sarina,

QLD and produces 60 million litres of ethanol per year, with a capacity to produce 90 million litres annually; and

- Dalby BioRefinery, owned by United Petroleum, is Australia's first grain to ethanol plant. Dalby BioRefinery purchases red sorghum and converts it to fuel-grade ethanol. The plant is located in Dalby, QLD with a capacity of 76 million litres of ethanol per year from red sorghum.

There also exists a range of project proposals for additional ethanol capacity slated for many years, but which have yet to be committed.

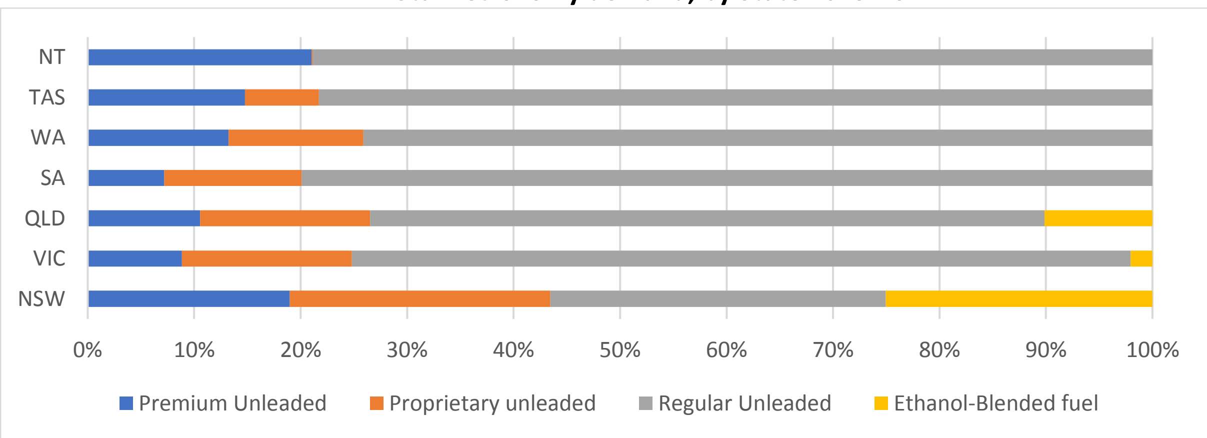
The 2007 *Biofuels in Australia* report by CSIRO concluded that an expanded ethanol industry was possible, but that it would require a full range of incentives. Furthermore, significantly expanded demand for biofuels would have implications for competition for crops in alternative markets, noting that:

> *"…there will be increasing competition with grains for food and with feedgrain for the livestock industry if the Australian ethanol industry expands….land and water will increasingly be contested for human food, animal feed, fibre, energy, water yield and environmental services".*

This is likely to put upward pressure on prices in a range of commodities. This may benefit some commodity producers while negatively impacting those who use these as commodities as feedstocks. A thorough assessment would need to be undertaken to better understand the impacts of a significantly expanded ethanol industry, such as would be required to supply sufficient volume of a nationally mandated blend of fuel for octane boosting purposes.

The experience with State mandates, in NSW and more latterly Queensland, is instructive in this area. In particular, consumer aversion to biofuels has seen NSW motorists prefer premium fuel use well beyond the national average. This is demonstrated in the following chart, where premium fuels in NSW represent almost 45 percent of total petrol demand. While NSW ethanol use reached a peak of just over 4 percent in 2010-11 largely due to the forced removal of ULP at many sites, demand has now fallen to just over 2 percent as consumers have effectively preferenced PULP over ethanol. Demand in Queensland is sitting just below 1 percent.

Total Petrol only demand, by State 2015-16



Numerous studies have also concluded that the biofuels mandates have in fact resulted in net consumer loss, with any benefit accruing to ethanol manufacturers. For example, IPART in its comprehensive analysis of the NSW Mandate found that:

> *"…the cost of reducing consumer choice is high. Most options to increase ethanol uptake would increase the cost of an already expensive policy, with little economic gain for the NSW community. Further, measures to increase ethanol uptake by reducing consumer choice would strengthen Manildra Group's already substantial market power."*

In its subsequent report analysing additional options to increase uptake to meet the increased demand, IPART concluded:

> *"Based on our analysis, the Additional Options would not achieve the 6 percent ethanol mandate and would add to the costs of the current policy. The additional cost burden would initially fall disproportionately on smaller service stations, and would be ultimately passed on to consumers through higher prices."*

IPART concluded that even with a range of additional government interventions aimed at increasing uptake, the 6 percent mandate would never be met.

It must be noted that biofuels are in fact generally supplied to the market at a higher price than conventional fuels if the excise exemption is taken into account. While biofuels mandates and targets may have helped to create increased consumer demand beyond where they may otherwise have been:

- the difference between the 39 cpl excise equivalent customs duty for ethanol imports and the historical effective zero rate of excise for domestically produced ethanol (albeit noting this is changing) has made ethanol imports uncompetitive and impeded the development of a properly functioning ethanol market and supply chain
- there is ongoing uncertainty surrounding biofuels supply reliability
- there is no guarantee of effective competition involving a diverse number of ethanol producers in the wholesale biofuels markets, as this depends on the balance of supply and demand which should include imports
- the compliance regime that has developed in NSW lacks predictable and equitable outcomes for all suppliers.

As part of the 2016 reforms to the NSW mandate, IPART were requested to develop a maximum wholesale price for ethanol. This price is currently set above the mineral diesel price.

Biofuels also impose significant costs on refiners, wholesalers and retailers due to the requirement to invest in dedicated infrastructure and site conversion so as to handle the unique parameters of biofuels.

There are also a range of barriers to the broad use of biofuels, beyond consumer aversion. While the number of unsuitable vehicles will reduce over time as the national vehicle fleet is replaced, there will still be significant numbers of vehicles which cannot use ethanol blends, estimated at 13.7 percent in NSW in 2013 (11.5 percent if motorcycles are not included). In addition, some applications such as marine and small engines are generally not able to use ethanol blends. These vehicles and applications will require the ongoing availability of conventional petrol for many years.

While biofuels may add new sources of supply to the market and thereby increase the diversity of the fuel mix, it is far from clear that this will result in more reliable fuel supplies. There are few suppliers of biofuels in Australia and Federal tax policies effectively prevent the use of imported ethanol and biodiesel. In addition, the inherent fragility of the nascent biofuels supply chains and the lack of redundancy in the biofuels supply system mean there is a significant risk of supply disruption given the demonstrated impact of droughts and flood on biofuels raw materials supply. Any failure of domestic biofuels supply imposes costs on the fuel supply chain to convert from biofuels to ULP 91RON. There is no experience to demonstrate a national biofuels mandate will encourage the development of robust and reliable local production of biofuels on a sustainable basis.

Furthermore, the benefits cited for the mandated use of biofuels have not been rigorously tested and it is therefore imperative that these be comprehensively assessed in a Regulation Impact Statement (RIS)

- The health benefits for ethanol use are minimal at best, with 2007 *Biofuels in Australia* Report by CSIRO finding that while there "may" be lower tailpipe emissions, there are increased evaporative emissions of smog-forming organic compounds which may lead to worse air quality outcomes
- Regional development benefits (such as jobs and economic development benefits) have not been adequately tested and may not be the optimal use of such a significant implicit subsidy of biofuels producers by retailers and motorists
- The environmental benefits have been found to be minimal and should be retested:
    - For example, if the carbon emissions abatement estimates for biofuels are robust then biofuels projects should be eligible for support under the Commonwealth Government's Emission Reduction Fund if they are competitive with other abatement options.

Technical barriers

Beyond the constraints and challenges for biofuels noted above, there are also a range of technical barriers for utilising ethanol as an octane enhancer and particularly for achieving a 12 percent ethanol blend. These principally relate to ethanol's relative effect on RON and MON, and the capacity for vehicles to utilise certain ethanol blends.

The impact on RON and MON of ethanol differs significantly. It is a good blend component for increasing RON, but relatively poor at increasing MON of fuels. Broadly speaking, in the case of E10, the addition of ethanol to ULP raises the RON by around 3 points, but only raises the MON by 1 point. Adding of 12 percent ethanol to 91 RON petrol is calculated to increase the RON to 95 minimum, however it will not increase the MON to the minimum regulated level of 85 minimum. Therefore, such a blend will not be compliant with the fuel quality standard for 95 RON petrol.

Furthermore, the overwhelming majority of vehicles in Australia that can use ethanol blended fuel are only warrantied for blends up to 10 percent. As such, motorists are likely to either suffer from operability issues and/or void manufacturer warranties.

Alternative octane enhancers

There are a range of options available to refiners, but these are also often at high cost. While some refinery technologies might reduce octane of the petrol (e.g SCANfining), there are different routes to desulfurisation and not all of these necessarily reduce octane. For reforming and alkylation, it is the feedstock to the units that is desulfurized, not the end product. As discussed in Section 6.3, the refineries do produce some good octane low aromatics streams (such as alkylate), but these are of limited availability. Aromatics however have superb octane and Australian refineries rely on of high aromatic streams (usually reformate produced in their gasoline reformer units) for the blending of high octane premium petrols. For example, one aromatic, m-xylene has a blending RON of 145 compared with Australian PULP98 RON.

While the use of octane boosting aromatics is likely to be the preferred option, AIP supports an approach where individual refineries are able to freely choose their preferred method within the bounds of the stipulations outlined in the FQSA. This may include use of ethanol, but AIP is opposed to mandating specific technologies or approaches for the purpose of octane enhancement.

Diesel Cetane

AIP strongly supports setting both Cetane Index (CI) and Derived Cetane Number (DCN) for the diesel standard (both mineral diesel and biodiesel blends) at the current 46 minimum.

Adoption of a 46 minimum cetane will not impose any additional costs upon the petroleum refiners, importers or fuel blenders and we are not aware of any adverse operability issues associated with a DCN of 46 in diesel (whether or not it contains biodiesel), nor have we seen any compelling evidence of environmental benefit. There are, however, significant costs associated with implementing a 51 cetane.

Australian refineries have very limited capability to control diesel cetane levels without incurring considerable cost.

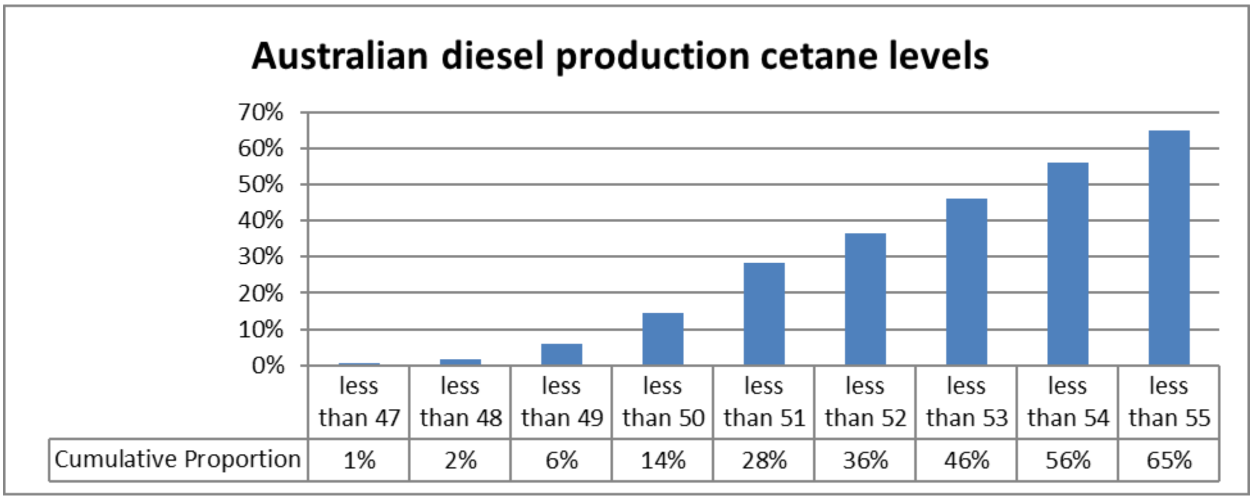
Diesel cetane is a function of the amount of paraffinic material in the diesel. Australian refineries do not have any refinery processing units which upgrade the level of cetane or allow direct control of cetane and therefore the diesel cetane is primarily an outcome of the type of crude oil processed by the refinery.

Each refinery has only a limited suite of crudes it can process dictated by the hardware configuration of the refinery. Within this, each refinery will optimise actual crude selection based on crude oil price, availability, and product demand mix.

If a refinery is forced to specify a specific paraffinic crude oil so as to meet a higher diesel cetane, this will push the refinery into a suboptimal outcome by paying more for crude or not producing an optimal product slate.

AIP estimated the scale of this issue by collecting the cetane levels for every batch of diesel supplied to the Australian market in 2008 and the first half of 2009. We then applied the 2010-11 import proportion to the batches above a DCN of 52 to estimate the levels of Australian produced diesel that does not meet a cetane level of DCN of 51.

Given the tight timetable for this consultation process, we have not had the opportunity to update the data, but we would not expect there to be a significant variance in terms of the outcomes and analysis presented here.

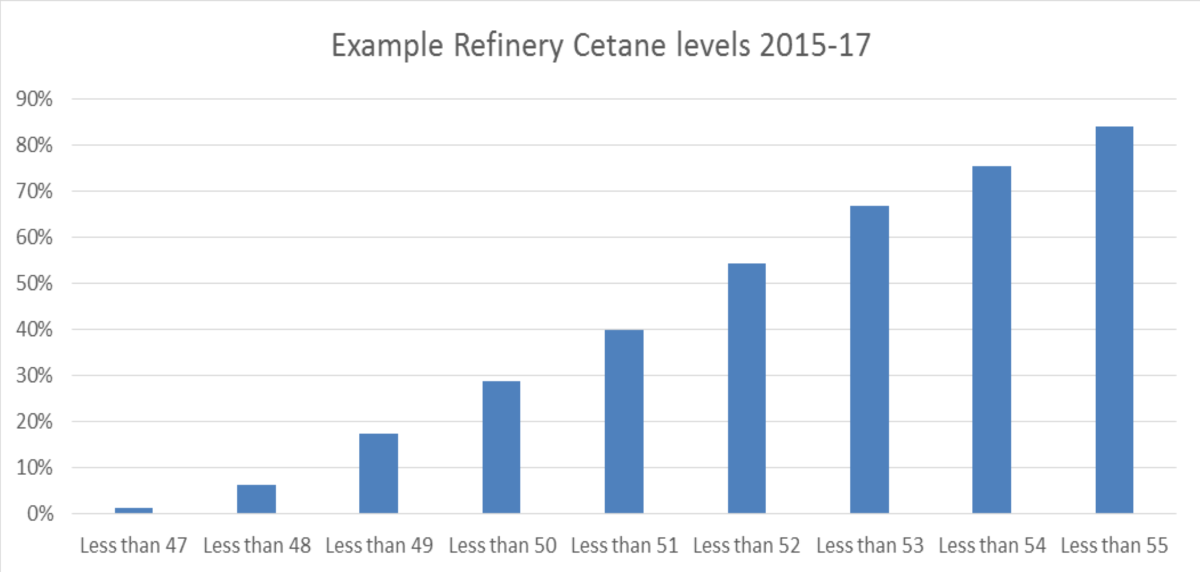


- Under refinery operating conditions at that time, <u>36 percent of Australian produced diesel would not meet 51</u> cetane levels under AIP member quality control procedures.
    - Diesel between 51 and less than 52 cetane may not be considered to have sufficient clearance from the quality specification to ensure it would be certified first time and consequently could be treated as non-compliant to the 51 cetane standard.
- Therefore, a significant proportion of Australian diesel would not comply with the 51 DCN.

However, under a similar logic applied above and in the time available for this Submission, AIP was able to collect data from one refinery, shown in the Chart below.

- The more recent data for one refinery confirms that a greater proportion (40 percent) of diesel produced over the period 2015-17 would not comply with 51 DCN.

- Diesel between 51 and less than 52 cetane may not be considered to have sufficient clearance from the quality specification to ensure it would be certified first time and consequently could be treated as non-compliant to the 51 cetane standard.
- **Therefore, the volume of diesel that would not be compliant to 51DCN could be as high as 54 percent. Clearly, this is a major impact on the operations of refineries.**



Cetane Index	Less than 47	Less than 48	Less than 49	Less than 50	Less than 51	Less than 52	Less than 53	Less than 54	Less than 55
Cumulative Proportion	1%	6%	17%	29%	40%	54%	67%	75%	84%

Each AIP member company currently has a s13 exemption in place for diesel blend DCN as they are unable to achieve the regulated level.

AIP and member companies consider there is no compelling evidence of operability impacts or environmental improvements for cetane levels above 46 minimum for Australian vehicles and conditions. In addition, a higher cetane does not facilitate better engine technology.

The main operability and environmental issues associated with cetane are related to potential cold starting issues, typically in temperatures of minus 10 degrees Celsius or less, that are not experienced in Australia's warmer climate.

While in the past, the performance of diesel vehicles was found to be sensitive to cetane number, particularly during cold start and cold operation, diesel engine technology has advanced significantly over recent years. In particular, with the evolution of fuel injection metering and fuel/air mixture preparation, we believe that cetane is no longer an operability concern under Australian climate conditions.

The main study we cite in support of this view is CRC Project AVFL-11 (2004) *The Effect of Fuel Cetane Quality of Light Duty Diesel Engines* – see http://www.crcao.com/publications/advancedVehiclesFuelsLubricants/index.html

The study was conducted on four European vehicles meeting Euro 3 & 4 emission requirements, using three different temperatures (-10°C, 0°C and 10°C) and eight different reference fuels with cetane number ranging from of 40.7 to 57.7. Significantly, three of the fuel specifications are lower cetane than the current Australian mineral diesel standard of 46 minimum.

The report concludes that modern vehicles equipped with solenoid controlled high pressure direct injection fuel systems (also known as common rail) are less sensitive to changes in cetane number than older technology vehicles.

On the whole, the performance of the vehicles tested was very good. All vehicles started readily under all conditions and suffered few driveability faults. Based on these results, modern diesel engines with common rail appear to be less sensitive to cetane than older vehicles with mechanical fuel injection over the range of temperatures studied. Some adverse effects of low cetane were detected: time for engine speed rise, idle quality, cold driveability, and cold-start smoke. In general, it would be difficult for consumers to perceive these impacts. As expected, the largest beneficial effects of higher cetane occurred at -10°C. Cetane impacts were very small at 0°C and +10°C. Surprisingly higher cetane had adverse effects on some performance attributes: fleet-average noise and vibration at 0°C and smoke after the vehicle was partially warmed-up at all test temperatures. As expected, there were also differences among vehicles in response to temperature and cetane variation.

The key results are summarised in the following table:

Summary of Fleet Average Trends
With Increasing Cetane Number (Confidence Level)

Variable	-10°C	0°C	+10°C
Time to 2000 RPM	Positive (99%)	None	None
Measured Idle Quality	Positive (99%)	Positive (99%)	None
Smoke 0-10 Seconds	Positive (99%)	Positive (NS)	None
Smoke 90-327 Seconds	Negative (95%)	Negative (99%)	Negative (99%)
Sound Pressure Level	None	Negative (99%)	None
Vibration	None	Negative (95%)	None
Driveability Demerits	Positive (NS)	None	None
Idle Quality Demerits	Positive (95%)	None	None

NS - Not statistically significant at 95% confidence level.

There are many other studies conducted on the impact of cetane on criteria pollutants and a useful literature review is at the following link:

http://www.sae.org/technical/papers/2009-01-1181

Key observations from the literature review include:

- Taken together the fuel properties of density, aromatics especially PAH, and cetane have been shown to affect diesel emissions, although contradictory studies have been published.
- Density, cetane and aromatics are closely associated with each other in diesel blends and in many programs these variables are correlated and it is not possible to distinguish the effects of one versus another.

- With a note of caution about the applicability of the following results to Australian conditions and currently available technologies, the following studies found:
    - A study by US EPA in 1998 using 1994-97 technology found that hydrocarbon and carbon monoxide emissions were reduced by around 10 percent but there was a slight increase in NO_x for a change in cetane from 45-52.
    - Several studies by the Japanese Clean Air Program (JCAP) found that there was no change in advanced engines with after-treatment for a cetane number between 47 and 54 and had no impact on NO_x and PM emissions.
- Given the large improvements in emissions associated with the cleaner fuels introduction and advancements in engine technology and after treatment system, these changes in emissions would appear to be relatively minor.

It would appear from the literature that there may be some very minor improvement in HC and CO as a result of increasing the cetane level in diesel but these pollutants are not a concern for Australian urban air quality.

However, there is no impact or possibly a negative impact on NO_x and PM as a result of increasing the cetane level in diesel. We would therefore have to seriously question an environmental case for increasing the cetane level in diesel.

These conclusions were generally supported by the HartEnergy desk study that was conducted for the DSEWPAC in June 2011. However, we argue that the desk study placed too much emphasis on the older studies such as EPEFE to find a stronger case for the reductions in HC and CO, where Euro3 vehicles were used without advanced pollutant control equipment. More recent studies such as De Ojeda et al (2011) found that under medium to high load levels there were insignificant differences between HC and CO emissions levels. Again we stress that neither of these pollutants present an issue for Australian urban air quality.

The general qualitative conclusions from the available literature are:

- It is difficult to unravel the impacts of each fuel parameter (cetane, aromatics and density) and later studies do not support the HartEnergy conclusions about the directional effects on criteria pollutants; and
- In any case, with advanced after treatment technologies, emission levels are becoming insensitive to the fuel quality parameters.

In the US, the minimum cetane number for mineral diesel and all biodiesel blends up to 20 percent volume is 40 cetane. Typical cetane levels for mineral diesel in the US range from 42-45. Despite the lower cetane than currently in Australia, US diesel engines still meet stringent emissions standards and operate to customer requirements.

Also, it should be noted that even though in the US cetane for 100 percent biodiesel is set at 47 minimum, the cetane limit for biodiesel blends remains at 40 minimum – the same as mineral diesel.

Consequently, AIP and its member companies do not consider there is any compelling evidence for adverse operability and environmental outcomes of setting the minimum DCN at 46 in Australian conditions and there is no requirement to set a higher cetane for B5 biodiesel blends.

<u>The cost of meeting DCN 51</u>

As stated above, AIP does not consider that there is any compelling evidence to require Australian mineral diesel nor biodiesel blends to meet a cetane limit of 51 minimum.

AIP member companies believe there is no net community benefit in increasing the cetane limit above the existing 46 minimum. Each refiner and importer will need to undertake a further significant analysis of the options presented and determine the industry aggregated costs.

While there are technical options for meeting a DCN of 51 that include crude selection, the addition of cetane improvers, and batch-by-batch management, each is costly and problematic.

Each refiner's situation will be unique, however, some general conclusions can be drawn for the sector as a whole. None of these options are found to be economically viable and some were considered to be undesirable from a safety and material handling point of view.

1. Crude oil selection

Detailed modelling has not been undertaken to determine the impact of achieving 51 cetane though crude feedstock selection, but modelling for one refinery conducted in 2011 indicated a cost of $11 million per annum.

2. Refinery blend optimisation

Australian refineries maximise the production of petrol via the use of a catalytic cracking unit (CCU) to break down long residues from the crude distillation units. The CCU produces various streams, of which one with a significant volume is Light Cycle Oil (LCO). LCO is a high density, low cetane diesel fraction which must be blended into diesel to realise its maximum value or sold as a fuel oil component at a significant financial loss relative to diesel volume value.

One option to boost cetane is to exclude LCO from blending and ship the LCO to Singapore for sale into the low value fuel market. Assessment of this minimised LCO blend option estimated the cost to be in the order of $20 million per annum for one Australian refinery.

This option is mostly infeasible for Australian refineries as it fundamentally affects the operation of the refinery and is subject to significant shipping and storage constraints.

3. Treatment with cetane improving additives

Mineral diesel cetane can be lifted by dosing the diesel with cetane improver 2-Ethyl Hexylnitrate (or 2-EHN).

Very initial estimates indicate that installation of a system for 2-EHN would be greater than $2 million per facility with ongoing operations costs of probably $0.5 million per year.

A key concern is that 2-EHN additive is a hazardous material with significant safety risks that must be managed more carefully than other materials commonly found in fuel manufacturing facilities. It has recognised explosion and fire safety issues associated with its storage and handling which introduces significant additional risk associated with the storage of bulk quantities of this additive that requires specialised equipment, systems and procedures to manage risk to as low as reasonably practicable.
The capital and operational costs associated with the use of cetane improvers are viewed as significant.

PAH in diesel

- AIP member companies believe there would be negligible environmental and operability benefits of reducing the PAH limit.

- CONCAWE report 4/05 concludes that *"In older technology vehicles, reducing fuel poly-aromatics content gave lower PAH emission, although reducing fuel poly-aromatics content even to zero would not eliminate PAH emissions, as a significant proportion of the total PAH is combustion derived."*
- *"In the newer technology diesel vehicles with effective exhaust after-treatment, either oxidation catalysts or diesel particulate filters, PAH emissions were so low that there was no longer any sensitivity to fuel poly-aromatic content."*
- Domestic refineries would likely need investment in expensive diesel hydrotreater reactors to achieve any substantial reduction in PAH.
- The average PAH levels produced by each Australian refinery are below 6 percent but to limit it to 6 percent would substantially constrain refinery flexibility and threaten refinery viability.
- Tightening PAH spec to 8 percent max would substantially constrain refinery flexibility and threaten refinery viability. Most domestic refineries would likely need investment in expensive high pressure diesel hydrotreater reactors to achieve any substantial reduction in PAH.

Proposed B20 Standard

Please refer to the AIP Submission dated 11 May 2012 to the Department of Sustainability, Environment, Water, Population and Communities on the Discussion Paper for Developing a B20 fuel quality standard in which the proposed B20 test properties and test methods are discussed extensively. Primary comments raised in that submission relevant to the currently proposed B20 Diesel Biodiesel Blend standard are outlined below.

Viscosity
The range needs to be adjusted to 2.0-4.6 so as to align with the resultant viscosity from blending the raw diesel and biodiesel. AIP recommends setting a range for Kinematic Viscosity @ 40 °C of 2.0 – 4.6 mm^2/s by ASTM D445 rather than 2.0 – 4.5 mm^2/s, to allow for the situation where both blend components are at their legislated maxima.

Restriction of the B20 specification of 4.5 max, indirectly places restrictions upon the mineral diesel and biodiesel blend components.

Derived Cetane Number
AIP is not aware of any compelling environmental or operability reasons for specifying a DCN of 51 for B20 that will outweigh the considerable costs. AIP strongly recommends a minimum DCN of 46 for the proposed B20 standard (in alignment with the cetane requirement for mineral diesel).

Acid Value
AIP recommends setting a limit for Acid Value of 0.5 mg KOH/g maximum by ASTM D664 rather than 0.3 mg KOH/g maximum proposed in the discussion paper to compensate for the currently specified Acid Value maximum of 0.8 mg KOH/g in the Australian fuels standard for B100.

Oxidation Stability
AIP recommends setting a limit for Oxidation Stability of 6 hours minimum by EN15751 to align with the Australian fuel standard for B100.

Oxidation Stability is heavily influenced by the biodiesel content and so it is appropriate to align with the B100 standard. AIP recommends that reference should be made to an established comparable product specification such as ASTM D7467 B6 - B20 to support the proposed limit. The US standard for B6-B20, ASTM D 7467, defines a minimum 6 hour induction period for blended fuels with no obvious quality concerns being detected in the American market.

AIP recommends the most appropriate starting position for oxidative stability is harmonisation with ASTM D7467, which defines a minimum 6 hour induction period.

Biodiesel content
AIP proposes that the biodiesel content be specified as 5.1 - 20 percent v/v maximum biodiesel content limit by EN 14078.

Water & Sediment
AIP supports setting a limit for water and sediment of 0.05 vol percent maximum by ASTM D2709. However, please see the 2012 submission regarding a discussion relating to harmonisation with ASTM and the current Australian standards for Automotive Diesel and biodiesel.

Filter Blocking Tendency
AIP supports a maximum limit for FBT by ASTM D D2068/IP387 of 2.0 to align the B20 specification with the diesel quality standard.

Summary of AIP position on Test Properties and Test Methods

Test Property	Test Method	AIP Submission
Flash Point , °C	D93	61.5 min
Water & Sediment %v/v	D2079	0.05 max
Distillation , 90% recovered, °C	D1160	360 max
Kinematic Viscosity @ 40 °C, cSt	D445	2.0 – **4.6**
Ash , mass%	D482	0.01 max
Sulfur content, mg/kg	D5453	10 max
Copper Corrosion (3h @ 50 °C)	D130	1 max
Derived Cetane Number	D6890	**46 min**
Carbon Residue(10% bottoms), % mass	D4530	0.3 max
Lubricity, HFRR @ 60 °C , µm	IP450	460 max
Biodiesel Content , vol%	EN14078	5.1 – **20. Note 1**
Acid Number, mg KOH/g	D664	**0.5 max**
Oxidation Stability, hours	EN15751	**6 min**
Density, kg/m³	D1298	820 – 858
Conductivity @ ambient temperature, pS/m – Needs to be agreed with AIP members	D2624	50 pS/m minimum
Filter Blocking Tendency	D2068	2.0 max

Note 1: Results to be rounded to two significant figures only for purposes of determining compliance with the standard

(6.4) PROHIBITED FUEL ADDITIVES

POLICY ALTERNATIVES: Register of Prohibited Fuel Additives

Do you agree with the Department's proposal to list the above additives [tetraethyl lead, NMA, MMT and polychlorinated n-alkanes] on the Register of Prohibited Fuel Additives? If not, why not?

1. *Should MMT (methylcyclopentadienyl manganese tricarbonyl) or other additives such as N-methylaniline be allowed in Australian fuel as an octane enhancer?*
2. *Are you aware of any substitute octane enhancers that can be used in place of MTBE and other ethers?*
3. *What (if any) other substances should be considered for listing on the Register of Prohibited Fuel Additives?*

AIP member companies are not able to offer an opinion on the prohibition of polychlorinated n-alkanes as the paper does not provide any reasoning behind their nominations and they are not a substance of current known concern to AIP member companies

AIP member companies support the inclusion, on the Register of Prohibited Fuel Additives, NMA and tetraethyl lead, however similar to lead and MTBE limits already present in the current Petrol Standard, some dispensation for possible importation of petrol batches containing trace quantities of these additives must also be considered. In addition, the Department should consult with OEMs and additive suppliers on the treatment of MMT.

Each of these octane enhancers are discussed separately below.

N-methylaniline (NMA)

NMA is an organic compound which is commonly used as a solvent or as an additive for dyes, fertiliser and organic products. When NMA is added to petrol, it can boost the octane of petrol (RON & MON).

NMA has been banned for use in petrol in many nations (eg. China, Russia, across Asia), and AIP member companies do not use NMA as a petrol additive or blendstock in Australia.

NMA is not expressly prohibited in the Australian *Fuel Quality Standards Act.*

AIP member companies are concerned that NMA may have been used as a petrol 'blendstock' in the Australian Market, to boost the octane of base-grade unleaded petrol (91RON) to levels consistent with premium petrol (95RON and 98RON).

This would require NMA to be blended at high concentrations of around 1.5-3.5 percent, which is a significant volume of NMA. At these significant levels, according to the *Fuel Quality Standards Act*, it would be considered a 'blendstock' rather than an 'additive'.

AIP members are not aware of any rigorous scientific information and testing publicly available in Australia that clearly demonstrates that NMA blended with 91 RON petrol to achieve higher octane fuels:

- is safe for use in Australian fuels and is fit for purpose
- will not lead to adverse operability impacts on vehicle engines
- will not result in negative environmental or emission outcomes
- will deliver the same high performance for engines as the premium fuels not including NMA and sold under the brand of AIP member companies.

In the global fuels market, when NMA has been used as a blendstock with petrol, rather than as a low-level additive, it has been linked to adverse operability impacts including engine malfunctions.

For example, a SAE International Technical Paper was recently released on the 'Impact of Aniline Octane Booster on Lubricating Oil' (see http://papers.sae.org/2016-01-2273/).

The preliminary findings of this research, in summary, were the *"observed impact of aniline octane booster and more specifically N-Methyl Aniline (NMA) on lubricating oil, following field issues encountered in vehicles in certain areas of the world where aniline based octane booster was assumed to be used. The observed field issue was heavy sludge formation, leading to engine malfunctions."*

There are also international references to NMA:

- interacting strongly with copper and copper alloys (see Wiley Guide to Chemical Incompatibility, Pohanish and Greene, P681, 2009); and
- causing seal swell when seal material is exposed to gasoline blended with 3 or 5 percent of NMA (see Asian Clean Fuels Association - http://www.acfa.org.sg/newsletterinfocus17_01.php) which could increase the likelihood of fuel leaks in motor vehicles and retail sites.

AIP member companies recommend that there should be significant further testing of the operability impacts of NMA blended petrol.

There are also a number of references to NMA being acutely toxic and harmful to health and has long term adverse effects on aquatic environments and organisms.

The Globally Harmonised System of Classification and Labelling of Chemicals (GHS) is used to classify and communicate chemical hazards using internationally consistent terms and information on chemical labels and Safety Data Sheets. The GHS provides criteria for the classification of physical hazards (e.g. flammable liquids), health hazards (e.g. carcinogens) and environmental hazards (e.g. aquatic toxicity).

Under Hazard Classifications and Statements, NMA is classified as:

- Toxic if swallowed
- Toxic in contact with skin
- Toxic if inhaled
- Causes serious eye irritation
- Suspected of causing genetic defects
- Suspected of causing cancer
- Very toxic to acquatic life with long lasting effects

10.1.1 **GHS Classification**

Signal: Danger
GHS Hazard Statements
H301: Toxic if swallowed [Danger Acute toxicity, oral - Category 3]
H311: Toxic in contact with skin [Danger Acute toxicity, dermal - Category 3]
H331: Toxic if inhaled [Danger Acute toxicity, inhalation - Category 3]
H373: Causes damage to organs through prolonged or repeated exposure [Warning Specific target organ toxicity, repeated exposure - Category 2]
H400: Very toxic to aquatic life [Warning Hazardous to the aquatic environment, acute hazard - Category 1]
H410: Very toxic to aquatic life with long lasting effects [Warning Hazardous to the aquatic environment, long-term hazard - Category 1]

NMA is also classified for road transport as a Class 6.1 Toxic compound and this would be because it is known to be readily taken up via skin contact. Consequently, NMA would require very careful storage and handling, particularly during blending activities and transport (including protective clothing, eyewear and gloves) as well as safeguards to prevent any environmental release and contact with soil, waterways, drains and sewers. It would be of particular concern in markets in close proximity to sensitive marine environments.

NMA and its containers must be also disposed of as hazardous waste.
NMA is listed on the (AICS) under the National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Chemicals on AICS can be imported or manufactured in Australia without notifying NICNAS.

Based on international experience, AIP member companies have strong concerns about adverse operability impacts of NMA being used as a blendstock for petrol in the Australian market, and concerns about adverse health and environmental impacts of NMA being used as an additive or blendstock.

AIP member companies support its inclusion in the Register of Prohibited Fuel Additives, unless compelling scientific evidence can be produced of no adverse operability impacts, including at low concentrations, and that potential adverse impacts on human health and environment can be rigorously controlled for.

Tetraethyl lead

The Australian Government phased out leaded petrol in Australia as of 1 January 2002. Lead additives in petrol raised the octane of the petrol, and provided protection against valve-seat recession. This was necessary for most cars produced before 1986.

Since that effective prohibition of the supply of leaded petrol, the supply of Lead Replacement Petrol (LRP) was widely available for use in vehicles that formerly used leaded petrol and some of those vehicles (those manufactured before 1986) were able to run on unleaded petrol.

However, the number of cars requiring LRP diminished over time to the point where it was unviable for fuel suppliers to produce, store and distribute the fuel, and for service stations to supply it. As a result, it was phased out. More information about the phase out of lead replacement petrol (LRP) is available from http://www.aip.com.au/pdf/LRP%20brochure.pdf.

AIP member companies support the proposed extension of the lead prohibition to all road vehicles, including racing vehicles.

Methylcyclopentadienyl manganese tricarbonyl (MMT)

MMT was the main additive used as lead replacement in LRP.

In Europe, use of MMT has been effectively banned through inclusion of a limit on Mn content in the Fuels Quality Directive that applied from January 2011. To reflect this legal limit, an update was made to the EN 228 petrol specification to limit Mn content to 6.0 mg/litre reducing to 2.0 mg/litre from January 2014.

More information on the status and use of MMT is available from:

- ACEA (the European trade association for the automotive industry) – see: https://www.leg.state.nv.us/App/NELIS/REL/77th2013/ExhibitDocument/OpenExhibitDocument?exhibitId=4942&fileDownloadName=ACEA%20MMT%20Paper.pdf

- The Coordinating Research Council, Inc. (CRC), CRC Project E-114, - *Effects of Organometallic Additives on Gasoline Vehicles: Analysis of Existing Literature* : Final Report (September 2015), see: https://crcao.org/reports/recentstudies2015/E-114/Final%20Report.pdf

Metal octane boosters are not just octane boosters, the additive also contains stabilisers to inhibit ash formation, metal octane boosters such as MMT and Ferrocene burn to produce metal oxide ash which can build up on spark plus, oxygen sensors and inside the combustion chamber increasing octane demand.

Ash deposits:

- on spark plugs reduce spark plug life and effectiveness, particularly if they are platinum tipped where life expectancy is expected to be 100,000 km and more, this will light up OBD systems and limit the ability to reduce vehicle service intervals.
- will coat oxygen sensors leading to incorrect diagnostics on fuel consumption leading to an increase in fuel consumption and emissions. OBD systems may also be triggered.
- can coat catalytic converters reducing their effectiveness and leading to an increase in exhaust emissions.

AIP recommends that the Department consult with OEMS and additive suppliers to determine the approach to this issue.

Polychlorinated n-alkanes

AIP member companies are not able to offer an opinion on the prohibition of polychlorinated n-alkanes as the paper does not provide any reasoning behind their nominations and they are not a substance of current known concern to AIP member companies

(7)NEXT STEPS AND CONSULTATION

AIP welcomes the opportunity to provide a submission to this consultation process and looks forward to ongoing consultation with relevant Departments on any proposals to change Australian fuel quality standards.

Given their significant role and investment, AIP member companies have a very strong interest in consultations relating to government policy proposals impacting on the downstream petroleum industry, particularly the refining industry's ongoing viability and competitiveness, given their significant contribution to local economies, communities and Australia's fuel supply security.

For two decades, AIP has strongly supported orderly transitions to different fuel standards where a community benefit has been clearly demonstrated in terms of environmental and health outcomes, and where the cost impacts on refineries and consumers can be managed.

AIP commits to work closely with the RIS consultant to ensure that accurate data is supplied and costs impacts are accurately modelled for the purposes of the Government's decision making particularly given the impacts of any refinery closures resulting from this policy.

Should you have any questions in relation to this submission, or require additional information from AIP, the relevant contact details are outlined below.

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AIP is happy for our submission to be made publicly available on the Department's website.

AIP member companies may also make submissions to this consultation process, addressing specific matters raised in the Discussion Paper dealing with commercial and other issues specifically related to those companies.

Given the potential for the proposed policy changes to require additional investment and ultimately bring about further refinery closures, each AIP member company commits to keep the Government closely informed of its respective options and decision making processes throughout any proposed implementation period.

APPENDIX:
AIP RESPONSES TO DISCUSSION PAPER CONSULTATION QUESTIONS

The Discussion Paper – Better Fuel for Cleaner Air – includes sixty consultation questions to assist the development of the RIS. AIP's brief responses to these questions, where relevant and known, are outlined below, including references to key findings and analysis in the main body of the AIP Submission.

QUESTION SET 1. QUESTIONS IN RELATION TO THE FUEL STANDARDS

Policy alternatives outlined in this paper

1. Can you provide evidence of the costs and/or benefits of any of the listed policy alternatives (A, B, C, D or E)?'

AIP has developed an alternative Option F and has provided evidence on the following for implementing the option:

- refinery operating and capital costs, including a confidence range and a likely estimate
- increased price of the fuel to 2027
- market fuel quality for better assessing health benefits
- economic benefits for the Australian refining sector to assess costs for refinery closures
- increased refinery emissions.

AIP will work closely with the Government's RIS consultant, Marsden Jacobs, to compile or develop any further information that may be required.

2. Do you have a different alternative which is not covered in this paper?

AIP has developed an alternative Option F which includes an interim step detailed as follows:

- ULP: 80 ppm pool average / 120 ppm max sulfur from 2021 (reporting not regulation)
- PULP: 40 ppm pool average / 50 ppm max sulfur from 2021 (reporting not regulation)
- 10ppm sulfur gasoline from 2027 across all grades of petrol
- Examination of health benefits for the existing fleet to determine whether a 30ppm ULP standard can be contemplated to address pipeline issues at distribution terminals.
- No change to any other gasoline or diesel parameter
- No changes to MTBE and other oxygenates limits
- Support the proposed prohibited substances register
- Some minor changes to test methods detailed in question 8.

3. Are there any changes which would improve or clarify the operation of the fuel standards?

AIP considers the Fuel Quality Standards to be essential to delivery of quality fuel to end users and supports the concept without reservation. The current method of operation with compliance with the standard at the point of sale is considered to be the correct method of application of the regulations as this delivers a defined quality of fuel while allowing supplying/manufacturing companies the flexibility to manage quality in their supply chains.

There are, however, some minor issues within individual standards that require resolution to facilitate operation and delivery of choice options to customers. In summary, AIP proposes to:

1. Remove the 51 DCN requirement from blended biodiesel and replace with a 46 DCN minimum to match mineral diesel so as to ensure compliance with the Diesel quality standard Cetane Index minimum without requirement for a Section 13 Variation. This is a barrier to wider uptake of biodiesel.
2. Introduce a maximum density limit for Diesel B5 blends of 852 kg/m^3@15C to allow for blending of biodiesel which has a higher density limit with high density diesel (compliant with the standard) and ensure compliance with an amended Diesel quality standard density maximum without requirement for Section 13 Variation.
3. Change the maximum density limit for Diesel B20 to 858kg/m^3@15C to allow for blending of biodiesel which has a higher density limit with high density diesel (compliant with the standard) and ensure compliance with the Biodiesel B20 quality standard density maximum without requirement for Section 13 Variation.
4. Modernise the referee test methods to utilise more modern test technology. Refer to details in response to Question 8.
5. Include a Filter Blocking Tendency (FBT) test in the biodiesel (B100) standard to determine/limit potential blended product operability before release of B100 for sale and establish biodiesel cleanliness by a FBT (ASTM D2068/IP387) as a blended B20 product using mineral diesel with a max FBT of 1.10 as the blend reagent. A maximum blend FBT of 1.6 is suggested to allow for degradation in the supply chain to the current Diesel quality standard maximum of 2.0. FBT of final biodiesel blends can be adversely impacted by B100 water, Mono-, Di- and Triglyceride content. The aim is to verify operability for potential blended product received by end user customers and mitigate the fitness for purpose risk for biodiesel blenders/purchasers.
6. Introduce the following limits in the Biodiesel (B100) standard to reduce final product blender quality risk and end user customer operability risks:
    - Test for and place limits on partially reacted feedstock contaminants specifically Monoglycerides (0.4 percent mass maximum), Diglycerides (0.2 percent mass maximum) and triglycerides (0.2 percent mass maximum) which have been linked to precipitation of solids in B100 and BXX blends and can result in filter blocking issues for customers. A suggested Test Method is ASTM D6584.
    - Test for and limit dissolved water content (500 mg/kg) by ASTM D6304 to limit risk of water saturation and resulting precipitation / haze on blending with mineral diesel.
    - Test for and limit Cold Soak Filterability (360 seconds maximum) by ASTM D7501. Some substances that are soluble or appear to be soluble in biodiesel (B100) at room temperature will, upon cooling to temperatures above the cloud point or standing at room temperature for extended periods, come out of solution. This phenomenon has been observed in both B100 and BXX blends. These substances can cause filter plugging. This method provides an accelerated means of assessing the presence of these substances in B100 and their propensity to plug filters.

      The aim is to reduce risk to vehicle operability for blended product received customers and mitigate the fitness for purpose risk for biodiesel purchasers.

4. Should any other fuel standards be developed (other than the proposed fuel standard for the B20 diesel biodiesel blend)?

No.

Additional questions

5. Can you provide evidence of the extent to which the current fuel standards limit the adoption/importation of existing technologies and models that meet higher specifications?

AIP is not aware that the current fuels standards limit the adoption/importation of existing technologies and mainstream models (other than a very limited number of high-end gasoline Lean Burn GDI vehicles which require 10ppm sulfur petrol).

6. What changes to the fuel standards would best reduce emissions, ensure engine operability and facilitate new engine technologies?

Both Petrol and Diesel standards are currently delivering high quality, well-regulated fuel to the market and allowing for operation of vehicles designed to deliver environmental and fuel economy outcomes. The fuel quality standards ensure that the industry supplies fuel to the same standards and that customers are never disadvantaged.

Based on current expectations around future vehicle technology requirements, the current fuel standards are appropriate and no further changes are required at this time. Although expected engine technology deployment pathways and the regulation of Euro 6 vehicle emissions standards will not require 10ppm sulfur gasoline, AIP acknowledges the adoption of 10ppm sulfur gasoline from 2027 may provide increased technology flexibility.

AIP does recommend the addition of a Silver Corrosion test for petrol (ASTM D7671 or D7667) with a specific limit of 2 maximum to protect customer vehicle fuel tank level sensing equipment. This test was introduced globally by most oil companies after incidents in the United States. The intent within the industry is to manage to a maximum result of 1. However, occasional batches with a result of 2 pose no operability risks and the industry requires flexibility to allow management of batches with a 2 rating.

For diesel, AIP recommends that the colour maximum of 2 be removed as this has no relationship to fuel performance and ultra-low sulfur diesel colour varies in ranges not covered by the ASTM D1500 test method.

7. What changes to the fuel standards do you believe will be required if the Australian Government mandates Euro 6 emissions standards for light vehicles?

AIP maintains that the current fuel standards are not a barrier to the adoption of Euro 6 emissions standards and will not prevent the certification of vehicles against the Australian Design Rules requirements. The only parameter which may need to be examined at all is gasoline sulfur.

There is sufficient evidence contained in available literature reviews (SGS Environmental Testing Corporation (June 2013) *Reversibility of Gasoline Sulfur Effects on Exhaust Emission from Late Model Vehicles American Petroleum Institute; Orbital Australia (June 2013) Review of Sulfur Limits in Petrol Department of Sustainability, Environment, Water Population and Communities (DSEWPAC))* to support this view. The Diesel standard is already adequately defined and specified to deliver all requirements. For Petrol, the discussions and reviews around sulfur limits indicate the Euro VI/6 vehicles can already operate effectively with currently specified premium grades in Australia; the pool averages of which are substantially below the quality standard maximum of 50 ppm.

8. Each fuel standard includes required test methods for analysis of fuel samples. Do you have any comments on the test methods specified in the fuel standards?

The following recommendations are made with respect to suggested changes to the test methods specified in the fuel standards.

Petrol Standard

Add:

- AIP believes that the addition of a Silver Corrosion requirement to the Petrol standards will benefit consumers by controlling potential corrosion issues that may impact on fuel tank contents level sensing sensors. Corrosion of the silver alloys in these units has resulted in operability issues in the United States and as a result controls to mitigate this risk should be implemented in the Petrol regulation to ensure appropriate protection for consumers. AIP recommends the addition of a Silver Corrosion test (ASTM D7671 or D7667) with a maximum result of 2 to protect customer vehicle fuel tank level sensing equipment. The industry intent is to manage to a 1 result however flexibility to manage occasional results of 2 are required.

Diesel Standard

Modify:

- As previously noted, AIP also advocates the Colour parameter in the Diesel Regulation be removed. Colour of diesel does not in any way reflect the quality of diesel. Different refineries utilise different technologies to deliver ultra-low sulfur diesel, with the colour of the finished product reflecting the technology employed. Consequently, diesel colour varies from the traditional ASTM D1500 amber/yellow/brown standard colours making measurement meaningless. Given the comprehensive nature of the current Diesel quality standard which defines key operability parameters, variations in colour are only of interest in the supply chain and do not relate to customer amenity, vehicle performance or tail pipe emissions.

9. Are there any other issues you would like to raise in relation to the fuel standards?

The diesel quality standard as currently defined makes blending of B5 and B20 biodiesel products impossible without the relaxation provided by a Section 13 Variation to the Act. AIP member companies are unable to practically respond on a batch by batch basis to implement biodiesel blending just to suit specific batches. A relaxation of density and cetane limits for blended diesels, as previously highlighted, will facilitate biodiesel blending, and may encourage a greater uptake of biofuel blends.

QUESTION SET 2. QUESTIONS IN RELATION TO THE FUEL QUALITY INFORMATION STANDARDS

10. Do you have any views on the Department's proposal to amend the Fuel Quality Information Standard for Ethanol (E85)?

There does not need to be any extra specification of vapour pressure maxima or minima for this product. The only variable component in E85 blends is the ULP component and specifying a final blend vapour pressure makes the blending of an E85 product too complex to enter into in any meaningful way. Compliance with a vapour pressure standard that is not possible to relate to the vapour pressure of the components makes compliance with a narrow regulatory target a hit or miss affair. The industry has comprehensive and cross company agreement on ULP vapour pressures that account for regional and seasonal variations. These agreements are based on experience with vehicle operability under various conditions. Summer fuel volatility is further controlled and must comply with various State EPA regulations. These agreements and regulations form the basis of complex contractual arrangements for supply of locally produced and imported fuels. They also provide for stringent quality specifications for vapour pressure for the base ULP blend component. E85 will be blended with product that complies with all industry, State and Federal regulations and additional constraints for vapour pressure will not provide for any enhanced environmental performance or consumer protection.

AIP notes that Vapour pressure is not currently specified in ULP grades in Federal regulations, and it is inconsistent and counterproductive to do so for E85 blends specifically.

11. To what extent are you aware of misfueling (the use of a fuel that is inappropriate for a given vehicle)? Do you believe the Fuel Quality Information Standards are useful in preventing misfueling?

AIP does not believe misfueling is a widespread problem although there is currently significant scope for this to occur with ULP and PULP grades. AIP considers that consumers are generally well informed about the required fuel for their vehicles. However, the Fuel Quality Information could assist in increasing this awareness.

QUESTION SET 3. QUESTIONS IN RELATION TO FUEL QUALITY STANDARDS REGULATIONS 2001

12. Have you identified any issue with the Regulations that you would like to draw to our attention?

There are inconsistencies between current diesel standard and Biodiesel (B100) standards with respect to Filter Blocking Tendency (FBT) of the finished diesel blend. As the B100 standard currently stands, there is no link between the FBT of the finished product (biodiesel blend) and the B100 regulated specification. The potential exists for residual trace bio-components (plant sterols and glycolipids) remaining from the transesterification process to remain dissolved in B100 to precipitate on blending with mineral diesel. This has caused unacceptably high FBT results in the blended product. Within the current standard, Biodiesel manufacturers do not have to validate fitness-for-purpose of B100 before it leaves the site. This opens up the possibility of having B100 product that meets all regulatory requirements that when blended as a B5 or B20 may result in product that does not meet regulatory FBT requirements for diesel blends. Some AIP members, through trials of potential biodiesel manufacturers' product, have identified this situation of 'on grade/compliant' B100 resulting in 'off grade/non-compliant' biodiesel blends, and therefore consider it a risk to customers that requires management. As such, there is a requirement for biodiesel to be determined as 'fit-for-purpose' before it leaves the manufacturing plant. Once biodiesel has been received at a terminal site, there are very few options to compensate for high FBT blends.

AIP therefore recommends that the Biodiesel quality standard be altered to include a fitness-for-purpose test which includes preparation of a laboratory blend of 20 percent biodiesel with commercially available diesel which is then tested for Filter Blocking Tendency (ASTM D2068/IP 387) to ensure the B100 component will be fit for purpose in diesel blends.

As already noted in previous sections, there is a discrepancy between the Diesel and blended biodiesel Cetane and Density. The Derived Cetane Number (DCN) for blended biodiesel needs to be reduced to 46 minimum and aligned the diesel Cetane Index (CI) regulation. This will allow blending of locally produced diesel. A review by one AIP member of 2 years' production of diesel has shown that 40 percent of batches produced had CI's below 51 which would have precluded their use in biodiesel blends without a Section 13 Variation. Without this alignment, the risk of releasing non-compliant blends results in companies being unable to release biodiesel fuels without the benefit of a Section 13 Variation for DCN and density. As a consequence, companies are unable to utilise significant biodiesel blending infrastructure that was installed at significant capital cost, which further inhibits the adoption of biodiesel blends for those customers seeking an alternative to straight mineral diesel.

With respect to density, a review of one refinery's production also revealed that average batch densities makes blending density compliant biodiesel fuels difficult to achieve without reliance on a Section 13 Variation. 24 percent of batches had densities high enough to risk compliance with the maximum density for 5 percent biodiesel blends (B5). 56 percent of batches had densities sufficiently high to risk compliance for 20 percent biodiesel blends (B20).

The fuel industry and biodiesel manufacturer's therefore require that B5 blend density maximum be adjusted to 852kg/m3@15C and B20 blends be allowed to have a maximum density of 858kg/m3@15C to remove this blending constraint.

In summary, AIP recommends:

- The Biodiesel standard requires a fitness for purpose test involving FBT testing of a B20 laboratory blend.
- The Diesel standard needs to have the 51 DCN minimum for blended biodiesel reduced to 46 to match the mineral diesel standard.
- The Diesel standard maximum density for B5 blends needs to be adjusted to 852kg/m3@15C to allow for blending high density B100 and mineral diesel.
- The proposed B20 standards needs to allow for a maximum density of 858kg/m3@15C to allow for blending high density B100 and mineral diesel.

13. Is the definition of 'fuel' adequate to enable all relevant standards to be made? For example, should the definition of fuel be expanded to cover marine diesel, synthetic diesel, methanol-based fuels, etc to enable standards to be made for these fuel types?

AIP member companies do not see any need to expand the definition of 'fuel' at this time as the current definition of fuel has adequate scope to allow for fuel quality standards which define potential ground fuels that may be employed by vehicles utilising roads for transport or engaged in off road work.

Other fuels used in the marine and aviation industries are already defined in detail by globally accepted quality standards and inclusion of standards for these grades in the FQSA will only result in duplicated regulation. The Australian market is not in a position to influence these standards.

With respect to 'synthetic diesel', consideration must be broadened to include any non-petroleum sourced fuel, including Fischer-Tropsch gas to liquids/biomass to liquids/coal to liquids, hydrogenated vegetable oil or other non-crude oil refining process derived diesel or motor spirit components. All fuels employed on Australian roads must comply with stringent and comprehensive FQSA and industry manufacturing fuel quality standards that define fit-for-purpose fuels regardless of manufacturing process or raw material source. Regulation in the FQSA by source or process adds complexity without any benefits to consumers or the environment. There is also no way for companies to easily verify what manufacturing process or source material is involved in the manufacture of imported fuels.

14. Currently, aviation gas (avgas) is explicitly excluded from the petrol standard. Do you believe avgas should be covered by a fuel standard?

AIP member companies do not see any need for avgas to be covered by a fuel standard.

Aviation fuels are covered by a comprehensive set of global quality standards which control composition of the fuel for manufacturers and importers. If Australia attempted to establish aviation fuel quality standards it would be at odds with the rest of the global industry. For standards to be accepted by Australian aviation operators, these must replicate current global standards so as to ensure acceptability across the entirety of the aviation industry, airframe and engine manufacturers and end users of existing and future equipment.

There is no environmental or consumer benefit to be gained from local regulation of aviation fuel as local fuel manufacturers and importers can only source and sell fuel that complies with the existing accepted standards. Changes to fuel specification or composition can only be made by the provision of data to build a case to the governing bodies of the existing global standards. The Australian fuel industry is not in a position to enact changes arising from any discrepancies between the existing global standards and potential local regulatory requirements.

QUESTION SET 4. QUESTIONS IN RELATION TO THE FUEL QUALITY STANDARDS *(REGISTER OF PROHIBITED FUEL ADDITIVES) GUIDELINES 2003*

15. Do you agree with the Department's proposal to list the above additives on the Register of Prohibited Fuel Additives? If not, why not?

AIP supports the proposal to list TEL and NMA on the Register of Prohibited Fuel Additives, allowing for trace concentrations which are to be defined. It should be noted that NMA is used in quantities which might be considered to be a blend stock rather than an additive and therefore it needs to be considered whether it would be captured within the fuel additive definition. AIP has no opinion on chlorinated paraffins. AIP recommends that the Department liaise with additive suppliers and vehicle manufactures directly on the suitability of additives in fuels.

Tetraethyl Lead (TEL) is already effectively prohibited in road fuels however it is not intended that placing TEL on the Prohibited Fuel Additive list prevents the manufacturing or importation of Aviation Gasoline. Importation of TEL for Aviation Gasoline manufacture at Geelong refinery and in Aviation Gasoline imported fuel is necessary for the Aviation industry.

N-Methylaniline (NMA) has a questionable impact on engine oil residues and performance (refer to *SAE 'Impact of Aniline Octane Booster on Lubricating Oil' Report #2016-01-2273*) which indicates some potentially adverse impacts on engine oil. The toxicity of NMA also makes it a questionable component to expose customers and operational personnel. It should also be noted that NMA has also been banned in some jurisdictions (eg. China).

MMT's effect on emission catalysts systems, spark plug life and on-board diagnostic systems via deposits on oxygen sensors (Refer to *CRC 2015 Literature review Report E-114 and SAE Report 2016-01-9073*) is questionable. AIP recommends the Department should consult with OEMs and additive suppliers on the treatment of MMT.

AIP will seek further clarification from the Department on the reference to chlorinated paraffins in the discussion paper.

16. Should MMT (methylcyclopentadienyl manganese tricarbonyl) or other additives such as N-methylaniline be allowed in Australian fuel as an octane enhancer?

See section on Prohibited Fuel Additives. NMA – Not currently expressly prohibited in the FQSA. In the global fuels market, NMA has been linked to adverse operability impacts including engine malfunctions. AIP member companies recommend that there should be significant further testing of the operability impacts of NMA-blended petrol.

The Department should consult with OEMs and additive suppliers on the treatment of MMT.

17. Are you aware of any substitute octane enhancers that can be used in place of MTBE and other ethers?

The only octane enhancers that AIP and member companies are aware of are ethanol, aromatics such as benzene, toluene, xylene and ethyl benzene, or Octane (the chemical). All are either limited by regulation with respect to final concentration in retail fuel or limited in availability.

Other octane enhancing additives are either restricted by regulation such as Tetra Ethly Lead / Tetra Methyl Lead by the lead limit in the Petrol standard, or restricted by industry self-regulation for additives such as MMT, Ferrocene and most recently N-methyl aniline.

Other octane enhancers pose other problems. Ethanol/oxygenate containing fuels are not allowed into supply chains shared with Aviation fuels without more stringent testing regimes being imposed on the Aviation fuels, so are generally not accepted due to contamination concerns. Incompatibility with Aviation fuels results in dosing of biofuels only at terminal gantries such as the case with E10 or B5 blending. This maintains complete segregation to prevent accidental contamination of aviation fuels. Also, other octane enhancers pose problems of scale/volume and supply.

As discussed in Section 6.3, 10 percent ethanol will increase octane by about 3 RON, but provides lesser boost for MON. Ethanol however has a lower energy density, adversely impacts vapour pressure, and may increase formaldehyde toxic emissions.

18. What (if any) other substances should be considered for listing on the Register of Prohibited Fuel Additives?

AIP has no recommendations on this issue.

QUESTION SET 5. QUESTIONS IN RELATION TO THE PROPOSED GUIDELINES FOR MORE STRINGENT FUEL STANDARDS

19. Are there any areas in Australia that require more stringent fuel standards? If so, which fuel standards should the more stringent standards apply to, and where should they be applied?

As previously noted, AIP recommends the addition of a Silver Corrosion requirement to the Petrol standards and the removal of the Colour parameter in the Diesel regulation.

20. Are changes to fuel standards necessary to better align them with other legislation, such as the Low Aromatic Fuel Act 2013?

AIP does not believe that the FQSA Petrol standard has any inconsistencies with the Low Aromatic Fuel Act. All low aromatic Petrol must comply with the FQSA regulation, which is in effect a sub set of a 'normal' FQSA compliant Petrol. If variations are required, a Section 13 Variation can be sought. AIP therefore does not see a need for amendments to the FQSA specifically to make allowances for Low Aromatic Fuels.

QUESTION SET 6. GENERAL QUESTIONS REGARDING THE APPROACH FOR ASSESSING THE POLICY ALTERNATIVES

21. Do you have any comments in relation to whether all likely costs or benefits have been identified?

A significant aspect not considered in Section 4.1 is the real potential that changes in the fuel standards could trigger the closure of some or all of the domestic refineries. The cost benefit analysis needs to consider the economic contribution of the refineries to the local/national economy as well as national liquid fuels supply security ramifications.

The assertion that there will be no price impact is incorrect and AIP has provided evidence that there will be a price impact of 1.75 cents per litre by 2027.

The health benefits need to be assessed based on the current market quality of fuel that is in fact significantly below the actual fuel standards. AIP questions how during a period of time when fuel quality standards were being improved and state based authorities were reporting good urban air quality, there was a supposed 95 percent increase in the cost of air quality related adverse health outcomes between 2005 and 2010 (*OECD, 2014. The Cost of Air Pollution: Health Impacts of Road Transport, OECD, Brussels*). This used a measure which is quoted as being "*in terms of the value their citizens place on not dying prematurely from dirty air*" so is not in reality an actual cost to government for health care.

AIP also questions the increase in deaths from 884 in 2005 to 1483 in 2010, which was at a time when fuel quality standards were significantly improving and State EPA air quality surveys were indicating that urban air quality was generally very good. Use of these figures of the reported health related costs, when viewed from this perspective are suspect and appear to be a reporting inconsistency arising from changes in data reporting and collection in Australia.

Introduction of a 10ppm sulfur petrol specification to deliver better Euro 6 vehicle emission and fuel efficiency standards is expected to result in significant costs for existing Australian refineries and for the Australian motorist. At present however, there is no post new vehicle sale "in service" testing of actual vehicle emissions to ensure that the emissions and fuel efficiency benefits for the community are being delivered in practice.

AIP has previously noted that it may not be necessary or desirable to introduce 10ppm, on the basis that it still needs to be demonstrated that there will be any demonstrable health or environmental benefits in existing vehicles. In that context, consideration may be given to adjusting the ULP91 standard to a maximum sulfur level of 30 ppm. The oil industry manages large volumes of product at all sites via non dedicated pipe work from refineries and ship receipt where product to product interfaces occur and need to be managed. All sites with truck loading gantries also must deal with road tanker drainings and volumes of aviation fuel slops generated from vehicle flushing, sampling and testing. These materials are reworked into ULP91 to minimise waste and cost to the business. A 30 ppm sulfur maximum limit in the 91 grade will allow for a continuation of the current industry wide operational practice of directing pipeline interfaces and gantry vehicle drainings back into ULP 91 at rates that do not threaten quality or FQSA compliance. Limiting sulfur levels to a maximum of 30 ppm allows the industry to carefully work off relatively high sulfur aviation fuel interfaces.

Since the introduction of 10 ppm diesel, the industry has been prevented from working high sulfur Jet/Diesel interfaces into diesel. This was previously common practice and did not cause operability or quality issues until this practice was prevented by the introduction of a 10ppm sulfur limit on diesel. This left petrol grades, and generally ULP 91 with its 150 ppm sulfur limit, as the safe option for rework of these mixed materials. Introduction of a 10 ppm limit will result in a major operational change for all aviation fuel site which will require installation of equipment (tanks, gantry loading arms, pipe work) to manage segregated pipeline interfaces and road tanker vehicle drainings. This will also result in operational costs due to lost value of product and costs of transport to a refinery for reprocessing or trade waste disposal of material, depending on which option is most economic. AIP sees no evidence that this unintended impact on the broader industry supply chain has been taken into consideration.

22. Can you provide information that may improve the reliability of the cost and benefit estimates for any of the policy alternatives?

AIP has included data regarding capital and operating costs for 10ppm sulfur gasoline in the primary submission along with the economic contribution of the refining industry. AIP has provided a summary of the price assessment conducted by FGE that provides evidence of the likely impacts on fuel prices.
AIP has also provided evidence on the market quality of fuel to conduct the health benefits assessment. AIP has also provided an estimate of the increase in refinery emissions

Cost implications

23. Do you have any evidence regarding the change in retail price of premium unleaded petrol (95 RON) fuel if unleaded petrol (91 RON) fuel were to be phased out (assuming taxes etc do not change)?

AIP has not undertaken this assessment as it is complex task requiring commercial assessments.

24. Noting the economies of scale in the provision of premium and high octane petrol (95 and 98 RON), what impact would phasing out or banning unleaded petrol (91 RON) have?

The petrol supply chain and refuelling stations are already largely established to manage the existing 3 octane grades of petrol sold into the market, therefore there are no significant economies of scale or cost savings available to be generated from the forced phase out or banning of 91 RON petrol. On the contrary:

- It would be physically and economically infeasible for the domestic refineries to change their product slate today to produce only premium grades of petrol and no 91 RON.
- A refinery's overall octane pool capability is essentially fixed by its octane generation hardware. Eliminating 91RON will dramatically increase the overall pool octane requirements which would require considerable new refinery hardware.
- Very preliminary assessments indicate the cost to refineries to phase out 91RON would be very considerable and even greater again than the cost/investment required to produce 10ppm sulfur and would threaten the viability of the refining industry.
- AIP strongly supports maintaining choice in the fuel that best suits vehicle requirements and customer preferences. Unless a car is specifically designed to run on higher octane fuels, it will deliver no/very little environmental or operability benefits if run on higher octane fuel than specified by the manufacturer. Eliminating 91RON would force a very large percentage of drivers to purchase more expensive octane fuels for no benefit. It is also our expectation that new vehicle manufacturers will continue to offer 91 RON petrol fuelled vehicles that meet tighter Euro 6 vehicle emission and mandated fuel efficiency standards. Therefore, the forced removal of 91 RON petrol will also impose higher costs on some new vehicle owners.
- 95RON and 98RON fuels are already readily available in the market for those cars which require (and can derive benefit from) the higher octane.
- The removal of ULP91 will remove the only viable option for terminal operations to rework mixed product material such as pipeline interfaces from multiproduct pipelines or gantry vehicle drainings, as previously discussed. This will result in storage and repatriation or licensed waste disposal as the only options for these materials. For remote locations, neither are practical options and either option will result in additional capital and operational costs to sites with high sulfur Aviation fuels. This will serve to increase operating costs for terminals which will be passed on to customers; particularly those in remote locations.

25. What are the associated issues, costs and benefits of reducing the sulfur parameter in petrol to 10 ppm?

The costs are considerable and of a magnitude which will threaten the viability of the domestic refining industry, whilst the benefits are very limited and uncertain.

26. If there was an immediate requirement to move to 10 ppm (sulfur), would a stepped approach mitigate problems that might be faced by refineries?

AIP has put forward a proposal, Option F, to seek to mitigate these factors.

27. What, if any, are the costs in making the changes proposed under the five alternatives? Is there an alternative more cost effective approach that would produce better environmental and health outcomes?

AIP has put forward a proposal, Option F, and significant cost evidence has been provided.

28. To what extent are refineries already producing low sulfur petrol? What might be the additional costs for those refineries that choose to upgrade to produce low sulfur and higher octane petrol?

Whilst it is true that the typical sulfur level of petrol produced today is significantly lower than the current ULP91 sulfur limit, this does not reduce the challenges or costs associated with producing 10ppm sulfur petrol. In order to further reduce sulfur from current levels to below 10ppm, all the domestic refineries will need substantial investment in expensive desulfurisation facilities.

Questions relating to the petrol standard

29. To what extent is the petrol fuel standard currently being met?

- The AIP member companies do not release product into the supply chain unless it fully meets the fuel standards.
- AIP member companies are unable to meet the Cetane specification of 51 DCN for diesel containing biodiesel and all member companies currently have s.13 exemptions in place.

30. Should the maximum limit on aromatics be reduced to 35 percent?

- AIP is not aware of any compelling need to reduce the petrol aromatics limit.
- The original intent of the Fuels Quality Standards Act and the policy approach that has continued to be followed is to harmonise with European standards **subject to Australian conditions**.
- The key difference between Australian and European standards is that the European standards allow for total ethers up to 22 percent whereas they are effectively banned in Australia at a 1 percent limit.
- Western Australia considers the threat of MTBE so serious that it has limited MTBE to 0.1 percent that was re-confirmed as recently as 2015.
- There is already a strict separate limit on benzene content.
- Any potential engine deposit issues are already controlled via additives.
- Any possible soot generation in GDI engines will be controllable via after-treatment technologies.

- Further, as aromatics are an important high-octane component in gasoline blends, the domestic refineries will be unable to economically produce the high octane premium grades petrol if aromatics were to be limited to 35 percent max. Particularly if the current MTBE limits remain in place.
- Finding an economic outlet for the excess aromatics will also be very problematic.
- In Europe, the usual arrangement would be to sell the high aromatics stream to a nearby chemical plant as a high-value feedstock. Unfortunately, that option does not exist in Australia.

This issue is discussed in greater detail in Section 6.3 on aromatics.

31. Do you think other parameters should be specified (e.g. methanol)?

As previously noted with respect to the Petrol Standards, AIP recommends:

- the addition of a Silver Corrosion test (ASTM D7671 or D7667) with a specific limit of 2 maximum to the Petrol standard to protect customer vehicle fuel tank level sensing equipment. This test was introduced globally by most oil companies after incidents in the United States.

New standards

32. Considering high octane petrol (98 RON) fuels are currently required to meet the premium unleaded petrol (95 RON) standard under the Fuel Quality Standards Act 2000, should the petrol standard include parameters for high octane petrol (98 RON) premium unleaded petrol fuels?

AIP member companies do not see a need to create a separate standard for 98 RON high octane petrol as we are not aware of any market failure or issues with the current arrangements. If a new 98RON standard were to be created, it will need to recognise that the marketed 98 RON fuels actually have a MON of 85 min – not 88 min as stated in the Discussion Paper Table 3.

33. Would there be a negative impact to the fuel or motor vehicle industry to implement the EU's MON and RON standards? If yes, please explain.

As explained in response to Q24, the domestic refineries are constrained by octane pool balance (both RON and MON). Any major shift in pool average octane will require substantial refinery upgrades and expenditure.

34. Are the test methods specified in the fuel standards correct and appropriate?

The following recommendations are made with respect to suggested changes to the test methods specified in the fuel standards.

Petrol Standard

Add:

- The addition of a Silver Corrosion requirement to the Petrol standards, as previously outlined

Diesel Standard

Remove:

- The Colour parameter in the Diesel Regulation be removed, as previously discussed.

MTBE

35. What would be the impact for the fuel and motor industry if MTBE limits remained at current limits in petrol? Should the level of MTBE in petrol be greater than 1 percent?

AIP member companies believe the environmental risk of MTBE to groundwater is serious and do not support any increase in the allowable MTBE levels.

36. Should a limit of 5 percent to 10 percent MTBE be permitted in high octane petrol (98 RON) petrol? Should similar limits be applied to ethanol in high octane petrol (98 RON) petrol?

As per Q35, the AIP member companies do not support an increase in MTBE or other oxygenate limits for any grade of fuel.

Other than for flex fuel (eg. E85) vehicles, most vehicle manufacturers do not warrant the addition of more than 10% ethanol to petrol, therefore AIP does not support any change to ethanol limits in any grade of petrol beyond the currently regulated 10% maximum. AIP can see no reason to single out 98 RON fuels for consideration of ethanol limits. The current standards limit ethanol contents to a maximum of 10 percent for 91 or premium 95 minimum RON grades and mandates pump labelling to clearly indicate the presence of ethanol. This is necessary to ensure that customers have full information to make appropriate choices about fuel selection. Further regulation does not improve the customer experience or vehicle operability in any way beyond that already addressed via current standards

37. Can you identify any other issues regarding emissions or operability?

Introduction of ethers and other oxygenates into petrol requires significant investment at the retail fuel station level due to the greater potential for contamination of, and with, water. This represents a potential major cost impost on the many smaller regional or independent service stations, with significant implications for the supply and cost of fuel in regional and remote areas.

38. Should oxygenates such as ethanol be used to increase the octane content of petrol, for example, adding 12 percent ethanol to ULP to create an E12 premium unleaded petrol (95 RON) fuel? Alternatively, are there other octane enhancers that can be used to create premium petrol?

This issue is discussed in Section 6.3.

Beyond the challenges associated with securing additional sufficient volumes of ethanol, and addressing significant consumer aversion as per the experience particularly with the NSW Mandate, there are a range of technical barriers to E12.

Addition of 12 percent ethanol to 91 RON petrol is calculated to increase the RON to 95 minimum, however it will not increase the MON to the minimum regulated level of 85 minimum. Therefore, such a blend will not be compliant with the fuel quality standard for 95 RON petrol. The impact on RON and MON of Ethanol differs significantly. It is an excellent blend component for increasing RON but relatively poor at increasing MON of fuels. Also, the overwhelming majority of vehicles are limited by warranty to 10 percent ethanol limit. Until vehicle manufactures recommend the use of ethanol blends of greater than 10 percent, AIP does not support this recommendation.

Questions relating to the automotive diesel standard

39. Given a minimum value of 51 is proposed in diesel with or without biodiesel (as in the EU), is the current Derived Cetane Number (DCN) appropriate?

- As previously discussed, AIP does not support any proposal to increase Cetane Index above 46 and further DCN should also be reduced to 46 for all diesels whether or not they contain biodiesel.
- AIP and member companies consider there is no compelling evidence of operability impacts or environmental improvements by changing the cetane from the current 46 minimum for Australian vehicles and conditions (whether containing biodiesel or not). Further, higher cetane will not facilitate better engine technology. The main operability and environmental issues associated with cetane are related to potential cold starting issues that do not occur in Australia's warmer climate, particularly with the evolution of engine technology and higher performance fuel injection systems.
- AIP and member companies are not aware of a reason why the cetane for diesel containing biofuel needs to be set any higher than diesel that does not contain biodiesel.
- The domestic refineries are unable today to consistently achieve 51 cetane which has already driven the need for ongoing s13 approvals for diesel cetane for each AIP member company.
- It is notable that the typical cetane levels of diesel in the US are 42-45.
- Furthermore, AIP member companies propose that as DCN is a suitable test method for both mineral diesel and biodiesel blends, the DCN test should be considered an acceptable alternative to Cetane Index.

40. What would be the effect of reducing polycyclic aromatic hydrocarbons (PAH) in automotive diesel on industry and other stakeholders?

- AIP and the member companies believe there would be negligible environmental and operability benefits of reducing the PAH limit.
- CONCAWE report 4/05 concludes that "In older technology vehicles, reducing fuel poly-aromatics content gave lower PAH emission, although reducing fuel poly-aromatics content even to zero would not eliminate PAH emissions, as a significant proportion of the total PAH is combustion derived."
- "In the newer technology diesel vehicles with effective exhaust after-treatment, either oxidation catalysts or diesel particulate filters, PAH emission were so low that there was no longer any sensitivity to fuel poly-aromatic content."
- Domestic refineries would likely need investment in expensive diesel hydrotreater reactors to achieve any substantial reduction in PAH.
- The average PAH levels produced by each Australian refinery are below 6 percent but to limit it to 6 percent would substantially constrain refinery flexibility and threaten refinery viability.

41. What would be the effect of reducing carbon residue limits in diesel on industry and other stakeholders?

AIP cannot comment on the impact of reducing carbon residue as it is not an independent quality parameter but is related to final boiling point, 95 percent received distillation point and distillation residue. To reduce the carbon residue of the fuel will entail reduction of the high boiling components. This will need to be modelled in more detail, but even a preliminary consideration reveals that there will be a cost impact to refineries and for imported product. The import specification based on the Platts Methodology and Specifications Guide trading specifications defines a carbon residue minimum of 0.2 percent on a 10 percent distillation residue. This is aligned with the current Diesel Standard and introduction of a tighter specification will result in an increase in cost to the consumer.

42. Should the standard apply more broadly to all diesel engines, including ships operating around the Australian coast?

Marine fuel qualities are already well regulated by international standards, so AIP does not support extension of Australian fuel quality standards to marine applications. In reality, it is probable that fuel suppliers already supply fuel complying with fuel quality standards, given the cost and complexity of establishing separate supply chains for additional segregated grades that have comparatively low volumes.

43. Should a standard be prescribed for synthetic diesel (non–crude oil)?

No. See response to Q13.

44. Are there any other issues regarding emissions or operability?

Not that AIP or member companies are aware of.

45. Do you think other parameters need to be specified?

See previous answers in relation to DCN requirements and maximum density limits.

Questions relating to the autogas standard

46. Should a standard be prescribed for Compressed Natural Gas (CNG)?

Yes. Regulators should liaise with natural gas providers and equipment manufacturers to determine appropriate parameters for the Standard.

47. Should a standard be prescribed for Liquid Natural Gas (LNG)?

Yes. Regulators should liaise with natural gas providers and equipment manufacturers to determine appropriate parameters for the Standard.

48. Are there any other issues regarding emissions or operability?

No opinion.

Questions relating to the biodiesel standard

49. Do you have a view on whether the biodiesel standard allows for advancements in technology?

The current Biodiesel Standard is deficient in operability determination for the finished blended product and as a result retards uptake due to customer confidence issues. As it is currently constructed, there is no link between finished, compliant B100 and operability of B5 or B20 blends. As previously noted:

- The standards would benefit from the inclusion of a Filter Blocking Tendency (FBT) test of a B20 laboratory blend in the biodiesel (B100) standard to determine / limit potential blended product operability before release of B100 for sale.
- It is also recommended that the water content be determined by Karl Fischer (D6304) and a limit of 500 mg/kg be set to allow for further water pickup pin the supply chain and prevent water precipitation in blended products (eg B20 blend of 100 mg/kg are anticipated to be haze free).

- Test for and limit Cold Soak Filterability (360 seconds maximum) by ASTM D7501.

50. Noting that all biodiesel blends have a proposed minimum value of 51; do you believe the current Derived Cetane Number (DCN) appropriate?

As previously stated in Q39 and elsewhere, AIP and member companies believe that both minimum Cetane Index and DCN should be set at 46 for both diesel and biodiesel blends.

51. Do you believe a reduction to the acidity parameter (to 0.50 mg KOH/g) in biodiesel be achievable? If so, can you identify any consequences for stakeholders?

AIP agrees with a reduction in the total acid parameter for B100/FAME as this will limit a variable that can impact on other vehicle operability parameters such as FBT. Also, a reduction in the total acid number parameter may potentially result in a reduction in manufacturing process contaminants such as mono- and di-glycerides through tighter controls on the transesterificaton process with a flow on operability benefit to end users through decreased filter blockage risk.

52. Would reducing the phosphorus content or increasing the oxidation stability requirements raise any issues for you or your stakeholders?

AIP member companies cannot currently comment and would need to investigate this further.

53. Would you like to raise any other issues regarding biodiesel blends, emissions or operability?

No other issues not already addressed in the preceding question responses.

Questions in relation to the ethanol (E85) standard

54. Do you believe the test methods are appropriate?

AIP does not believe the E85 standard should include a vapour pressure limit. This is inconsistent with the Petrol determination where this limit is not addressed and it is left to Fuel manufacturers and suppliers to implement controls that are consistent with State EPA limits and customer equipment operability requirements. This has effectively managed Petrol vapour pressure for the markets and state based regulators, with no operability concerns for fuel manufacturers, suppliers or customers. We recommend against adoption of this limit as it is inconsistent and creates extra burdens on administrative complexity and product testing costs.

For RON and MON it is recommended that the ASTM D2699 test method be used for RON determination and ASTM D2700 test method for MON determination. These methods can be used as the test/referee methods.

55. Would a reduction in the sulfur or acidity parameters raise any issues for you or your stakeholders?

AIP has no comments on these specification points.

56. Would an increase in the solvent washed gum parameter raise any issues for you or your stakeholders?

AIP does not recommend an increase in washed gum as the current specification is aligned with the industry internal standards which are supported by a historical lack of operability issue in the market.

57. Would you like to raise any other issues regarding emissions or operability?

No other issues not already addressed in the preceding question responses.

Questions relating to the proposed B20 standard

58. Do you believe the B20 standard allows for advancements in technology?

AIP has no comments on this point.

59. In your view, are the test methods valid?

AIP believes that the test standards proposed in the standard are valid.

60. In your view, are the B20 parameters appropriate?

Please refer to the AIP Submission dated 11 May 2012 to the Department of Sustainability, Environment, Water, Population and Communities on the Discussion Paper for Developing a B20 fuel quality standard in which the proposed B20 test properties and test methods are discussed extensively.

Primary comments are:

- Viscosity range needs to be adjusted to 2.0-4.6 so as to align with the resultant viscosity from blending the raw diesel and biodiesel.
- Derived Cetane Number – 46 min.
- Acid Value – 0.3 mg KOH/g is potentially an issue (too low), revise to 0.5.
- Water at 200mg/kg may be too low. Suggest adoption EU value of 260.
- Oxidation stability of 8 hours may be an issue; previously proposed 6 hours.
- Conductivity should be minimum 50 pS/m to comply with the existing diesel standard.
- Filter Blocking Tendency of 2.0 maximum to align with the diesel standard.