Australian Institute of Petroleum

Submission to the

Vehicle Emissions Working Group

on the

Vehicle Emissions Discussion Paper February 2016

8 April 2016

About AIP

The Australian Institute of Petroleum (AIP) was established in 1976 as a non-profit 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 expectations. AIP provides a wide range of factual information and industry data to assist policy makers, analysts and the community in understanding the key market, industry and other factors influencing Australia's downstream petroleum sector.

AIP is represented on key statutory and advisory bodies including the National Oil Supplies Emergency Committee (NOSEC), the Fuel Standards Consultative Committee (FSCC), the Oil Stewardship Advisory Council (OSAC), the New South Wales Biofuels Expert Panel and the National Remediation Framework Steering Group (NFRSG). AIP sponsors or manages important industry health and environmental programs and the Australian Marine Oil Spill Centre (AMOSC) is a wholly owned subsidiary of AIP.

AIP is pleased to present this Submission to the Vehicle Emissions Working Group of the Ministerial Forum on Vehicle Emissions on behalf of its core member companies:

BP Australia Pty Ltd
Caltex Australia Limited
Mobil Oil (Australia) Pty Ltd
Viva Energy Australia Pty Ltd

About AIP Member Companies

AIP member companies operate across the liquid fuels supply chain including crude and 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.

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% of the transport fuel market.
- 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 blended fuels and blended biodiesel to the Australian market.

Given this background and their significant role in the Australian fuels supply chain and broader economy, AIP member companies have a very strong interest in vehicle emissions and their interaction with fuel quality, and the maintenance of liquid fuel supply reliability. Background information on the downstream petroleum industry is contained in the AIP publications *Downstream Petroleum 2013* (http://www.aip.com.au/topics/new.htm), *Maintaining liquid supply security and reliability in Australia* (http://www.aip.com.au/topics/new.htm) and the AIP Submission to the Energy White Paper http://www.aip.com.au/pdf/submissions/AIP%20Submission%20-%20EWP%20Issues%20Paper.pdf

Contact Details

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

Mr Paul Barrett
Chief Executive Officer
Australian Institute of Petroleum Limited
GPO Box 279
CANBERRA ACT 2601
Phone: (02) 6247 3044

Table of Contents

Executive Summary

AIP Position

- The AIP and member company position on the need for 10 parts per million (ppm) sulfur in petrol has been largely unchanged since 2005 and is supported by various Australian Government reviews supported by the international scientific research over that time.
- AIP does not consider that 10ppm sulfur petrol is required to implement Euro 6 light vehicle emissions standards because there are no operability benefits and very few environmental benefits of changing the fuels standards.
- AIP does not consider that 10 ppm sulfur petrol is required to implement mandatory CO2 standards.
- AIP considers that the minor additional environmental benefits from the introduction of 10ppm sulfur petrol need to be thoroughly assessed in a Regulation Impact Statement (RIS) against the significant costs of the:
    - required refinery investment and increased operational costs (which will threaten refinery economic viability),
    - increased refinery emissions, and
    - increased cost of fuel to motorists.
- The potential closure of refineries presents a considerable cost risk to the community through the loss of the refinery's broader societal economic contribution.

Key Messages

<u>Cleaner Fuels Program</u>

- AIP and its member companies accept the community imperatives for improving urban air quality and addressing climate change, and support the development of policy based on sound science, thorough economic analysis, affordability for industry and acceptability to the community.
- AIP and member companies appreciate that there are many jurisdictions around the world (such as China) who have or are planning on moving to 10ppm primarily due to urban air quality issues. Australia does not have an urban air quality issue.
- The Australian refining industry strongly supported the Commonwealth Government's Cleaner Fuels Program including the introduction of the *Fuel Quality Standards Act 2000* (FQSA) to facilitate advanced engine technologies in the market and reduce motor vehicle emissions to improve urban air quality.
    - These air quality benefits will continue to be captured as the motor vehicle fleet is replaced with latest standard vehicles
- The Cleaner Fuels Program required investment by Australian refineries of over $3 billion which resulted in the closure of one refinery and substantial reconfiguration of the remaining refineries which delivered, inter alia:
    - The prohibition of MTBE in 2003
    - The reduction of olefins in petrol in 2003
    - 50ppm sulfur diesel in 2006
    - 1% benzene in all grades of petrol in 2006
    - 50ppm sulfur in Premium Unleaded Petrol in 2008
    - 10ppm sulfur in diesel in 2009

<u>Australian oil refineries</u>

- 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 the average refinery contributes around $1 billion of GDP depending on its size and employs around 1,500 highly skilled personnel people which can significantly expand (double) during regular major maintenance periods ("turnarounds").
- Australian refineries currently supply 70% of Australia's petrol demand and this is expected to increase as part 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.
- The refinery industry has reached a steady state and each company is confident of the ongoing future for the industry and is investing significant capital to ensure ongoing competitiveness and reliability of operations.
- 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.
- 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.

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 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 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% of the market to 30% 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 19 billion litres and has remained the same for 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 change

- 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 (see Page 8).

- 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.
    - 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.

Key issues for further consideration

Euro 6 light vehicle emission standards

- Vehicle emission standards are regulated by Australian Design Rules (ADR) which are largely harmonised with UN standards – the Euro standards: Australia is currently at Euro 5.
    - Euro 6 low mileage emission limits (e.g. NOx, CO) are the same as Euro 5 for petrol engines.
- Changing from operating on Australia's current quality fuels is only expected to produce minimal additional environmental benefits particularly as the actual sulfur levels of Australian market fuels are much lower than the current standard.
- Any environmental benefit is likely to be significantly outweighed by the substantial costs to motorists by way of increased costs of fuel, and the refining industry for additional capital costs and operating costs.
- The broad objective for Australian fuel standards is to harmonise with European fuel standards subject to Australian conditions as was stated in 2000 Commonwealth Position[1], "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".
- As any vehicle currently sold in Europe must be Euro 6 compliant, and as AIP considers that it is likely that the majority of vehicles from Japan and Korea are also Euro 6 equivalent, AIP expects it is likely there are a considerable numbers of Euro 6 vehicles being currently supplied to the Australian market which to our knowledge have not been modified for the Australian market. Certainly there is by now a large pool of Euro 5 vehicles.
- Actual experience with these pools of vehicles should provide an opportunity to understand the emissions behaviour and operability performance under Australian conditions and existing sulfur levels.
- **It is critical that the exact certification status of vehicles sold in Australia is known as this will determine the environmental performance of the fleet in the future.**
- The Federal Chamber of Automotive Industries (FCAI) have been pushing for a reduction of the sulfur limit in petrol to 10 ppm to harmonise with European fuel standards which they claim is required to introduce Euro 6 vehicle emission standards and mandatory CO2 standards.
- The only evidence ever presented by FCAI or motor vehicle manufacturers in support of this claim was summary data from an in-house study by Toyota presented to the Orbital report in 2013.
    - No detail was provided on the methodology or sensitivities and most importantly, there was no indication that the study had been conducted using Australian market fuels.
- **AIP strongly considers that no credible evidence has been presented to support the claim that Euro 6 certified vehicles cannot operate effectively on current market fuel quality and meet Euro 6 emission requirements.**
- The only engine technology currently requiring 10ppm is lean burn Gasoline Direct Injection (GDI) which is only being manufactured for a few very high end vehicle models. Lean burn GDI vehicles can also operate satisfactorily on Australian specification fuels but won't achieve optimal environmental benefits.
    - The decision to introduce 10ppm sulfur petrol to Europe, Japan and Korea was based on the expected benefits of the introduction of lean burn GDI.
    - The decision to implement 10ppm sulfur petrol to the US, Mexico and China was based on specific local air quality issues.

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

  - In the case of the US the decision to introduce 10ppm sulfur petrol was based on lower vehicle emission standards than proposed under Euro 5/6.
- Moreover, during the last ten years, FCAI has been requested on numerous occasions in the Fuel Standards Consultative Committee (FSCC) to nominate models that have not been imported to Australia because of fuel quality. In the last ten years not one car has been nominated.
- A range of studies over the last twenty years has concluded that below 150 ppm sulfur, the sulfur response curve (the response of emissions to different sulfur levels) is quite flat.
- The question of whether the Euro 6 certified vehicle will meet the Euro 6 emission standards was largely answered by the Orbital report[2] which concluded that the Euro 6 vehicles can operate satisfactorily on PULP with a current sulfur standard of 50ppm.
  - The only areas of doubt were on the durability of the catalyst. It has been shown however in recent studies that the sulfur impacts on the catalysts are reversible.
  - Further Orbital conducted the assessment without the knowledge that the market fuel quality average for PULP in 2014-15 for Sydney was 16ppm and Melbourne it was 28ppm which are significantly below the legislated maximum sulfur levels.
- The certification fuel will never match the fuel market quality. Other parameters that affect emissions including MTBE, aromatics and olefins also vary from the certification fuels.
  - Motor vehicle manufacturers are <u>not</u> required to specify the certification fuel quality as the recommended fuel in the owner's handbook although their emission performance is certified on these lower sulfur fuels.
- Further it should be noted that the ADR vehicle certification process stipulates the use of a specified Euro 5/6 certification fuel and therefore the actual market fuel quality is not a barrier to vehicle Euro 5/6 certification.
- **AIP considers that it is essential that the claims by FCAI and motor vehicle manufacturers are tested to determine whether Euro 6 certified vehicles can meet Euro 6 emission limits on <u>current Australian market fuels</u>.**
  - **AIP notes that a definitive conclusion will require vehicle testing.**

<u>Australian market fuel quality</u>

- The average sulfur levels of petrol supplied to the Australian market are significantly lower than the Australian fuel standards driven by crude oil economics/pricing which has allowed the Australian refineries to select crude oils that have lower sulfur content and purchase the typically lower sulfur levels of imported petrol.
- Although the Australian refineries have typically been producing at these lower average sulfur levels, the current Australian standards allows for flexibility in the refining operation and in crude selection, sourcing of blending components and other intermediate products.
  - This flexibility is required to maintain the competitive performance of Australian refineries and to allow for crude selection flexibility and operational redundancy.
- AIP collected the sulfur levels for every parcel of fuel imported and produced in the Sydney and Melbourne markets in 2014-15 and found that:
  - In markets supplied by Australian refineries such as Melbourne, the 2014-15 average sulfur level was for ULP 60 ppm and 28 ppm for PULP, well below their respective 150ppm and 50ppm limits.
  - In markets totally supplied by imports such as Sydney, the average sulfur level was 26 ppm for ULP and 16 ppm for PULP.
  - In markets that are jointly supplied by imported and domestically refined fuel, such as Perth and Brisbane it could be reasonably expected that the levels would fall in between these two figures.
  - In Sydney, 70% of the PULP 98 supplied was below 5 ppm.
- Based on the current consumption levels these provide a total pool average for ULP and PULP combined of:
  - 53 ppm for Melbourne.
  - 21 ppm for Sydney.

---

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

- Australian motorists enjoy these lower levels of sulfur in their fuel without having to pay a price premium.
    - Importers to Australia specify the current Australian specification and are generally supplied lower sulfur fuels. Generally, the narrower specification of fuel quality the greater the fuel quality premium.
- **Additionally, if lower sulfur levels were regulated in Australia, it could affect the supply balance for these products in the Asian region and a full assessment of the likely impact will need to considered in any RIS.**
- The Australian market petrol pool is being driven naturally by market forces to lower sulfur levels where:
    - 10ppm is becoming more available in the Asian region and the price premium for imported product could be expected to reduce over time
    - Grade switching towards PULP is occurring with many new cars requiring higher octane.

<u>The implications of a fuel standards RIS</u>

- A RIS specifically for fuel standards is a complex and expensive exercise for the Australian refineries.
- It has been assumed in the Discussion Paper that sulfur is the only parameter that will be examined when the petrol standard is reviewed. However, the petrol standard review will need to consider a range of parameters including:
    - Sulfur
    - Aromatics
    - Olefins
    - Oxygenates – MMT, MTBE, methanol
- All these changes have an impact on the refineries and need to be modelled for feasibility and costs.
- **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.**
- At the commencement of the RIS, a multi-disciplinary team needs to be formed by each AIP member which then needs to aggregate to cross industry considerations including:
    - Refinery planners and designers to consider the impacts on the physical infrastructure – complex linear planning models are run on multiple scenarios to optimise the refinery's technical and financial performance
    - Supply needs to be analysed to ensure that any proposals are feasible from a distribution perspective, including aligning supply with the refinery turnaround
    - The financial viability needs to be assessed to ascertain whether the proposal will induce refinery closure and the closure cost is included in the RIS.
- These are complex considerations that are likely to involve between 20-30 FTE staff across the industry and come at a substantial cost.
- AIP and member companies have not fully analysed the cost of forming a RIS response team but consider that it could cost the industry at least $15 million to undertake the analysis.
- Moreover, AIP and member companies consider that it would take up to two years to reliably complete this work.
- **Given this cost and significant undertaking involved, AIP considers that the environmental case for changing the fuel standards must be adequately demonstrated before AIP member companies are forced to undertake such considerable time and expense.**
- In addition, it should be recognised that a decision to commence a review of the fuel standards will undermine confidence and investment in the current facilities by introducing uncertainty to the future of their operations and the availability of capital to fund growth or reliability projects.
- The examination of the technical solutions in a RIS are a detailed and complex exercise for the Australian refining industry involving:
    - Detailed market assessment of the demand outcomes including the <u>likely volume and price movements in different grades</u> of petrol.
    - Detailed pre-FEED (front end engineering and design) of technical solutions for Australian refineries including:
        - Desulfurisation of gasoline streams – technology assessment, sizing and costs
        - Augmentation of octane production units (e.g. alkylation, isomerization or platforming units) or other octane enhancing alternatives

    - Augmentation of utilities – power supply and water supply
    - Impact on refinery fuel and hydrogen balances
    - Quantification of negative impacts on ongoing refinery margin and overall profitability
    - Assessment of technical options to identify a preferred option
    - Assessment of refinery viability and financing.
  - The detailed pre-FEED will need to develop for the purposes of a RIS the following data:
    - Capital cost requirements for the refineries
    - Additional operating costs of the refinery
    - Increased energy usage and infrastructure
    - Increase in greenhouse gas emissions
    - Barriers to construction including land availability, state and local approvals, ongoing environmental licence requirements
    - Calculation of refinery shutdown requirements and construction program feasibility
    - Considerations of workforce consultation and industrial relations changes and
    - Viability assessment and the community cost of closure including remediation and loss of economic activity.
- The key and most significant cost for potential inclusion is the assessment of refinery viability.
  - AIP notes that the economic contribution per refinery is around one billion dollars depending on the refinery's size.

Fuel price increases

- **The increase in fuel prices is likely to be a major cost to Australian motorists that should be assessed in any RIS process.**
- As Australia is a product importer, the domestic wholesale prices are based on Import Parity Prices (IPP)
- 10ppm sulfur petrol represents a higher quality fuel and will attract a price premium when that quality is expressly specified by the importer.
- The assessment of the impact of prices requires knowledge of the complete suite of fuel quality parameters and the likely volume
  - For example, the effective prohibition of MTBE limits the number of sources that can be utilised for supply.
- If the implementation of the 10ppm sulfur petrol leads to refinery closures, it will also place a significant volume demand on the import market in Asia providing upward pressure on the price of new Australian grade fuel specifications.

1. Introduction

The Australian Institute of Petroleum (AIP) welcomes the opportunity to provide feedback on the Vehicle Emissions Discussions Paper.

AIP is pleased to present this Submission on behalf of its core member companies:

BP Australia Pty Ltd
Caltex Australia Limited
Mobil Oil (Australia) Pty Ltd
Viva Energy Australia Pty Ltd

This submission has concentrated on fuel quality standards as the key priority issue for AIP member companies as any changes threaten the viability of the Australian refining industry. AIP also has a strong interest in alternative fuels and general comments on the industry approach to alternative fuels can be found in the Energy White Paper Submission (pp17-20):
http://www.aip.com.au/pdf/submissions/AIP%20Submission%20-%20EWP%20Issues%20Paper.pdf

1.1 AIP Board Position

At its meeting of 19 March 2014, the AIP Board agreed the following position on the facts about fuel quality and operability:

- 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 Australian refineries.
- The introduction of a 10ppm sulfur standard across all grades of petrol would significantly threaten the ongoing viability of the Australian refining industry

2. Australian Oil Refining – Cleaner Fuels Context

AIP and its member companies accept the community imperatives for improving urban air quality and addressing climate change and support the development of policy based on sound science, thorough economic analysis, affordability for industry and acceptability to the community.

The Australian oil refining industry supported the Commonwealth Government's Cleaner Fuels Program including the introduction of the *Fuel Quality Standards Act* 2000 (FQSA) and subsequent changes to the fuel quality framework to facilitate advanced engine technologies in the market and reduce motor vehicle emissions to improve urban air quality. These environmental improvements will continue to be progressively captured as the motor vehicle fleet is replaced. Cleaner fuels required the significant investment by Australian refineries of over $3 billion and led to the closure of one refinery.

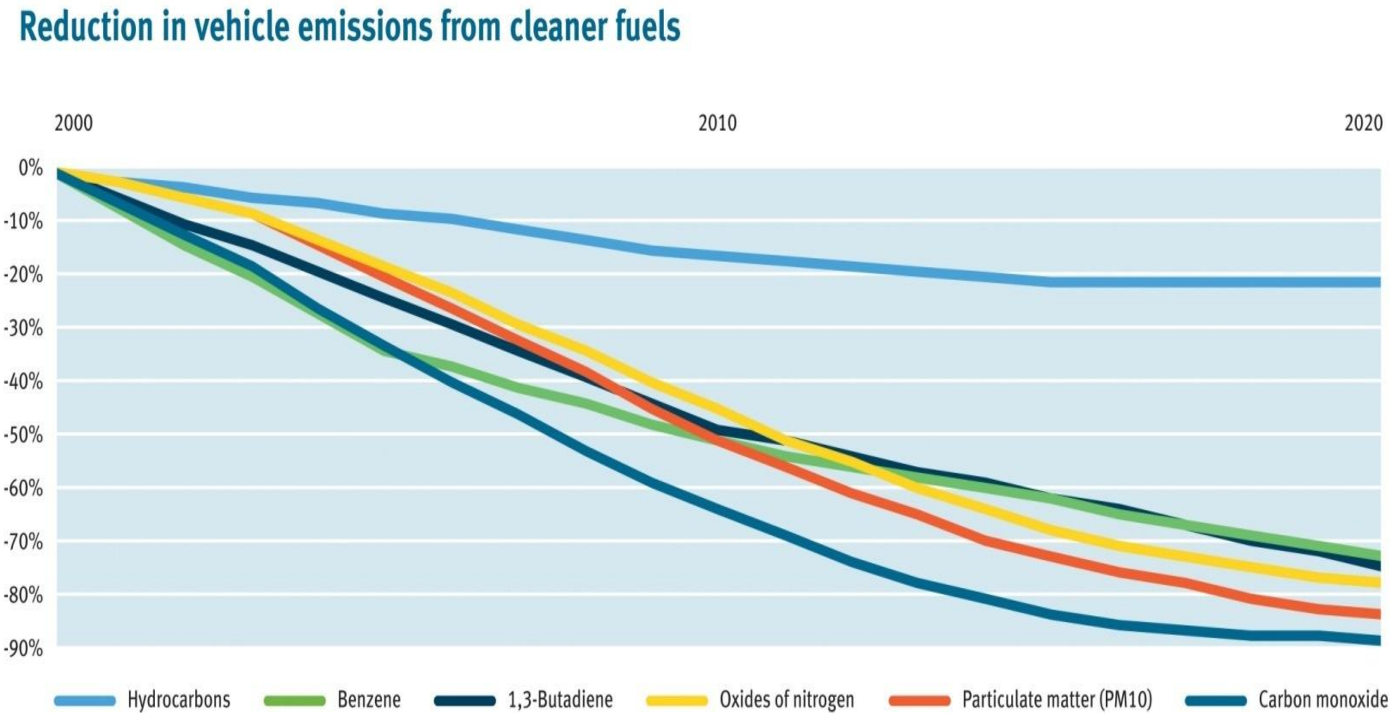
The Australian refining industry seeks to closely cooperate with regulators and the motor vehicle industry to ensure that fuel standards are introduced when vehicles requiring a particular quality of fuel arrive in the market. The refining industry has generally ensured that fuels are available to the Australian market on the time frame agreed with regulators and, therefore, has made a strong and positive contribution to the implementation of the Commonwealth Government's Cleaner Fuels Program.

The Australian refining industry is a high technology industry with highly skilled jobs and a direct and substantial economic contribution by delivering quality fuels to a geographically dispersed market in a timely and efficient manner. Australian refineries are critical to the diversity and reliability of liquid fuel supply in Australia which supports the competitiveness of key Australian industries and the Australian way of life.

Australia has four operating refineries with relatively small capacities by global standards as detailed in the table below. A major competitive advantage for refineries is size where economies of scale are leveraged. Australian refineries compete against larger export refineries in the Asian region, for example, the Jamnagar refinery in India has a total capacity of 69,350 mega litres per annum (ML pa) or over twice the size of the entire Australian refining industry. In order to be competitive, the Australian refineries have to be highly efficient and are rated as some of the most efficient refineries in the world in their classification.

Refinery	Capacity ML pa
Bulwer Island (BP - Brisbane)	Closed 2015
Lytton (Caltex - Brisbane)	6,500
Clyde (Shell - Sydney)	Import terminal 2012
Kurnell (Caltex - Sydney)	Import terminal 2014
Altona (Mobil - Melbourne)	4,950
Geelong (Viva Energy)	7,470
Kwinana (BP – Kwinana)	8,650
Total	**27,570**

In 2003, Australia had eight operating refineries with the capacity to supply over 95 per cent 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 in petrol 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.

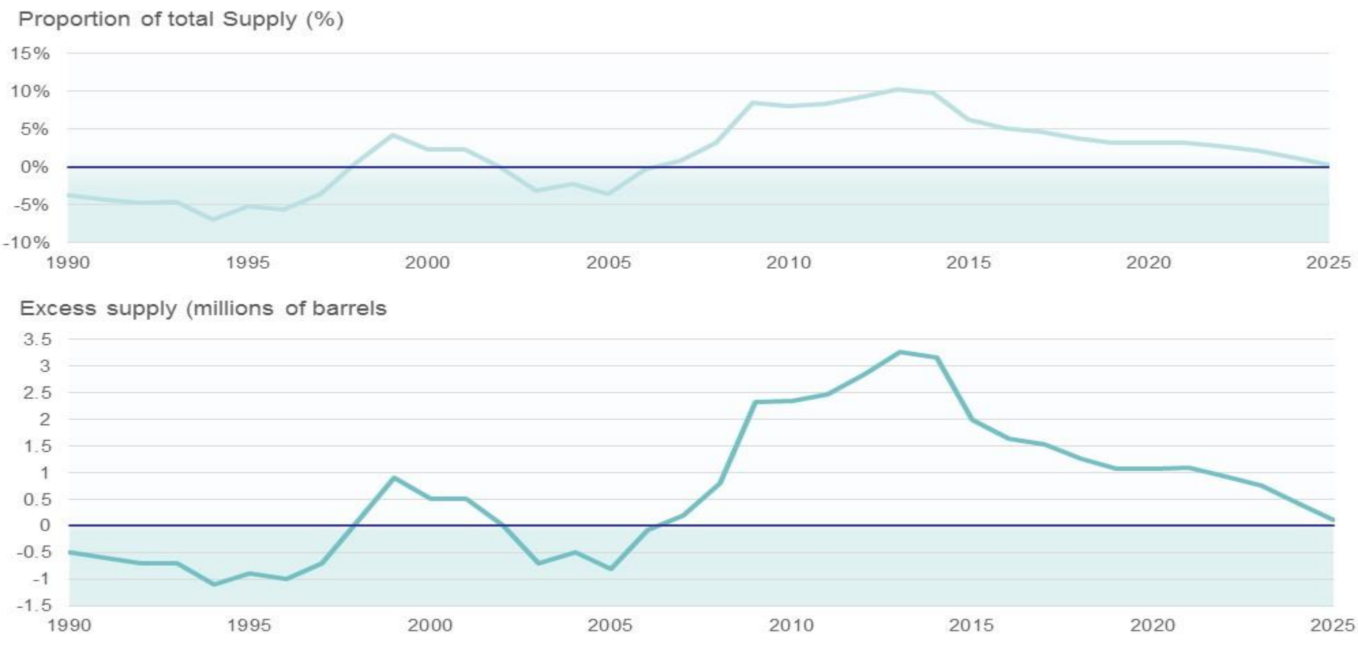


Source: Fuel Standard (Petrol) Determination Regulation Impact Statement 2001

As a direct result of the capital requirements 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 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%. However, the Altona refinery is actively evaluating plans to expand capacity in the future.

During the mid-2000s a supply surplus began to emerge in the Asian region as a result of large scale refinery construction programs in India and China, as detailed in the following chart. This surplus was exacerbated by the Global Financial Crisis which saw a reduction in petroleum demand growth and the emergence of a global overcapacity in the supply of refined petroleum products. The overcapacity in the supply of petroleum products is likely to persist until the middle of the next decade, gradually declining as demand improves.

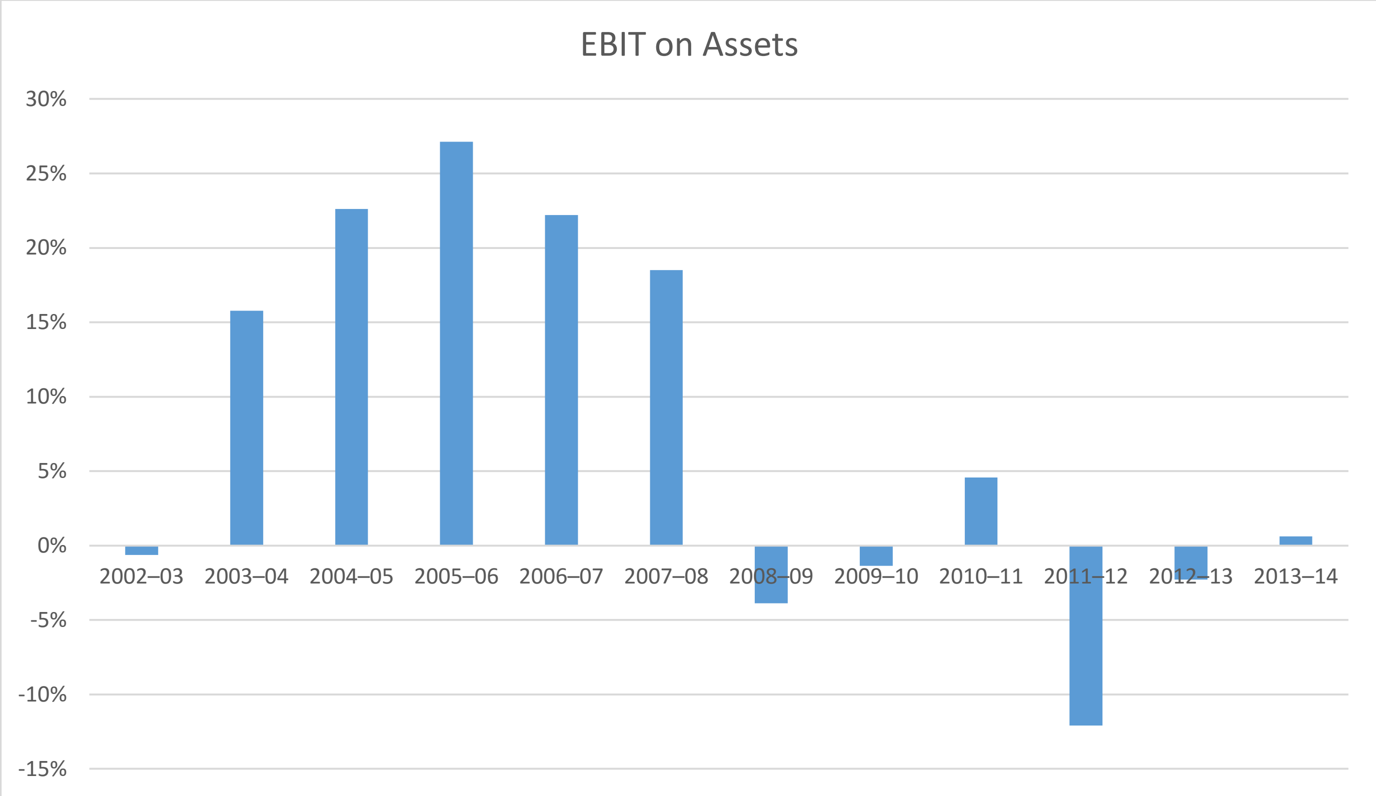
Asian region petroleum product excess supply



Source: FGE and Caltex Australia estimates

The Australian refining industry faced an unprecedented level of competition from larger and more efficient Asian export refineries which led to significant financial losses in 2008-09 and 2011-12. The profitability of the refining industry is shown in the following chart which highlights a significant underperformance since 2008. The ACCC has not yet collated 2014-15 profits and while these are expected to show a substantial improvement, the ongoing regional excess supply in the Asian region will continue to present a challenging environment for the Australian refining industry.

Australian oil refining sector profitability



Source: ACCC Annual Price Monitoring Report 2015

In response to the poor profitability and challenging outlook, Shell's Clyde refinery in Sydney was converted to an import terminal in 2012. Agreement was also reached in 2014 on the sale of the remainder of the Shell downstream petroleum assets in Australia to Vitol, the world's largest petroleum trader. The Vitol sale also included the Geelong refinery, and the Australian operating company Viva Energy Australia Ltd has indicated that it will continue to operate the refinery.

Further rationalisations include the closure of Caltex' Kurnell refinery in Sydney, which was converted into Australia's largest fuels import terminal in the fourth-quarter 2014; and the closure of BP's Bulwer Island refinery in Brisbane in 2015, which may be converted to an import terminal in the future.

The remaining Australian refineries, BP Kwinana in Western Australia, Caltex Lytton in Brisbane, Mobil Altona in Melbourne and Viva Energy Geelong will still be subject to ongoing intense competitive pressures because the unprecedented level of oversupply, both globally and in the Asian region, is not expected to ease until around2025.

Assuming the level of Australian refining capacity stabilises at these levels, the closures, de-rating and conversions will have accounted for a 50% reduction in Australian refining capacity, and as a consequence the Australian refining sector will be capable of producing about half of Australia's current liquid fuel requirements. However, the total figure for all petroleum products masks a considerable difference between each product category, i.e. gasoline (petrol), diesel and jet fuel.

3. Australian fuels market

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

- petrol (42%)
- diesel (37%)
- jet fuel (14%)
- fuel oil (2%)
- LPG (3%)
- other products (1%).

It also produces a substantial volume of chemical feedstock.

In 2014–15 Australia consumed 55 100 ML (megalitres) of petroleum products (or around 151 ML per day) — a 5.3 per cent increase since 2010–11. Australian refineries produced 30 604 ML of petroleum products, of which around 8 per cent was exported (excluding LPG). Net imports from over 20 countries accounted for 40 per cent (or 22 500 ML) of total consumption. 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. Import terminals are located throughout Australia. The bulk of imported petrol came from refiners and regional traders in Singapore and South Korea.

The Australian demand for liquid fuels is supplied by a mix of refinery production supplied from Australia's four remaining oil refineries and by imported petroleum products supplied through seaboard terminals located around the Australian coast.

The Australian petroleum products supply chain

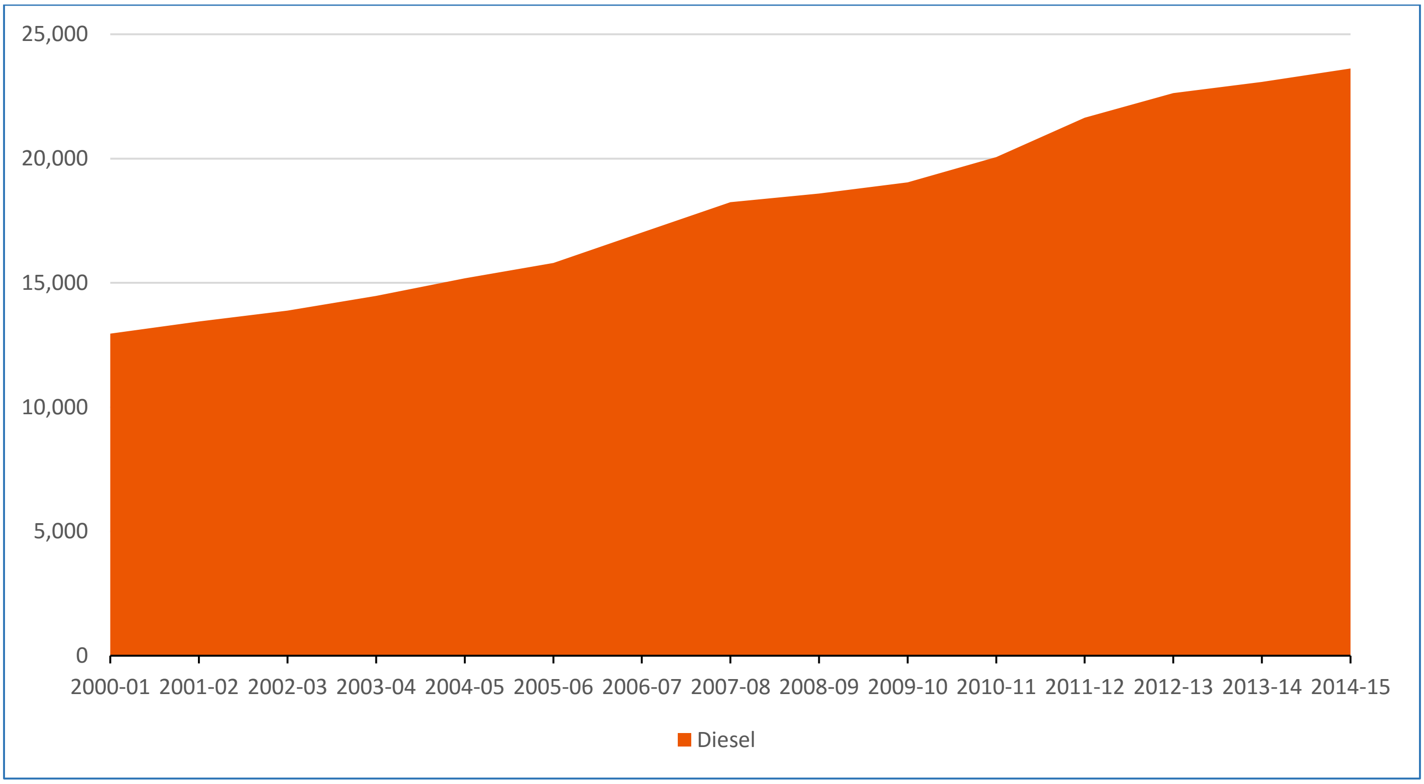
The closure of Australian oil refineries since 2004 has seen an increase in the level of imported petroleum products overall but there has been a substantial difference between the growth rates in different fuel types. Over the past decade, Australian use of petroleum products has increased by around 2 per cent per year. Petrol, diesel and jet fuel consumption now comprise 89 per cent of the total petroleum product demand.

Since 2003–04:

- Diesel use has increased by around 63 per cent 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 shows comparatively volatile demand but has increased by around 88 per cent due to growth in air travel for business and leisure.
- Petrol use has slightly declined as vehicle fuel efficiency has continued to improve. Use of regular unleaded petrol (ULP) has declined by 34 per cent as consumers chose new vehicles that require higher octane fuels or moved to ethanol blend petrol. The demand for ethanol blend petrol increased to a peak of 16 per cent of petrol use in 2010–11, largely in response to the ethanol fuel mandate in NSW, but has subsequently declined.

As will be observed later, the changes to the import proportions of each fuel type have been largely determined by the changing demand patterns with strong growth in diesel and jet fuel and constant demand for petrol. These changes are demonstrated by the following charts which shows that diesel is now the dominant fuel in Australia.

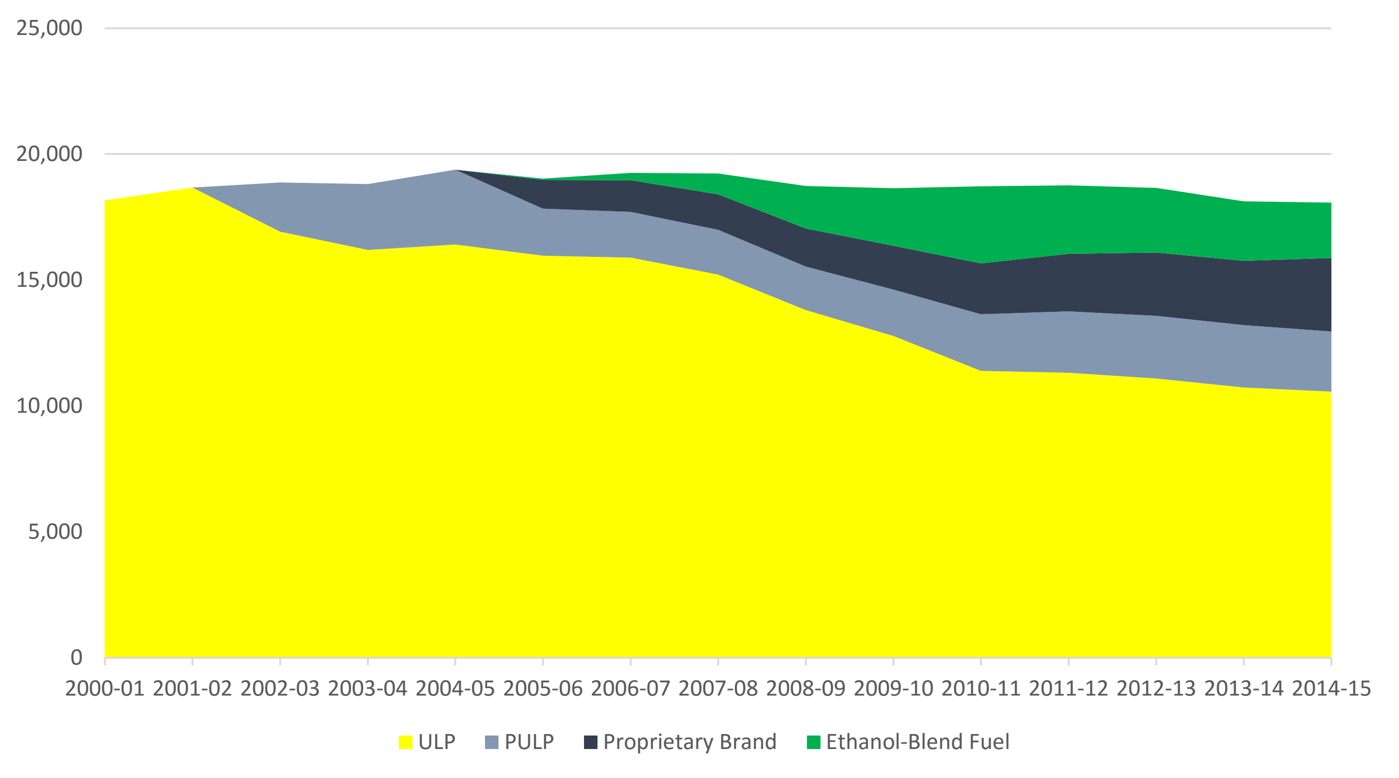
Australian diesel demand 2000-01 to 2014-15 (megalitres)



Source: Australian Petroleum Statistics (various publications)

There have also been substantial changes in the fuel grades within petrol demand with the ongoing growth in Premium Unleaded Petrol (PULP) and proprietary blends (usually 98 RON) at the expense of Unleaded Petrol (ULP) as demonstrated in the following chart. The other feature has been the growth in ethanol blends that has been largely driven by State Government ethanol mandates.

Australian petrol demand 2000-01 to 2014-15 (megalitres)



Source: Australian Petroleum Statistics (various publications)

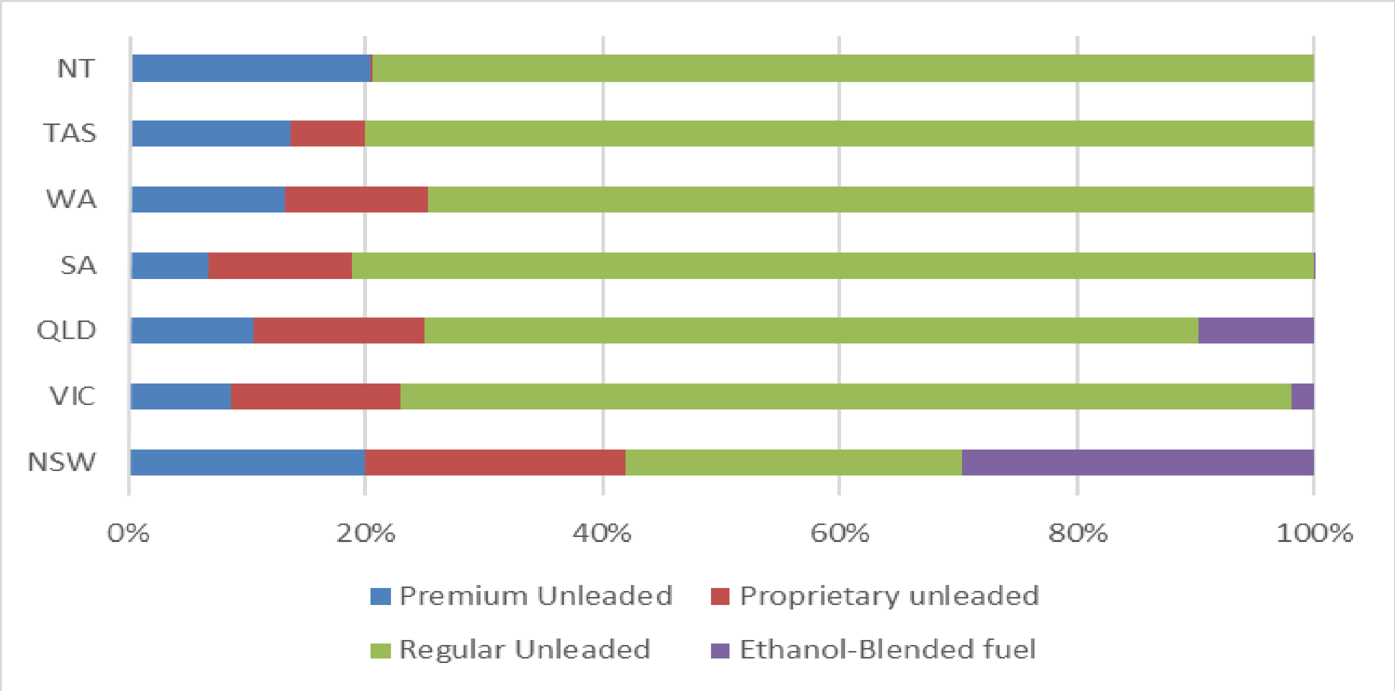
There are some important observations about fuel quality and urban air quality as a result of these changes in demand patterns.

- 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.
- 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 per cent with an average of 1% of the petrol market converting to PULP per year.

There are also important differences between states where, overall, the age of the car fleet has driven greater demand of PULP fuels. In States with newer fleets such as WA and Queensland PULP sales represent about 24% of the petrol market as compared to States with older car fleets such as SA and Tasmania that have a PULP proportion of the less than 20% of the petrol market.

The exception is NSW, with PULP representing 42% of the petrol market - driven by the ethanol mandate. In response to the removal of ULP from service station forecourts, consumers choose to switch to PULP rather than consume E10 blends. As discussed in Section 6, this leads NSW to have significantly lower fleet average sulfur levels than would be the case if demand patterns were similar to other States.

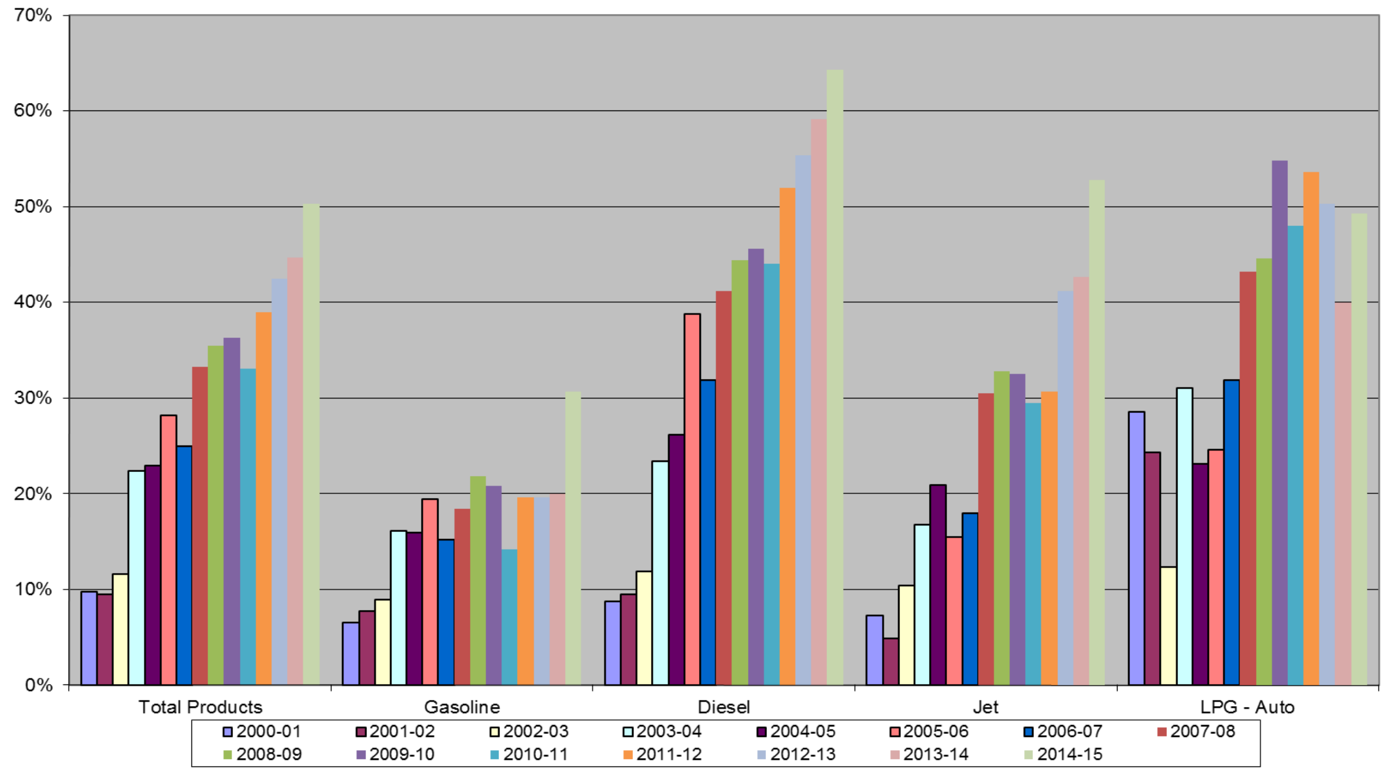
Australian states petrol demand by fuel grade 2014-15



Source: Australian Petroleum Statistics (various publications)

These changes in production and demand patterns means that there is a substantially different supply profile for each type of fuel. Overall, the following chart 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 30% 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 proposition for petrol is likely to decline further.

Australian petroleum products demand supplied by imports



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.

4. Interaction between Australian fuels and motor vehicles regulation

Motor vehicle emissions are regulated through Australian Design Rules (ADR) under the Motor Vehicle Standards Act 1989 (MVSA). Fuel quality is regulated under the Fuel Quality Standards Act 2000 (FQSA) and the individual fuel determinations are given effect by Fuel Quality Standards Regulations (FQSR) which specify the individual parameters.

The certification fuel is defined in the ADR as the United Nations Economic Commission for Europe (UNECE) Regulation no 83 *Uniform provisions concerning the approval of vehicles with regard to the emission of pollutants according to engine fuel requirements.*

Motor vehicle manufacturers are required to certify their vehicles on this fuel, however, the parameters specified in UNECE certification fuel contains significant flexibilities that are not reflected in market fuels. For example:

- Octane is defined as 95 Research Octane Number (RON) 85 Motor Octane Number (MON.)
- the use of oxygenates in the UNECE fuels is a “Report” requirement only.
- aromatics can be present in a range of 29-35%.
- olefins can be present in a range of 3-13%.

The flexibility in the specification of the UNECE certification fuel means that the EU fuel standards will not match the UNECE certification fuel in all circumstances. For example:

- European member states are permitted to allow the marketing of petrol containing a minimum of 91 RON and 81 MON.
- Oxygenates are permitted up to 15%, notably MTBE at 15% but a range of other oxygenates are permitted over 10%
- Olefins are permitted up to a maximum of 18%.
- Aromatics are permitted up to a maximum of 35%.

Given these differences and the fact that Australian fuel standards were harmonised with Euro standards subject to Australian conditions means that Australian fuel standards will never match the certification fuel quality because:

- MTBE is limited to 1% volume in Australia and to 0.1% in Western Australian because of the threat of groundwater contamination.
    - The inclusion of MTBE at European levels is an important reason for the lower sulfur levels and other parameter difference in the EU standards.
- Distillation points are not defined in the Australian standard.
- Volatility limits applied by State Government regulation are generally lower than the European standards reflecting climatic differences.

The key point is that vehicles will be certified on fuels which are not likely to match the market grade fuel. Moreover, vehicle manufacturers are not required to specify in the owner’s handbook a required fuel which most closely resembles the certification fuel even though the emission performance is certified on these lower sulfur fuels. AIP is aware that there are brands that specify ULP as the recommended fuel for the vehicle even though ULP is supplied to the market 150ppm sulfur. The key gap in this process is that there is no in-service compliance testing of vehicles in Australia which would specifically determine these compliance issues and the general emission performance on market based fuels.

The ADR also allows for the use of other certification procedures from Europe, Japan and Korea to demonstrate compliance with the requirements of the ADR. AIP is not aware of any publicly available information on the certification procedures for individual vehicle models but consider that it is critically important to determine the emissions performance of the vehicle fleet. However, AIP considers it is probable that European, Japanese and Korean models which comprise the majority of the light passenger vehicle fleet are likely to be Euro 6 certified or are capable of being Euro 6 certified without further modification.

Consequently, there are a number of significant unanswered questions on the emission performance of vehicles sold in Australia. AIP puts forward the following questions to elicit a good understanding of the certification procedures and environmental performance of vehicles currently sold in the Australian market.

- What makes and models specifically are not supplied to Australia because of the quality of Australian fuel? Lean burn GDI models should be separately identified.
- Why do manufactures still supply cars and indeed advertise (e.g. Corolla) that their cars can operate on 91?
- Where is the evidence that there will be substantial environmental benefits for emissions from the existing fleet assuming the introduction of 10ppm sulfur petrol?
- What operability issues do you expect to occur if Euro 6 compliant models are operated on fuels currently in the market?
    - If this is an On-board Diagnostic (OBD) concern can you point to anywhere else in the world where large numbers of false OBD readings have occurred?
- Is there any evidence of the environmental dis-benefit that result from operating new cars on Australian market fuels?
- Is there a role for testing of the current and expected Australian fleet to determine the extent of the operability and environmental concerns?
- Would the vehicle industry be willing to pay for any testing to prove their assertions?
- Are any vehicles certified in Australia using the procedures specified in ADR 79/04?
    - With the closure of Australian domestic motor vehicle manufacturing in 2017 will this continue to be the case?
- Are other certification regimes utilised in certifying vehicles supplied in Australian to the ADR standards?
    - What are the major differences in test parameters, e.g. drive cycle, certification fuel etc.?
- Any car sold in Europe must be Euro 6 compliant, so how many Euro 6 compliant vehicles are supplied to Australia currently?
    - Is the Euro 6 certification used as a proxy for ADR certification?
    - What, if any, modifications are made to vehicles before they are brought to Australia?

5. The quality of marketed Australian fuel

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. The failure to recognise that sulfur levels supplied to the Australian market are considerably below the parameters specified in the FQSA 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.

5.1 Actual petrol sulfur levels in 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 were 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 of over 90% 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 the alternative fuels and vehicles like electric vehicles and hybrids.

Average Sulfur (ppm) in Gasoline 2014-15

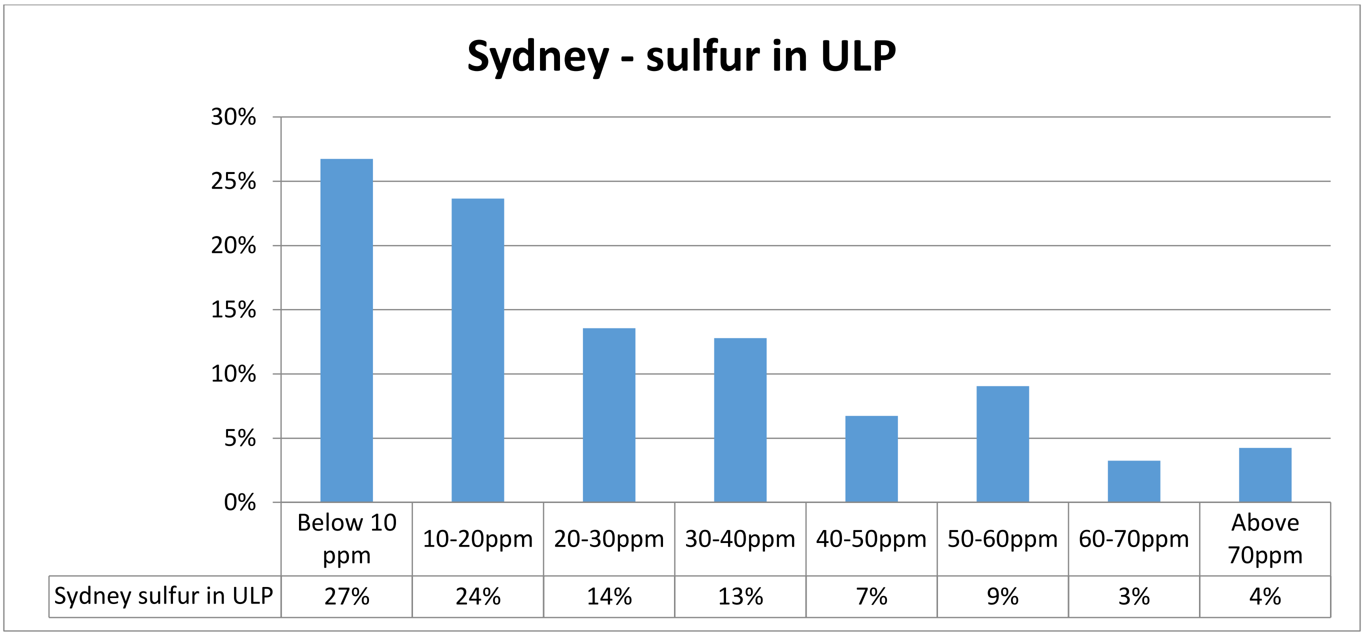
	Sydney ULP	Sydney PULP	Sydney PULP 98	Melbourne ULP	Melbourne PULP
Average	26	16	10	60	28
Minimum	1	1	1	1	1
Maximum	85	45	31	147	49

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.

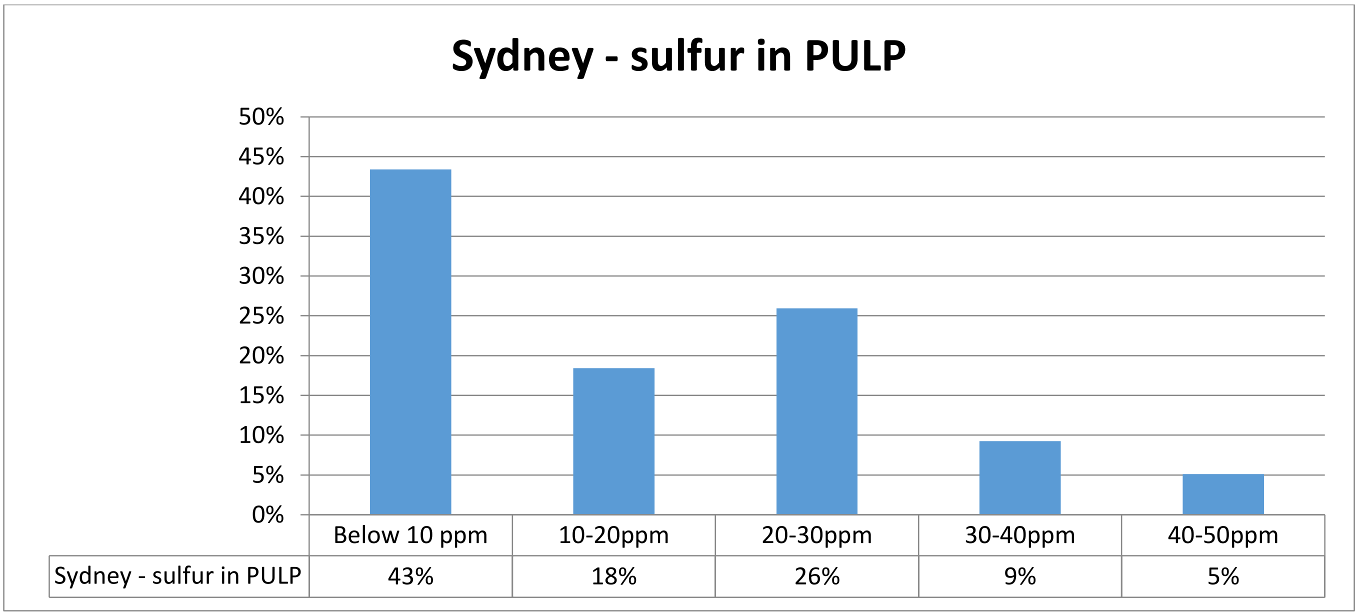
The following graphs show the distribution of the sulfur levels for each grade of fuel which also demonstrate the fairly wide distribution of the sulfur levels within each of these grades.

Sydney ULP



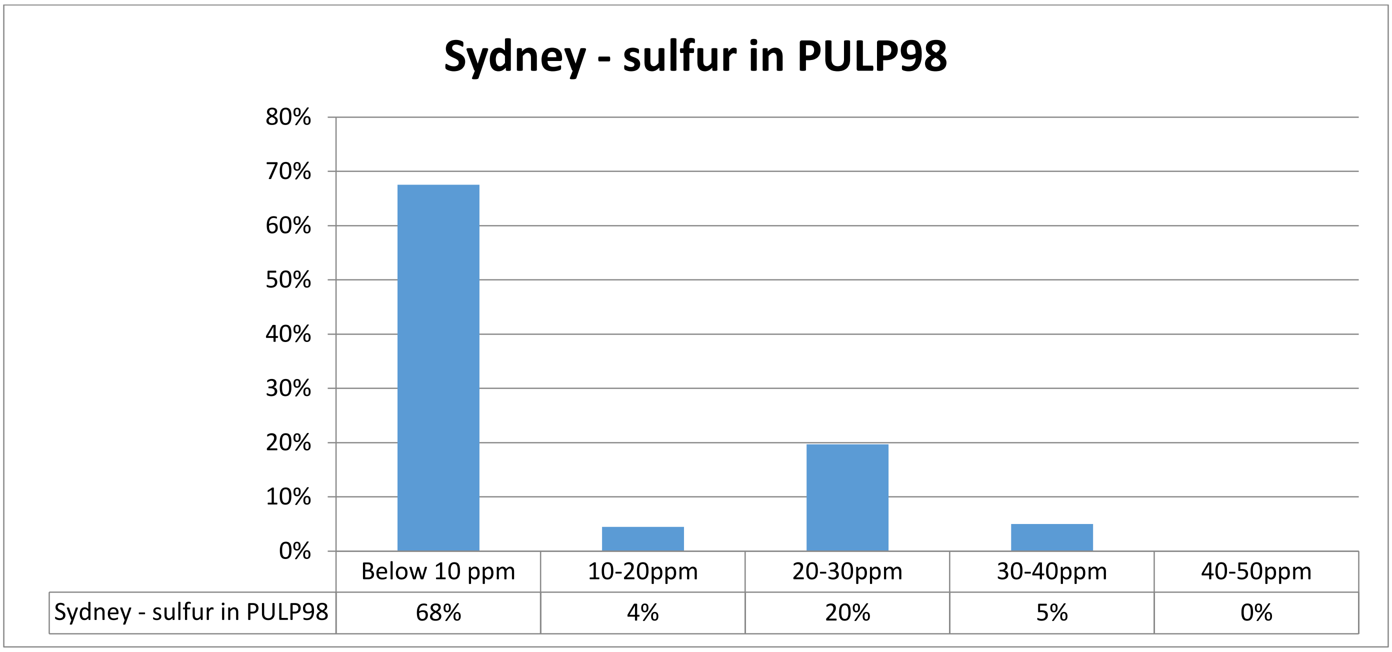
- Almost one third of the ULP supplied to Sydney was below 10ppm sulfur
- Over 80% of the ULP supplied to Sydney was below 50ppm sulfur
- There were very few loads of gasoline with higher sulfur levels above 70ppm sulfur and the maximum was 85ppm.

Sydney – sulfur in PULP



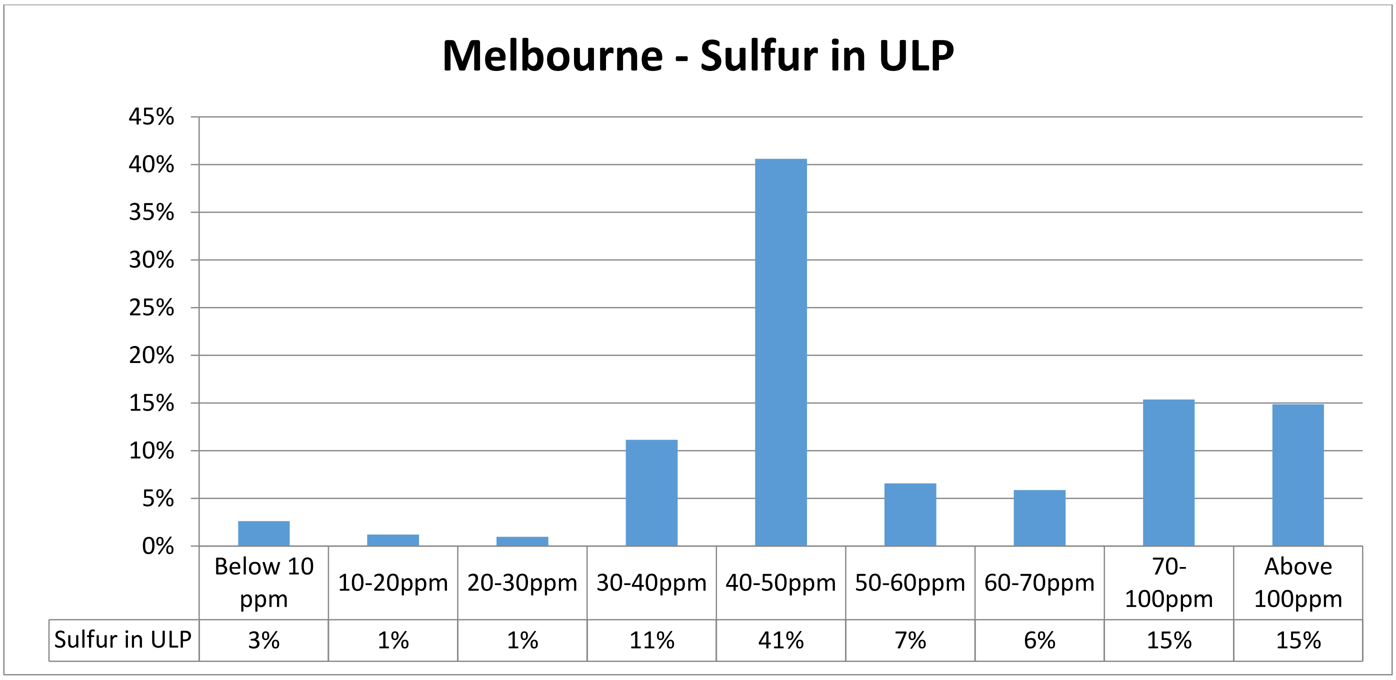
- Almost one half of the PULP supplied to Sydney was below 10ppm
- Over 80% of the PULP supplied to Sydney was below 30ppm

Sydney – sulfur in PULP 98



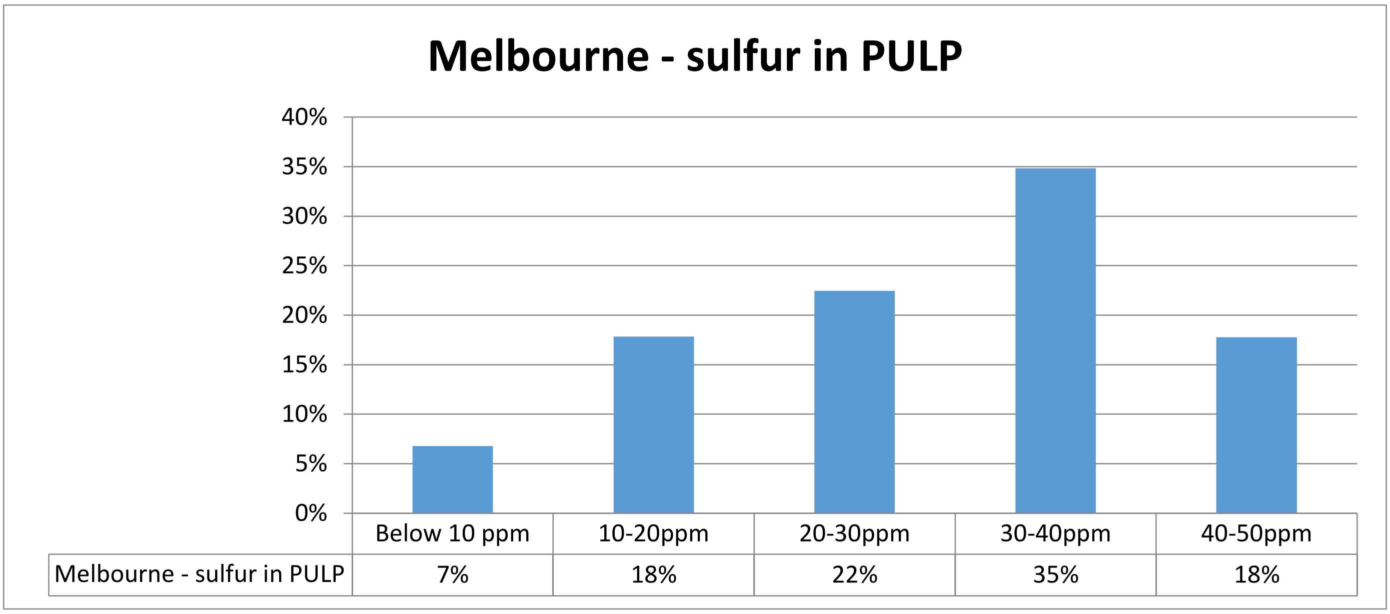
- Almost 70% of the PULP 98 supplied to Sydney was below 10ppm sulfur
- 95% of the PULP 98 supplied to Sydney was below 30ppm
- PULP 98 is fastest growing segment of the fuels market

Melbourne – sulfur in ULP



- Over 50% 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 necessary operating flexibility

Melbourne – Sulfur in PULP



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

5.2 Gasoline grade projections

The following data is drawn from the Australian Petroleum Statistics for total petrol consumed in Australia in kilolitres

	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% per annum
- Ethanol consumption growth has, at times, been significantly driven by State Government mandates but has reduced in recent years

The observations provide the key uncertainties for forecasting future fuel consumption with the following drivers being relevant:

- 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. traffic congestion leading to greater use of public transport)
- PULP growth
  - New vehicles requiring PULP
  - Substitution by the existing fleet to PULP
  - Emergence of PULP as the base grade of fuel
  - The interaction of State Government ethanol mandates driving growth
- E10 growth
  - Significant uncertainty around the ability to meet State government mandates due to consumer aversion
  - Lower oil prices undermine the competitive advantage of biofuels

5.3 Scenarios: Forecasted petrol and sulfur levels

5.3.1 Scenario assumptions

The following scenarios 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. For example, 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.

The data sets are for State total consumption for each grade drawn from the Australian Petroleum Statistics. 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.

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.

A key aspect that has not been considered in this analysis is that PULP has not been separated into PULP95, PULP98. From the previous analysis on sulfur levels PULP98 has significantly lower sulfur levels in Sydney and PULP 98 is the fastest growing segment of the petrol market. Consequently, AIP considers that the estimate of the levels of sulfur in the petrol pool is therefore conservative.

5.3.2 Scenario 1

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

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

5.3.3 Scenario 2

- Petrol demand is constant
- PULP growth is at the average growth of 6% 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.

5.3.4 Scenario 3

- Petrol demand is constant
- PULP growth is at the average growth of 6% pa
- E10 demand declines at historical rate of minus 6% 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.

6. 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 that the argument of the move by other countries to implement 10ppm sulfur petrol provides sufficient justification for Australia to also implement the fuel standard. AIP considers this argument is erroneous 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.

The direct technical evidence base for the sulfur sensitivity of the car fleet is based on studies that are now quite dated and only tangentially relevant to the current Australian car fleet and its environmental performance. This available evidence base will be reviewed in the discussion of the Orbital report later in this submission which reviewed many of the relevant studies.

A key factor to realise is that many of these technical studies used to justify the introduction of 10ppm relied heavily on the introduction of sulfur sensitive technologies, specifically lean burn gasoline direct injection (GDI) to achieve the forecast emission reductions. 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 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.

6.1 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[3]. 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:

1. *provide harmonisation with international standards i.e. 'Euro' standards;*

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

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.

6.2 McLennan, Magasanik Associates (MMA) 2005[4]

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 the evidence that was utilised in that study was predicated on substantial improvements in fuel economy (up to 8%) 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

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

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, development 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 -$1,500 million to $2,700 million.

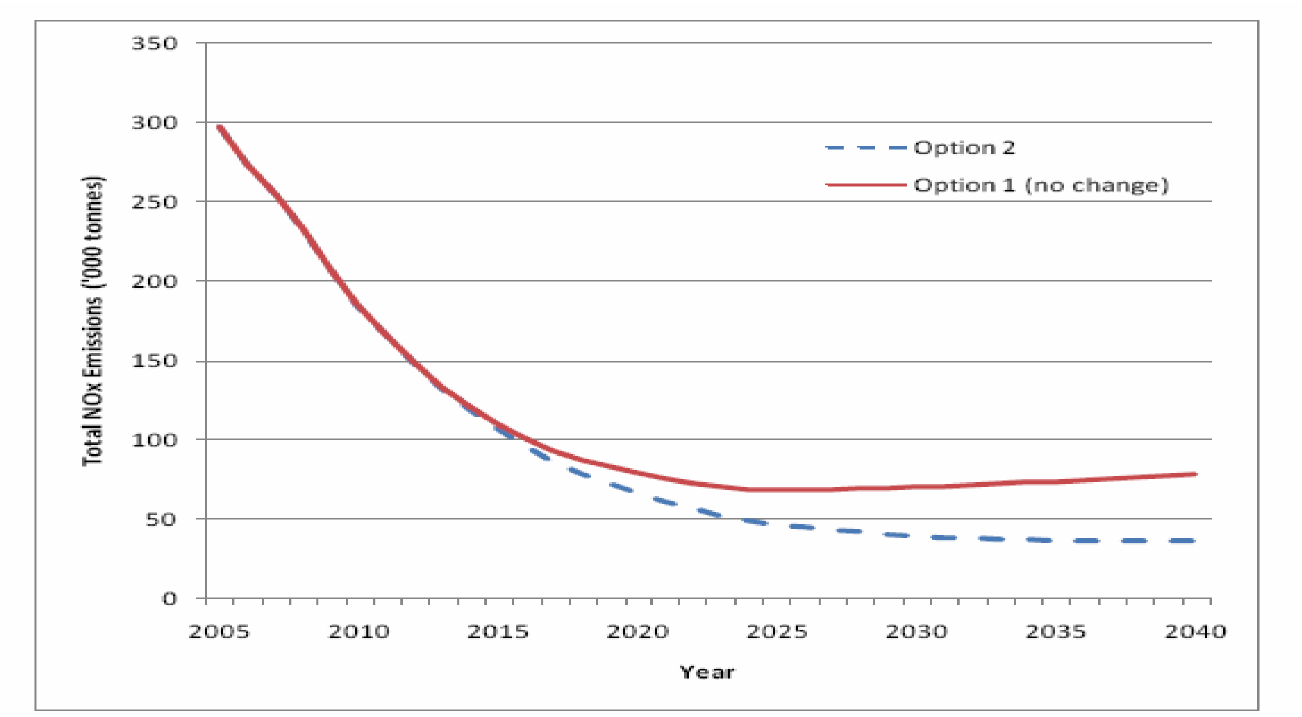
The key MMA conclusion from the analysis is that the introduction of 10ppm sulfur petrol should be delayed until such time as more information is obtained. Although the analysis indicated that net benefits are possible, these net benefits can only occur under certain circumstances.

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.

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

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:



Source: BITRE Estimates (2009)

The estimates in this graphs 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.

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

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.

6.4 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[6] 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[7] 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)[8] concluded that it was clear that there was no damage to catalysts operating long term on 150ppm sulfur petrol. In a Mexican study[9], 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[10].

A further study by CONCAWE[11] 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[12] 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

---

[6] 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

[7] 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.

[8] 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

[9] 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.

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

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

[12] 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

debits. These engines require low sulfur petrol because the lean environment requires the use of lean NO_x trap exhaust treatment technology which is adversely impacted by sulfur. Lean burn GDI engines can still operate at higher sulfur levels but will use more fuel. 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 any catalyst damage or any other reported operability issues. Moreover, the next generation of technologies of engines, Homogeneous Charge Compressed Ignition (HCCI) and Controlled Auto Ignition (CAI) are very tolerant of fuel types and may actually require lower octane than other 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 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[13] 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% to 10% for HC, CO and NO_x.
- Particle emissions are not an issue for petrol engines and there is a question whether the levels can even be measured effectively.
- 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% 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

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

by up to 90% 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% 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 50ppm sulfur ULP standard. As explained in more detail later in the paper, desulfurisation of petrol is energy intensive and because the process destroys octane, augmentation of high octane blendstocks production would 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.

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% depending on the drive and load characteristics. It should be noted that engine improvements are only one strategy 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.[14]

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 NOx requiring the use of lean NOx catalyst ("NOx trap"). The lean NOx 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 NOx 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% in the US and 5% in Europe. This proportion is expected to grow to 26% in the US and 30% in Europe[15]. 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 is likely to be Homogenous Charge Compression Ignition (HCCI) or Controlled Auto Ignition (CAI) that combines features of both spark ignition and compression ignition. In test

[14] 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

[15] Beecham M (2009) *Global market review of fuel injection systems – forecasts to 2016* Just-Auto.

conditions[16] 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 part-load and full-load operating conditions. An implication for fuels is that these engines may be optimised with very different fuels than currently available such as kerosene. A further implication is that the octane requirements when operating on petrol are significantly lower as are the cetane requirements of diesel.

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 a time if these technologies ultimately emerge into the mainstream.

6.5 Martec Study on lean burn GDI 2010[17]

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% 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% of demand in 2001. Stoichiometric GDI engines with advanced valvetrains are 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% 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 and specialised vehicle models. Therefore, arguments that utilise sulfur sensitive technologies such as lean burn GDI should be discounted as irrelevant to the debate.

6.6 Orbital Report 2013[18]

The Orbital report was 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 was that of technology enablement making 10ppm sulfur petrol 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

---

[16] 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

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

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

the lower sulfur the argument is fuel consumption and CO2 will effectively be nullified by 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.

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

> *"Toyota Australia did provide some summary data and opinion that their in-house testing indicated that with 50ppm sulfur (compared to 10ppm) there was a 10-20% 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.

The key conclusions of the Orbital report were stated on page 22 and was 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 with, 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 general operability is expected to be unimpaired."* 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.

6.7 SGS catalyst durability study 2013[19]

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.

---

[19] 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% 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% 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.

6.8 US Tier 3 2014[20]

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.

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,

[20] 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

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 including 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[21] 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.

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

7. Refinery industry contribution to RIS on fuel standards

As was detailed in the MMA report the major costs of introducing 10ppm sulfur are:

- Refinery constructions costs
- Increased refinery operations
- Increased refinery emissions
- Greater cost of fuel to motorists

The assessment of the introduction of 10ppm sulfur petrol for the purposes of a 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 RIS cost benefit assessment.

While each Australian refinery has a different configuration, it has been assessed by each AIP member company at a general level that the introduction of 10ppm sulfur for any grade will require extensive capital construction of new refinery processing units. As part of this general assessment it has also been determined that is not possible to introduce 10ppm to just one grade of petrol, such as PULP, without construction. It may be possible to introduce 50ppm to ULP with more limited construction, but this has not been assessed in any great detail.

AIP notes that the economic contribution of each refinery has been assessed at around $1 billion depending on its size. The closure of refineries is also likely to have disproportionate negative impacts on regional centres such as Geelong which is struggling to adjust to the closure of the motor vehicle manufacturing and aluminium smelting industries.

There are additional complications to the assessment that have not been considered in the Discussion Paper. It has been assumed in the Discussion Paper that sulfur is the only parameter that will be examined when the petrol standard is reviewed. However, the petrol standard review will inevitably consider a range of parameters including:

- Sulfur
- Aromatics
- Olefins
- Oxygenates – MMT, MTBE, methanol

Moreover, given that the FQSA review is likely to recommend the introduction of consumer protection in the objects of the FQSA there could be other parameters that may be introduced to the Australian petrol specification, such as distillation. Each of these parameters may have an impact on the refineries and require further investment and need to be modelled for feasibility and costs.

Consequently, AIP considers 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.

At the commencement of the RIS, each AIP member company will need to form a multi-disciplinary team comprising

- Refinery planners and designers to consider the impacts on the physical infrastructure
  - complex linear planning models are run on multiple scenarios to optimise the refineries technical and financial performance
- Supply operations and logistics personnel
  - Supply needs to be analysed to ensure that any proposals are feasible from a distribution perspective, including aligning alternative supplies with the refinery turnaround
- Financial analysts
  - Finance needs to be assessed to ascertain whether the proposal will induce refinery closure and the closure cost is included in the RIS.
- Corporate affairs

- Corporate affairs will be required to synthesise the results from the different operational areas of the company and make recommendations to the Board of each AIP member company.

Following the completion of the individual AIP member company assessments these results will then need to be synthesised into an industry position that may involve a combination of closure and construction.

These are complex considerations that are likely to involve an aggregate of 20-30 FTE staff and a substantial cost. AIP and member companies have not fully analysed the cost of forming a RIS response team but consider that it could cost the industry at least $10 million to undertake the analysis. As a guide, the Cleaner Fuels Program that led to capital construction in 2004 to 2006 employed a design and implementation team of over 500 personnel in one company. Given the complexity and multifaceted nature of these assessments AIP and member companies consider that it would take up to two years to reliably complete this work.

Given the complexity and the disruption to the business that will occur as a result of this response requirement, AIP considers that the environmental case for changing fuel standards must be adequately demonstrated before AIP member companies are forced to undertake such considerable time and expense. As has been detailed in this submission there is considerable doubt that there is a significant environmental benefit that would warrant such an impact on the Australian refining industry.

AIP cautions that these are significant decisions for each of the Australian refineries. It should be recognised that the decision to move in this direction undermines confidence and investment in the current facilities by introducing uncertainty to the future of their operations.

The examination of the technical solutions in a RIS are a detailed and complex exercise for the Australian refining industry involving:

- Detailed market assessment of the demand outcomes including the likely cost movements in different grades of gasoline and additional fuel costs to Australian motorists
- Detailed pre-FEED (front end engineering and design) of technical solutions for Australian refineries including:
    - Desulfurisation of gasoline streams – technology assessment, sizing and costs
    - Augmentation of octane production units (e.g. alkylation unit) or alternatives
    - Augmentation of utilities – power supply and water supply
- The detailed pre-FEED will need to develop for the purposes of a RIS the following data:
    - Capital cost requirements for the refineries
    - Additional operating costs of the refinery
    - Increased energy usage and infrastructure
    - Increase in greenhouse gas emissions
    - Barriers to construction including land availability, state and local approvals, ongoing environmental licence requirements.
    - Calculation of refinery shutdown requirements and construction program feasibility

AIP emphasises that the key and most significant cost for potential inclusion in RIS is the assessment of refinery viability.

8. Options to reduce vehicle emissions - Submission questions

Adopt Euro 6/VI noxious emission standards for light and heavy vehicles

1. **What are the likely costs and benefits of adopting Euro 6 emissions standards for light vehicles and/or Euro VI emission standards for heavy vehicles?**
   - In the case of diesel vehicles, the current standard is 10ppm which is the specified fuel for meeting Euro VI emission standards.
   - The benefits will largely be in accordance with those estimated in the Euro 5/6 RIS prepared by the Department of Infrastructure and Transport in November 2010
   - The costs will vary depending on whether there is a decision to alter fuel standards.
     - The Euro 5/6 RIS prepared by the Department of Infrastructure and Transport in November 2010 found that there was a positive community benefit for the introduction of Euro6 but it did not consider the cost of changing fuel standards.
     - With the greatest positive community benefit of $807m estimated in that study, it is difficult to see how a positive community benefit can be achieved by a change in fuel standards.
   - AIP does not consider that any changes to fuel standards are required to meet the Euro 6 emission limits for gasoline light vehicles.
     - The Department of Environment Report conducted by Orbital Australia in June 2013 found that, "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." "Some compromise to real world air quality is anticipated **if in-field reversibility is not demonstrated** while general operability is expected to be unimpaired".
   - The doubts expressed by Orbital were in relation to reversibility of the sulfur impacts on catalysts and the consequent higher emissions. Generally, the literature supports the fact that sulfur effects on catalysts are reversible
     - SGS Environmental Testing Corporation undertook a study in June 2013 on the reversibility of gasoline sulfur effects on exhaust emissions from late model vehicles found
     - "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% confidence that the differences in mean emissions values measured before and after the high sulfur fuel exposure were not statistically different."

2. **If Euro 6/VI standards were adopted, when would be an appropriate start date and why?**
   - If fuel standards are not altered, then implementation of Euro 6 motor vehicle emission standards will not have any lead-time ramifications for the refining industry.
   - AIP strongly considers that no credible evidence has been presented to support the claim that Euro 6 certified vehicles cannot operate effectively on current market fuel quality and meet Euro 6 emission requirements.

3. **To what extent do current Australian fuel quality standards limit the adoption/import of existing technologies and models that meet Euro 6 specifications?**
   - Current fuel quality standards do not limit the adoption of any technology, however, the environmental performance of lean burn GDI technologies will poorer than if they are operating on 10ppm sulfur. However, lean burn GDI is not likely to be mainstream technology in the future.

4. **Are there other ways governments could encourage the purchase and supply of vehicles that meet Euro 6/VI emissions standards?**
   - It is critical that the exact certification status of vehicles sold in Australia is known as this will determine the environmental performance of the fleet in the future.

5. **What measures could governments adopt to ensure vehicles continue to comply with noxious emission requirements beyond the point of supply to the market?**

6. **Should the Australian Government conduct a review to consider whether noxious emissions standards for motorcycles should be adopted in Australia?**

Develop Fuel Efficiency (CO_2) Standards

7. **What are the costs and benefits of adopting a fleet average standard for fuel efficiency (CO_2)?**

8. **If standards were adopted, what would be an appropriate fleet average target for 2020 and why?**

9. **What would be an appropriate target for 2025 and why?**

10. **How would standards affect the range of vehicles offered in Australia?**

11. **Apart from standards, are there any complementary or alternative measures that could be adopted to encourage the purchase and supply of more fuel efficient vehicles?**

12. **What would be the most efficient and effective measures to improve the fuel efficiency of heavy vehicles in Australia?**

13. **Should the Australian Government conduct a review to consider whether fuel efficiency measures for motorcycles should be adopted in Australia?**

Fuel Quality Standards

14. **Are there changes to fuel quality standards that could assist with reducing noxious emissions and/or CO_2 emissions?**
    - Australian retail fuels are already highly regulated, 'clean' and provide for reliable vehicle operation. Diesel fuels have been at ultra-low sulfur levels for a significant period and 95 and 98 octane petrol grades provide low sulfur alternatives that already allow for the trouble free operation of Euro 5 and Euro 6 vehicles imported into Australia.
    - These factors in combination with the evidence from air quality monitoring programs by State authorities, which continue to demonstrate a lack of ambient air quality issues associated with vehicle emissions, indicates that further modification to the Australian Fuel Quality Standards should be unnecessary to achieve air quality outcomes.
    - As already outlined in this submission, current sulfur pools values for ULP 91 and PULP 95/98 in the Melbourne and Sydney markets clearly indicate an average value well below the specified maxima of 150ppm and 50ppm respectively. Any slight incremental improvements to already acceptable air quality parameters by mandated changes to lower sulfur levels would come at a disproportionate cost to the Australian motorist and impact ongoing viability of the Australian refinery industry.
    - See section, "Fuel Quality and Vehicle Emissions – the evidence base"

15. **Do you have new information that could assist with the assessment of costs and benefits of adopting more stringent fuel quality standards, in particular for petrol?**
    - The Australian refining industry is unable to give an accurate cost impact without a clear knowledge of the combination of fuel parameter changes that are proposed. Without a detailed understanding of what parameter will be changed and to which value maxima or minima, we are unable to model impacts on refinery operational costs and capital works required to achieve the end results.
    - Further, without a clear understanding of the proposed parameter values, AIP and member companies are unable to determine the market cost impacts to overseas sourced finished product.
    - Once proposed fuel quality parameter changes are clarified, the refining industry can allocate resources to perform modelling of refinery operations and initiate studies into technological options and associated capital works to achieve the desired outcomes for locally manufactured product.
    - See section "Refinery industry contribution to a RIS on fuel standards".

16. **To what extent, if any, do current fuel quality standards limit the choices of vehicles/technologies in Australia and why?**
    - AIP believes that current evidence does not support the assertion that currently available Australian fuels hinder the choice of vehicles available in the Australian market.
    - This is supported by the importation, sale and successful operation of Euro 5 and Euro 6 vehicles and Asian or American equivalents. At this point in time, AIP is not aware of evidence that any vehicle manufacturer is failing to import and sell the latest marque vehicle into Australia. All vehicles appear to be successfully operating on fuel currently available in the Australian market.
    - AIP member companies have not to date been approached by any vehicle manufacturer on any topic relating to vehicle operability issues relating to the use of company supplied fuel specifically or Australian standard fuel in general.
    - Australian Fuel Quality Standards are complex by Asia-Pacific standards and are aligned with some variations, with European, American and some Asian standards which indicate that vehicles manufactured in these localities and imported into Australia should operate successfully. This is supported by the available evidence in the market.
    - See section "Interaction between Australian fuel and vehicles regulations"

17. **Are there other measures that governments could adopt to encourage the supply and purchase of higher quality fuels?**

Information and Education

18. **Have you found the information provided on the fuel consumption label and the Green Vehicle Guide website useful in considering the purchase of a new vehicle?**

19. **How could the information provided on the fuel consumption label and the Green Vehicle Guide be improved to encourage the purchase of more efficient vehicles?**

20. **Have manufacturers and dealers found the information provided on the fuel consumption label and the Green Vehicle Guide useful for product planning and marketing?**

21. **At what point in the decision making process is information on vehicle efficiency most effective in influencing purchasing decisions and what information mediums are most effective?**

22. **What could governments do to improve the availability of data on fuel efficiency of used vehicles?**

23. **How could governments encourage more efficient driver behaviour?**

Fleet Purchasing Policy

24. **What role, if any, should the Government fleet purchasing policy play in encouraging the supply and purchase of more efficient vehicles?**

Tax policy

25. **How could taxes and charges for motor vehicle purchase and/or use be reformed to encourage the purchase and supply of more efficient vehicles?**

26. **To ensure incentives do not have any unintended consequences on air quality, should incentives include noxious emissions requirements as well as CO_2 requirements, or do current noxious emissions standards sufficiently mitigate this risk?**

Alternative Fuels and electric vehicles

27. **What measures could be adopted to improve consumer awareness of the benefits of alternative fuelled and electric vehicles, particularly where they complement environmental benefits?**

28. **What measures could be adopted to encourage the supply of alternative fuelled vehicles and supporting infrastructure, to reduce emissions from road transport?**

29. **How might fuel standards need to be adapted to accommodate alternative fuels?**
    - The current fuel standard regulation for diesel and biodiesel blends contains constraints that limit the ability of fuel manufacturers to blend fuels freely within the limits of the specifications. Biodiesel suppliers must currently rely on the instrument of a Section 13 variation (s.13) to all for the disparity between Cetane limits in the current diesel and biodiesel regulations and a lack of allowance for density increase on blending biodiesel. The requirements of a s.13 there is greater complexity and expense associated with the sale of blended biodiesels.
    - Cetane
      Biodiesel blends currently require the blended fuel to have a minimum Derived Cetane Number (DCN) of 51.0. This is at odds with the current regulation for diesel which mandates a minimum Cetane Index (CI) of 46.0. This disparity between the two closely correlating cetane properties limits the blending of biodiesel due to refinery economic constraints which in up to 30% of batches result in a diesel CI being below the critical 51.0 minimum for biodiesel blends. AIP and member companies argue that harmonisation of the regulated diesel CI and biodiesel blend DCN figures at a minimum of 46.0 would facilitate increased biodiesel blend volume and deliver combustion characteristics of the blended fuel which would still meet current vehicle emission regulatory requirements.
    - Density
      Current diesel and biodiesel density regulations mandate that all blends must fall between 820.0 and 850.0 kg/m3@15C which is met by the manufacturing refinery. Biodiesel densities may vary between the regulated limits of 860 – 890 kg/m3@15C. Based on these figures for both blend components, blends of 5% biodiesel (B5) may as a result have a density of up to 852 and 20% blends (B20) of up to 858 kg/m3@15C. As a result, AIP considers that the density maxima for B5 blends should be varied to allow a maximum of 852kg/m and B20 blends be allowed a maximum of 858 kg/m3@15C. This would allow for continuous manufacture of biodiesel blends when both components, diesel and biodiesel, comply with all regulated requirements and allow vehicles to meet regulatory emission requirements.
    - s.13 Requirements
      Controls imposed by the granting under s.13 increase cost and complexity of operation by imposing a need to sample and test from all facilities manufacturing biodiesel blends. Sampling imposes extra risk to the business due to a requirement to sample vehicles from the top hatches which represents a working at heights risk. Testing of the samples for density, composition and DCN imposes cost as all tests can only be performed by third party laboratory organisations. All these activities and added complexity to operations require internal resourcing to facilitate, record and report. This imposes a cost for biodiesel blends over and above the cost of supplying diesel which cannot be recovered as B5 blends are considered to be within the scope of 'diesel' for sale to customers.
    - Experience
      Biodiesel blends sold into the Australian market over the last 4 years indicate that blends prepared from diesel and biodiesel components complying with the individual base fuel regulations and the requirements of the Section 13 waiver application, have met all operability requirements and pose no risk to air quality or equipment. As such, amendments to the regulations for biodiesel blend DCN and maximum density limits pose no risk and facilitate the sale of biodiesel into the Australian market.

Vehicle Emissions Testing

30. **Should the Australian Government conduct a testing program to assess the effectiveness of UN Regulations in reducing real-world emissions?**

31. **How should the costs of a testing programme be met?**

32. **How could UN Regulations for vehicle emissions testing be improved?**