Pegasus Economics

Australian Energy Security for Liquid Fuels

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Photograph on the front cover is of the former Kwinana refinery near Perth.

Photograph by bp Australia.

Table of Contents

Executive Summary

Energy Security

- Energy security is said to exist if the energy sector does not cause (major) welfare-reducing frictions in the economy at national and global levels (Loschel, Moslener, & Rubbelke, 2010, p. 1666).
- Sometimes energy security gets bundled in with energy independence where a nation relies entirely on its own resources for its energy requirements.
- With significant natural gas and coal reserves, it is technically feasible for Australia to achieve energy independence in relation to liquid fuels.
- There have been numerous warnings against concerns regarding energy dependency and the high cost that energy independence entails: including the following:

> *It would involve paying more for liquid fuels than the rest of the world due to the development of new methods of production as well as the construction of new oil refining capacity beyond what the market would necessarily choose to provide. The attainment of energy independence may also entail an element of picking winners through, for example, mandating certain technology which otherwise would be too expensive and/or risky for the market to develop, an expense and risk that would ultimately be borne by Australian liquid fuel consumers and possibly taxpayers. (Smart & Davey, 2008, p. 7)*

Sources of Supply and Prices of Liquid Fuels

Oil refining is highly capital intensive with dedicated production units and unit costs can be minimised by maximising refinery throughputs (Industry Commission, 1994, p. 7). In turn, refining is subject to large economies of scale and scope as capital costs rise less than proportionately with capacity. It has been estimated that refineries need a processing capacity of 200,000 barrels per day in order to reach the minimum efficient scale (Scherer, 1996, p. 114).

The Australian Competition and Consumer Commission (ACCC) (2013, p. 19) has previously observed that Australian refineries are small by international standards and face increasing competitive pressures from large and complex international refineries. The only real cost advantage ever enjoyed by Australian refineries was the cost differential between shipping 'dirty' crude oil and 'clean' refined product from overseas.

Since 2002-03 the number of refineries operating in Australia has halved from eight to four with the following closures. Since October last year the number of Australian refineries has fallen further from four to two. Recent retrenchment of refining capacity has not been isolated to Australia, but has occurred throughout the Asia-Pacific region.

If Australia can purchase and transport refined petroleum products from Asian refineries at lower cost than we can produce domestically, then it is a more efficient allocation of resources to source more product from overseas.

Within all three of the major Australian liquid fuels markets – diesel, petrol, and jet fuel – Australia is dependent on imports to fill the shortfall as domestic production and supply is unable to satisfy domestic demand. While domestic production was balanced with domestic supply around 2000-01, as demand for diesel and jet fuel has increased and domestic refinery capacity has been retrenched, imports have steadily increased to fill the shortfall.

The main sources of refined product supply to Australia are Singapore, Korea, Japan and China.

In a competitive market wholesale prices are based on the cost of the marginal source of supply that is the final component of supply needed to satisfy demand (Ofgem, 2016, p. 12). Whenever higher cost supply sources become the marginal supply of product, market prices rise to reflect these higher production costs (Farmer, 1991, p. 12). Australian petrol prices have traditionally been benchmarked to an import parity price as imports have represented the marginal source of supply (Davey, 2015, p. 155).

According to the ACCC (2021, p. 8) the relevant benchmark for the wholesale price of petrol in Australia is the price of Singapore Mogas 95 Unleaded (Mogas 95). Similarly, the ACCC (2021, p. 52) has observed the price of Singapore Gasoil with 10 parts per million sulphur content (Gasoil 10 ppm) is the appropriate international benchmark for the wholesale price of diesel.

Benchmarking Australian wholesale petrol and diesel prices to Singapore appears reasonable at it is the primary source of petrol and diesel product imported into Australia. However, Korea is the primary source of jet fuel. The benchmark price for jet fuel will reflect the closest trading market for that airport. Given there is no jet fuel trading market in Australia, the closest jet fuel trading market is in Singapore.

Singapore exerts enormous influence as a trading hub for refined petroleum products across the Asia-Pacific region. Singapore is the largest oil and petroleum product trading hub in the Asia-Pacific region, and one of the top three in the world along with the U.S Gulf Coast and Amsterdam-Rotterdam-Antwerp in North West Europe. Singapore serves as the primary product market and all other markets in the Asia-Pacific region are benchmarked to it.

The Australian Government has made claims to the effect that domestic refinery closures lead to higher fuel prices.

The ACCC (2021, p. 7) has expressed scepticism regarding the Australian Government's contention that domestic refining capacity leads to lower domestic fuel prices. Pegasus Economics also has difficulty in reconciling how the continued operation of domestic refineries that are no longer price competitive with imported product could possibly lead to lower domestic fuel prices.

In order to determine the veracity of the Australian Government's contentions that refinery closures lead to higher fuel prices, Pegasus Economics has undertaken an analysis comparing weekly terminal gate prices (TGPs) for petrol and diesel in Sydney following the closure of the Clyde and Kurnell refineries and in Brisbane following the closure of the Bulwer Island refinery against a weekly import parity price (IPP) based on the Singapore benchmark price lagged one week.

Overall, our analysis suggests that wholesale fuel prices have not universally risen following the closure of domestic refineries.

Any increase in retail prices for petrol and diesel relative to TGPs in Sydney and Brisbane that may have occurred over the period covering the closures of the Clyde, Kurnell and Bulwer Island refineries may not necessarily be associated with, or directly attributable to, refinery closures. For instance, the ACCC was extremely active in pursuing investigations and launching legal actions against fuel retailers over this period in relation to shopper dockets and the use of the Informed Sources real time retail price information service that may have impacted on retail fuel markets.

Australian Energy Security

The ongoing presence of domestic refining capacity does not necessarily guarantee ongoing Australian energy security. This is because refineries can be vulnerable to unplanned shutdowns. Unplanned refinery shutdowns in turn can result in tightness, sometimes shortages and even stockouts for various fuels.

The retrenchment of domestic refining capacity does not necessarily diminish Australia's energy security provided we have the means of procuring alternative sources of refined product from overseas.

As refineries close, domestic refining capacity and capability reduces and Australia becomes more reliant on imports of refined product (Laidlaw, 2020). Australia's fuel supply therefore becomes more reliant on industry's ability to source and ship the necessary fuels when required.

Refining capacity within the Asian region is expected to continue to expand, with major additions expected in China, India and Malaysia. With an increase of refining capacity in the Middle East and North Africa region, the export of liquid fuels from the Middle East are also expected to increase (Fitch Solutions, 2021c, p. 32).

As a consequence of continuing refining capacity expansion, the threat of a regional refining capacity overhang grows (Fitch Solutions, 2021a, p. 92).

Competition in export fuel markets remains intense across Asia, spearheaded by rampant refining capacity additions in China, as well as refining capacity expansions planned across South and Southeast Asia (Fitch Solutions, 2021f, p. 14).

While geopolitical tensions between China and Australia along with other nations have risen since the outbreak of the COVID-19 pandemic, increasing Chinese exports of liquid fuels will simply displace and free up refining capacity elsewhere. On this basis, Australia's increasing reliance on imported liquid fuels does not necessarily translate into increasing dependency upon China. Indeed, during 2019-20 Australia received imports of liquid fuel from 69 countries. Furthermore, Singapore acts as the major trading hub for liquid fuels throughout the Asia Pacific region where many of the supply agreements are actually negotiated.

The available evidence suggests that there is more than sufficient refining capacity in the Asia-Pacific region to make up for the production shortfall arising from the closure of refineries in Australia.

If Australia becomes more dependent on imported refined petroleum products, it will in turn have to rely on more regular product shipments from overseas.

However, with the retrenchment of domestic refining capacity, the required additional product shipments from overseas are largely replacing crude oil shipments from overseas. This is because Australian refineries were generally configured to run largely on imported crude oils with the exception of the Altona and Geelong refineries that were also able to process domestically produced crude oil largely from Bass Strait and to a lesser extent from the Cooper Basin.

An oil tanker is a merchant ship designed for the transport of crude oil and refined petroleum products. For petroleum products, shipping is delineated into Clean Petroleum Products (CPP - generally petrol, jet fuel and diesel) and Dirty Petroleum Products (DPP - generally fuel oil and crude oil) (Hale & Twomey, 2013, p. 4).

There is currently a global overhang in the CCP tanker freight market. According to United Nations Conference on Trade and Development (2021, p. 54), clean and dirty tanker supply will remain high for some time. Tanker removals in 2020 (through scrapping or conversion to other vessel types) were at their lowest level in 30 years, which means the tanker market will enter 2021 with a growing surplus of tonnage (Simpson Spence Young, 2021, p. 15). However, the market is expected to rebalance itself through the withdrawal of existing CPP tankers and a reduction in the construction of new CCP tankers.

In relation to product shipments, consultants Hale & Twomey (Twomey & West, 2012, p. 24) have concluded in a report to the Australian Government that:

> *The petroleum shipping market has proved to be a reliable element in the supply chain; ships are always readily available (although at times they can be expensive) and the market tends to respond quickly if tightness in the market is indicated through rising rates, by bring in further shipping resource from other regions and ultimately commissioning new build vessels.*

Another issue raised by increased reliance on regular product shipments from overseas is the security of sea lanes.

World oil supplies are characterised by a number of key chokepoints including the Straits of Hormuz in the Middle East and the Malacca Straits between Malaysia, Indonesia and Singapore. Chokepoints are narrow channels along widely used global sea routes that are critical to global energy security (Barden, 2019). The inability of oil to transit a major chokepoint, even temporarily, can lead to substantial supply delays and higher shipping costs, resulting in higher world energy prices. Although most chokepoints can be circumvented by using other routes that add significantly to transit time, some chokepoints have no practical alternatives.

For decades, Iran has threatened repeatedly to obstruct naval traffic and disrupt the global energy market in the Strait of Hormuz, although these threats have rung hollow for the most part (Catalano Ewers & Tabatabai, 2020).

According to Professor Rockford Weitz (2020), Director of the Maritime Studies Program at The Fletcher School of Tufts University:

> *In my view, Iran certainly would have trouble stopping all shipping through the Strait of Hormuz. Modern cargo vessels are massive and difficult to disable.*
>
> *Unlike in the 1980s, most oil tankers now have double hulls, making them harder to sink.*

According to naval warfare expert Dr Sidharth Kaushal (2020) from defence think tank the Royal United Services Institute for Defence and Security Studies in London, Iran could not shut down the Strait of Hormuz for very long even if it wished to and is unlikely to incur the substantial risks that an attempt would entail.

While the Strait of Malacca is widely considered the most vulnerable chokepoint, it is perhaps the easiest to circumvent in the event of a disruption (Robert Strauss Center for International Security and Law, 2008). If the Strait of Malacca were blocked, nearly half of the world's shipping fleet would be required to reroute around the Indonesian archipelago, such as through the Lombok Strait between the Indonesian islands of Bali and Lombok or through the Sunda Strait between the Indonesian islands of Java and Sumatra (Villar & Hamilton, 2017)

Overall, maritime shipping routes are not easily disrupted (Stokes, 2020).

International Energy Agency

The employment of oil as a political lever or political weapon has been a recurring theme in Arab political thought and Middle East politics since the early 1940s (Itayim, 1974, p. 85). Ever since the 1950s, members of the Arab world had been talking about using the hazily defined *oil weapon* to achieve their various objectives regarding Israel, which ranged from its total annihilation to forcing it to give up territory (Yergin, 2008, p. 575).

The first world oil crisis began in October 1973. An embargo was established when Arab oil ministers also agreed that they would use oil as a weapon to punish Western nations for their support of Israel in the Yom Kippur war in order to induce policy changes on the part of Western governments. Members of the Organisation of Arab Petroleum Exporting Countries (OAPEC consisting of Arab members of OPEC along with Egypt and Syria) took concerted action to reduce their oil production.

The response of Western nations to the embargo, initiated by the United States, led to the creation of the International Energy Agency (IEA) in November 1974, within the framework of the Organisation of Economic Cooperation and Development (OECD). The IEA carried a broad institutional mandate to foster improved energy security through cooperation on energy policy between major consuming nations (Kissinger, 2009).

In the aftermath of the first world oil crisis, virtually all of the industrial countries, responding to both price and security concerns, embarked on energy policies aimed at reducing dependence on imported oil (Yergin, 2008, p. 636). The mix of policies may have been different across different countries, but the elements were all the same: the use of alternative fuels, the search for diversified sources of oil, and conservation. All the Arab countries ultimately achieved from the embargo was reducing demand for their own oil production.

As a member of the IEA, Australia is required to participate in the IEA's oil security program. The IEA's emergency response mechanisms to oil supply disruptions were set up under the 1974 Agreement on an International Energy Program (IEP Agreement). The IEP Agreement requires that IEA member countries hold oil stocks equivalent to at least 90 days of net oil imports and – in the case of a major oil supply disruption – to release stocks, restrain demand, switch to other fuels, increase domestic production, or share stocks available if necessary (International Energy Agency, 2012, p. 3). (International Energy Agency, 2014)

The IEA's collective emergency response system mechanism is designed to ensure a stabilising influence on markets and the global economy (International Energy Agency, 2021). The aim of the IEA (2014, pp. 21-22) is to mitigate the negative impacts of sudden oil supply shortages by making additional oil available to the global market, not necessarily to improve Australia's energy security.

Australia has not been compliant with its obligations under the IEP Agreement since 2011.[1] Australia's compliance with the 90 days of net oil imports stockholding obligation has fallen largely due to a decline in domestic crude oil production and increased product demand (Australian Institute of Petroleum, 2014, p. 8). Commercial stocks of fuel held in the domestic supply chain (e.g. stocks of petrol, diesel, jet fuel) have actually increased in response to demand growth and increasing product imports following refinery closures, although imports of crude oil have been trending downwards as a consequence. As such, the decline in Australia's 90 day stockholding obligation raises no heightened supply risk for the domestic liquid fuel markets nor for fuel users.

However, the IEA's 90 day stockholding obligation is calculated using a complex methodology developed in 1974 for the highly regulated European market prior to the significant globalisation of the oil market and trade activity (Australian Institute of Petroleum, 2014, p. 7). As a result, this IEA methodology is not reflective of the way the Asia-Pacific market works, and is even becoming less reflective of how the European market operates (i.e. with the European market now increasingly relying on petroleum product imports and longer supply chains).

In particular, 'stock on water' and stocks held overseas awaiting delivery to Australia cannot be counted towards a member country's IEA stockholding obligation, despite this stock being integral to supply operations in Australia and in our region and representing around one quarter of total stockholdings directly owned/controlled by Australian companies.

Including fuel stocks that are managed, transported, and owned by Australian companies en route to Australia would dramatically reduce the shortfall in relation to Australia's IEP treaty obligation. Including these fuel stocks increased Australia's stockholdings to 81 days on average during 2020.[2] A vessel with a product shipment for Australia is unlikely to be diverted away for several reasons. First, operators have a commercial and contractual interest to maintain continuity of supply for customers. Second, fuel produced overseas to Australian fuel standards, especially petrol, are not readily compatible with fuel standards in other countries and thus not readily substitutable.

The Australian Government has committed to returning to full compliance with the International Energy Agency's 90-day oil stockholding obligation by 2026 (Department of Industry, Science, Energy

[1] See Department of Industry, Innovation and Science (2016).
[2] See Department of Industry, Science, Energy and Resources (2021a).

and Resources, 2021b). It intends to achieve this through a combination of government-owned strategic stocks and industry obligated stockholdings.

In April 2020 the Australian Government announced that it would establish the first Government-owned oil reserves for domestic fuel security (Taylor, 2020a). This included a deal with the United States to store Australian Government owned crude oil in the U.S. Strategic Petroleum Reserve (SPR), with Australia having access to hold oil in the SPR for an initial period of 10 years.

While this initiative will certainly assist Australia in complying with its IEP treaty obligations, nevertheless it is difficult to see how the Australian Government holding oil reserves in the SPR over in the United States will necessarily assist in improving domestic fuel security back in Australia. Further, it does appear incongruous that fuel stocks that are managed, transported, and owned by Australian companies en route to Australia are not counted towards Australia's IEP obligations, but oil reserves held in the United States by the Australian Government are.

Up until the present time the Australian Government has not required fuel industry participants to hold stocks of refined petroleum products. Instead, stocks have been held to accommodate short-term fluctuations in demand and have been based on commercial considerations (Smart & Davey, 2008, p. 135). Suppliers of liquid fuels have been able to determine their own level of stockholding in order to maintain commercial operations and continuity of supply to their customers.

The available evidence suggests the industry has responded to market signals and invested in new fuel storage capacity. Furthermore, there have been no widespread or prolonged fuel shortages being experienced in Australia for decades (Australian Institute of Petroleum, 2014a, p. 12).

Despite the industry increasing its fuel storage capacity and no recent experience of fuel supply disruptions, the Australian Government announced its intention to impose a minimum stockholding obligation on the fuel industry in September last year (Morrison & Taylor, 2020).

The imposition of stockholding obligations upon Australian fuel suppliers is not a costless exercise. There are four principal sets of expenses incurred by industry in imposing stockholding obligations, namely:

- set-up costs of the storage facilities: the capital costs and associated amortisation for construction of the storage facility and the purchase of the oil stocks, including material costs (storage tanks, pipelines, pumps and any discharge/loading terminal or equipment) and labour costs
- operating and maintenance costs, including labour costs, utility costs, and insurance
- refreshment costs for maintaining quality specifications of petroleum products
- costs for renting or buying the needed terrain (Stelter & Nishida, 2013, p. 6).

If previous regulatory interventions into capital city fuel markets are any guide, such as the wholesale petrol price declaration and the Victorian terminal gate pricing scheme, then the imposition of a minimum stockholding obligation upon fuel suppliers can be expected to impose an across-the-board price increase on fuel consumers in the order of at least 3 cents per litre even before the costs associated with holding additional quantities of diesel are taken into account.[3]

In seeking to impose a stockholding obligation on liquid fuel suppliers, the Australian Government should design a system that imposes the least cost on industry and ultimately consumers. This would include allowing for tickets. Ticketed stock (tickets) is the name given to a stockholding arrangement under which the seller agrees to hold (or reserve) an amount of oil on behalf of the buyer in return for an agreed fee (Twomey, 2012, p. 9).

Because the establishment of domestic ticket market is likely to be very thin indeed, potentially putting fuel suppliers at the mercy of their competitors and exploitation, fuel suppliers should also

[3] See Davey (2010) and (2013).

be permitted to purchase tickets from overseas as well. Such arrangements provide some flexibility in strategic stockholding by offering a feasible alternative to physically acquiring stocks and building or renting additional storage capacity (Lukach, et al., 2015, p. 279).

It is critically important that the Australian Government imposes stockholding obligations in a non-discriminatory fashion upon all fuel suppliers alike – otherwise it risks distorting competition and creating an uneven playing field in fuel markets.

A stock obligation is usually apportioned by requiring each market participant to hold a minimum amount of stock equal to or above a number of days of their market supply (Twomey, 2013, p. 20). In order to ameliorate potential distortions created in fuel markets from industry stockholding obligations, it has been suggested that financing could be undertaken through an agency with fees related to the sales of final products in a transparent way in order to ensure a more neutral way of cost distribution (Lukach, et al., 2015, p. 280).

It is imperative that all fuel suppliers are treated fairly and equally. In the design of a compulsory stockholding obligation, no discounts nor special dispensations should be provided to any particular category fuel supplier – such as remaining oil refiners for example.

In order to minimise unnecessary cost imposts on fuel suppliers from stockholding obligations, in the event of changing and declining patterns of fuel consumption on the part of Australian consumers it is important that the Australian Government revises its stockholding obligations accordingly.

While the imposition of a stockholding obligation will provide a small increase to a “security margin” as a buffer against supply shocks, it appears to have more to do with IEA IEP Agreement compliance rather than improving Australia’s energy security.

It appears that tensions behind one of the root causes of previous attempts to use the oil weapon, the Arab-Israeli conflict, have eased considerably since the mid-1970s. Furthermore, it appears that the world is coming to the end of the *Age of Oil* with oil demand set to peak and then go into decline within the foreseeable future.

Further attempts by Arab states to use the oil weapon are only likely to hasten the transition away from petroleum-based transport fuels. It is just not in the interests of Middle East oil producing countries to threaten to oil supplies as their economies are heavily dependent on oil revenues and any such moves would likely hasten its demise.

Since it was enacted back in 1974, the provisions of the IEP treaty have never been seriously enacted. The available evidence suggests the IEP Agreement appears to be anachronistic and a relic of a bygone era. As such, rather than exhibiting an energy security problem, it has been suggested that Australia has an IEA problem instead (Stokes, 2020).

Supporting Refinery Production

While the term *industry policy* is used in Australia, it is generally expressed as *industrial policy* elsewhere and in the relevant grey and academic literature.[4] There is wide divergence of opinions over exactly what exactly constitutes industry policy.

Professor Dani Rodrik (2004, p. 2) of Harvard University has defined industry policy as restructuring policies in favour of more dynamic activities generally, regardless of whether those are located within industry or manufacturing per se.

Well formulated industry policy should focus on addressing and correcting market failures. Of particular importance to industry policy are dynamic market failures originating from knowledge

[4] The terms industry policy and industrial policy will be used interchangeably and be taken to mean the same thing.

spillovers and innovation as well as informational externalities and co-ordination failures (Aiginger, 2007, p. 303).

The pursuit of industry policy in Australia has often been associated with protectionism. With the advent of trade liberalisation, the pursuit of Australian industry policy has more recently been pursued through the provision of *ad hoc* assistance packages directed towards assisting certain sectors especially in manufacturing. Such assistance packages do not have a great track record of success.

Arguably the most common criticism regarding industry policy centres around the ability of government to pick winners:

> *The most recurrent argument against industrial interventionism is that it is 'picking winners'. According to this, government is, at best, ill-placed to assess chances of commercial success more effectively than the market. At worst, government is captured by the interests that benefit from its intervention... (Aghion, Boulanger, & Cohen, 2011, p. 3)*

Professor Michael Grubb (2004), Research Director and Professor of Energy and Climate Change in the Institute for Sustainable Resources at University College London has observed:

> *As one cynic put it, 'governments are bad at picking winners, but losers are good at picking governments'.*

Professor Dani Rodrik (2008, p. 29) of Harvard University argues that governments shouldn't even try to pick winners, but should instead focus on the capacity to let the losers go through phasing out support. While Rodrik (2008, p. 29) recognises that this could still be hard to achieve, it is far less demanding of the government than full omniscience.

Pegasus Economics is concerned the design of the refinery production payments scheme does not meet the criteria for industry policy as articulated by Professor Rodrik. Instead, it appears to be a protectionist measure seeking to preserve a domestic refining capacity even if it is no longer commercially viable.

Pegasus Economics is also concerned that through the refinery production payments scheme the Australian Government is engaging in a forlorn attempt to preserve an industry that is in decline and the world is transitioning away from. While the world will require crude oil derived products for many decades to come, the world is shifting away from its reliance on fossil fuels (bp p.l.c., 2020, p. 5).

The emissions intensity of the light-duty vehicle fleet is projected to experience the greatest reductions in emissions intensity (g CO_2-e/km) over the period to 2030 that is attributed to:

> *Changes in the emissions intensity of internal combustion engine (ICE) vehicles and uptake of, hybrid, electric and fuel-cell vehicles are the main drivers of reductions in the emissions intensity of the fleet. (Department of Industry, Science, Energy and Resources, 2020, p. 32)*

The reduction in emissions intensity infers that consumption of liquid fuels by the light-duty vehicle will continue to decline.

Another concern with the refinery production payments is that it may distort competition in various fuel markets, with the ACCC (2021, p. 7) observing:

> *… depending on its design, the scheme could impact on market competition and potentially affect Australian fuel prices.*

In relation to the interaction between the refinery production payments and the stockholding obligations the Australian Government is planning to impose on fuel suppliers, the ACCC (2021, p. 7) has warned:

> *While government is still finalising the full details, the package proposes payments to some parts of the fuel industry (domestic refiners) and potentially additional costs on other parts (such as fuel importers). These payments and costs imposed on vertically-integrated operators have the potential to alter the relative competitive dynamics in the wholesale and retail fuel markets in Australia and thus impact on consumers.*

Due to growing awareness of rising CO_2 levels, global warming and securing energy supply it would be advantageous to use biofeedstock in existing oil refinery infrastructure (Primo & Garcia, 2014).

Biofeedstock is a renewable energy source that will reduce dependency on conventional fuels and provides significant environmental advantages over petroleum-based fuels (Tanneru & Steele, 2015, p. 268). It is greenhouse gas neutral because the CO_2 emitted from biofuels from which it is produced is recycled by photosynthesis. The availability of biomass in the world is 220 billion dry tons per year and is the world's largest and most sustainable energy resource.

Under the Australian Government's fuel security package, it has offered to pay refineries a minimum of 1 cent per litre for production of primary transport fuels in petrol, diesel and jet fuel (Department of Industry, Science, Energy and Resources, 2021b). It would be desirable to ensure the refinery production payments scheme does not discriminate between petroleum-based fuels and biofuels, thus disadvantaging the production of biofuels.

The refinery production payments should be provided on a non-discriminatory basis to producers using renewable as well crude oil feedstocks alike. In this way it will assist in directing capital flows and investment towards the fuels of both today and tomorrow. If the objective of the refinery production payments scheme is to enhance Australia's energy security, then it shouldn't matter whether the feedstock is crude oil or biomass.

1. Introduction

Pegasus Economics has been commissioned by bp Australia to prepare a submission to the Productivity Commission's inquiry into vulnerable supply chains to address Australian energy security as it relates to liquid fuels.

The views and opinions expressed in this report are entirely those of the author.

2. Energy Security

2.1 Defining Energy Security

Interest in energy security is based on the notion that an uninterrupted supply of energy is critical for the functioning of an economy (Kruyt, deVries, & Groenenberg, 2009, p. 2167). Energy insecurity has been defined as "the loss of economic welfare that may occur as a result of a change in the price or availability of energy" (Bohi & Toman, 1996, p. 1). Energy security is said to exist if the energy sector does not cause (major) welfare-reducing frictions in the economy at national and global levels (Loschel, Moslener, & Rubbelke, 2010, p. 1666).

It is a common observation that energy security means different things in different situations and to different people (Cherp & Jewell, 2014, p. 416). As such, energy security can be defined in various ways (Bohi & Toman, 1993). One recent definition has defined it as 'low vulnerability of vital energy systems' (Cherp & Jewell, 2014). According to the Australian Government's 2019 *Liquid Fuel Security Review - Interim Report*:

> *At its core, energy security comes down to ensuring reliability of supply at a competitive price for Australians. Energy supply also needs to be resilient to make sure it can withstand the most likely disruptions Australia might experience and evolve to changing needs over time. (Commonwealth of Australia, 2019, p. 13)*

The International Energy Agency (IEA) (2014, p. 13) defines energy security as the uninterrupted availability of energy sources at an affordable price. The IEA (2007, p. 161) has characterised energy security in practice as a problem of risk management where the objective is to reduce to an acceptable level the risks and consequences of disruptions and adverse long-term market trends. According to the IEA (2007, p. 164), there is no single universally recognised way of measuring a country's level of energy security and it depends on a large array of different matters.

According to energy consultant Daniel Yergin (2005, p. 70), the key to energy security is diversification. According to Yergin (2005, p. 76):

> *Multiplying one's supply sources reduces the impact of a disruption in supply from one source by providing alternatives, serving the interests of both consumers and producers, for whom stable markets are a prime concern.*

However, Yergin (2005, p. 76) contends that diversification is not enough and that a second principle of energy security is resilience where a "security margin" in the energy supply system can provide a buffer against shocks and can facilitate recovery following disruption:

> *Resilience can come from many factors, including sufficient spare production capacity, strategic reserves, backup supplies of equipment, adequate storage capacity along the supply chain, and the stockpiling of critical parts for electric power production and distribution, as well as carefully conceived plans for responding to disruptions that may affect large regions.*

A third principle of energy security is recognition of the reality of integration in that there is only one oil market (Yergin, 2005, p. 76). According to Joel Darmstadter (2006, p. 3) from the Resources for the Future think tank in Washington D.C., there is an integrated and fungible world oil market whereby a price spike *anywhere* will spawn price spikes *everywhere*. As a consequence of fungibility oil and oil products will be routed across the globe so as to equalise the price everywhere.

2.2 Energy Independence

Sometimes energy security gets bundled in with energy independence where a nation relies entirely on its own resources for its energy requirements:

> *Policymakers often equate the attainment of energy security with 'energy independence.' Rising imports as a share of total consumption is thus taken to imply lower energy security, without an analysis of a country's vulnerability to supply disruptions or energy price increases. Equating security with independence also leads policymakers to focus primarily on promoting expanding domestic supplies – for example through subsidies or quotas on domestic production – rather than on efficient methods to manage risk by diversifying suppliers or enhancing substitution among fuel types. (Cohen, Joutz, & Loungani, 2011)*

With significant natural gas and coal reserves, it is technically feasible for Australia to achieve energy independence in relation to liquid fuels. Production of liquid fuels from coal, known as coal-to-liquids (CTL) technology, involves either direct or indirect liquefaction (Styles, 2008). CTL can utilise either black or brown coal.

The direct process involves dissolving the coal in a solvent at high temperature and pressure, followed by hydrogenation (adding hydrogen) with a catalyst, and further refining to produce high-grade clean fuel suitable for use in transport (Styles, 2008). The indirect process first requires gasification of the coal that is typically carried out with steam and controlled amounts of oxygen at high temperature and pressure, to produce a clean-burning fuel known as synthetic gas or 'syngas' (mostly hydrogen and carbon monoxide). The Fischer–Tropsch synthesis (FTS) then combines the hydrogen with carbon monoxide to form different liquid hydrocarbons (Mallik & Mantri, 2014). These liquid products are then in turn further processed using different refining technologies into liquid fuels.

The South African based SASOL oil company operates the world's largest CTL at its Secunda plant east of Johannesburg. However, with emissions of 56.5 million tons of greenhouse gases a year, the Secunda plant is the world's largest single site emitter of greenhouse gases, exceeding the individual totals of more than 100 countries, including Norway and Portugal, according to the Global Carbon Atlas (Sguazzin, 2020).

There is strong momentum for CTL transformations in China, as coal conversion is perceived as a way to raise energy security, monetise otherwise stranded coal reserves and contribute to the economic development of certain regions (International Energy Agency, 2019, p. 18). In turn, China has announced a series of projects involving coal conversions, including CTL (International Energy Agency, 2020, p. 17). China's largest CTL project developed by the state-owned Shenhua Group (now China Energy Investment Group) began operating in the Ningxia region at full capacity at the end of 2017 with a processing capacity the equivalent of 80,000 barrels of oil per day.

However, CTL is very capital intensive, poses investment risks, and is also very CO_2-intensive (International Energy Agency, 2020, p. 18).

Gas-to-liquids (GTL) is a process that converts natural gas to liquid fuels (Mallik & Mantri, 2014). The most common production method used for GTL is the FTS. A GTL project operated in New Zealand from 1986 until 1996 that converted gas to methanol and then to petrol (Maiden, 1988; Brownstein, 2014). However, the conversion to petrol was subsequently abandoned due to the rising price of natural gas that made the process uneconomic (Smith & Evans, 2012).

There are fewer than 10 industrial-scale GTL plants currently in operation around the world (Dwortzan, 2017). The economics of GTL are primarily a function of the feedstock gas price, the capital and operating costs, and the oil price (Hay, 2009). It has been found that GTL is not a commercially viable proposition unless considered under some rather extreme optimistic assumptions and is not viable at all with the imposition of any cap on CO_2 emissions (Ramberg, Henry Chen, Paltsev, & Parsons, 2017).

There have been numerous warnings against concerns regarding energy dependency and the high cost that energy independence entails. The editorial in the *Oil & Gas Journal* (2002) has previously warned:

> *In debates over energy policy, excessive worry about oil dependency breeds the worst proposals: heavy subsidies for economically hopeless fuels, high taxes on the consumption of oil, forced conservation, and fuel selection by politicians and bureaucrats.*

Similarly, the Australian Government's 2004 Energy White Paper warned:

> *Any consideration of Australia's energy security position must pay close heed to overseas experiences and the lessons of the past. One major international lesson is that policies which seek to pre-empt or override market forces rarely work in the longer term. Examples of this in the world are plentiful. New Zealand's experience in subsidising conversion of gas to liquid fuels has led to the uneconomic depletion of a valuable national resource. (Commonwealth of Australia, 2004, p. 116)*

The 2008 Liquid Fuel Vulnerability Assessment warned:

> *While technically feasible in light of Australia's abundant reserves of gas and coal, energy independence in liquid fuels is not something that Australia could readily obtain without incurring higher economic costs. It would involve paying more for liquid fuels than the rest of the world due to the development of new methods of production as well as the construction of new oil refining capacity beyond what the market would necessarily choose to provide. The attainment of energy independence may also entail an element of picking winners through, for example, mandating certain technology which otherwise would be too expensive and/or risky for the market to develop, an expense and risk that would ultimately be borne by Australian liquid fuel consumers and possibly taxpayers. (Smart & Davey, 2008, p. 7)*

3. Sources of Supply and Prices of Liquid Fuels

3.1 Oil Refining

The refining of crude oil involves the separation of crude oil into different categories of hydrocarbons, also known as fractions. Oil refining is a joint production process whereby several products are manufactured simultaneously. The products manufactured during the refining process include petrol, diesel, jet fuel, fuel oil, and a number of other derivative products.

Different hydrocarbons have different boiling points which allows crude oil to be separated into different fractions through distillation. The primary refining process commences when crude oil is heated under vacuum conditions until it evaporates whereby the vapour flows into a distillation tower where it condenses in various stages, with the most volatile or lighter fractions condensing at the top, intermediate fractions condensing at lower levels, and the heaviest fractions settling near the bottom scale (Scherer, 1996, p. 113).

In order to increase the yield of higher value products from a given quantity of crude oil, further chemical processing of other fractions is required. The greater a refinery's yield of higher value added products is, the greater will be the refinery's capital costs.

Oil refining is highly capital intensive with dedicated production units and unit costs can be minimised by maximising refinery throughput (Industry Commission, 1994, p. 7). In turn, refining is subject to large economies of scale and scope as capital costs rise less than proportionately with capacity. It has been estimated that refineries need a processing capacity of 200,000 barrels per day in order to reach the minimum efficient scale (Scherer, 1996, p. 114).

The Australian Competition and Consumer Commission (ACCC) (2013, p. 19) has previously observed that Australian refineries are small by international standards and face increasing competitive pressures from large and complex international refineries. The only real cost advantage ever enjoyed by Australian refineries was the cost differential between shipping 'dirty' crude oil and 'clean' refined product from overseas. It was this cost differential that has generally made imported refined product the marginal source of supply as the overseas refineries supplying Australia have generally been more efficient and have had lower production costs than Australian refineries. Even then, this cost advantage was only applicable to domestic refineries servicing local fuel markets and excluded fuel transported by coastal shipping with its double handling within Australia.

Since 2002-03 the number of refineries operating in Australia has halved from eight to four with the following closures:

- the mothballing of Mobil's Port Stanvac refinery in Adelaide from July 2003 and its subsequent demolition in 2014
- the cessation of refining at Shell's Clyde refinery in Sydney in September 2012 and its conversion to an import terminal (now owned by Viva Energy)
- the cessation of Caltex's Kurnell refinery in Sydney in October 2014 and its conversion to an import terminal (now Ampol)
- the closure of bp Australia's Bulwer Island refinery in Brisbane in June 2015 and its conversion into an import terminal for jet fuel (Australian Competition and Consumer Commission, 2020, p. 46).

Since October last year the number of Australian refineries has fallen further from four to two. Australia's remaining two refineries have the following production capacity:

- Viva Energy's Geelong refinery has a capacity to process 120,000 barrels of oil per day to produce refined products (Oil & Gas Journal, 2021).
- Ampol's Lytton refinery has a capacity of 109,000 barrels of oil per day (Oil & Gas Journal, 2021).

In the interim, two other domestic refineries have recently closed that possessed the following production capacity:

- bp Australia's Kwinana refinery that had a processing capacity of 144,685 barrels of oil per day (Oil & Gas Journal, 2020).
- ExxonMobil's Altona refinery that had processing capacity to 86,000 barrels of oil per day (Oil & Gas Journal, 2021).

In late October last year bp Australia (2020) announced that it would cease fuel production at its Kwinana refinery and convert the site over to an import terminal. bp Australia (2020) commented at the time:

> *… the continued growth of large-scale, export-oriented refineries throughout Asia and the Middle East has structurally changed the Australian market.*
>
> *Regional oversupply and sustained low refining margins mean the Kwinana Refinery is no longer economically viable. Having explored multiple possibilities for the refinery's future, bp has concluded that conversion to an import terminal is the best option.*[5]

The Kwinana refinery was previously Australia's largest and presumably would have enjoyed cost advantages over the other domestic refineries as it was lower down the cost curve due to economies of scale. However, even this wasn't sufficient to enable the Kwinana refinery to remain commercially viable.

In February 2021 ExxonMobil Australia (2021) announced the Altona refinery was no longer considered economically viable and would be converted to an import terminal. The decision was made following an extensive review of operations of the refinery that considered the competitive supply of products into Australia, declining domestic crude oil production, future capital investments and the impacts of these factors on operating earnings.

By way of comparison Singapore – the main source of petrol and diesel imports to Australia – is serviced by three major oil refineries:

- Shell operates a refinery at Pulau Bukom with a capacity of 463,000 barrels per day coupled with a petrochemical manufacturing facility (Oil & Gas Journal, 2021).
- ExxonMobil operates an integrated refinery complex at two sites - one on the mainland (referred to as Jurong) and another on Jurong Island (referred to as Pulau Ayer Chawan or PAC) with the two sites connected by a series of pipelines. This integrated refinery complex has a capacity of 592,500 barrels per day (Oil & Gas Journal, 2021).
- Singapore Refining Company Private Limited (SRC) operates a refinery with a capacity of 275,500 barrels per day on Jurong Island (Oil & Gas Journal, 2021).

Korea – the main source of jet fuel imports to Australia – is serviced by five major oil refineries:

- SK energy operates the Ulsan Complex with a capacity of 840,000 barrels per day (Oil & Gas Journal, 2021).
- SG Caltex operates the Yeosu Complex with a capacity of 785,000 barrels per day (Oil & Gas Journal, 2021).
- S-Oil operates the Onsan refinery with a capacity of 669,000 barrels per day (Oil & Gas Journal, 2021).
- Hyundi Oilbank operates the Daesan refinery with a capacity of 390,000 barrels per day (Oil & Gas Journal, 2021).
- SK energy operates the Inchon refinery with a capacity of 275,000 barrels per day (Oil & Gas Journal, 2021).

China – currently the fourth largest supplier of liquid fuels to Australia – has refining capacity of an estimated 16.3 million barrels per day that is expected to increase by 1.6 million barrels per day by 2024 (Fitch Solutions, 2021a). According to BIS Oxford Economics (2020, p. 13):

[5] Refining margins are the difference between the price of refined petroleum products and crude oil used to produce it. Like any price, refining margins convey information regarding the relative scarcity of refined petroleum products. The concept of scarcity pricing is that prices should change in the short-term to reflect changes in the relative scarcity of the provision of certain services. For example, if there is an ongoing refining capacity overhang one would expect refining margins to contract in response.

> *It has been increasingly difficult for domestic refineries to compete with the mega-refineries in China, Saudi Arabia, India and Singapore.*

India also has a large refining sector with substantial surplus capacity (Fitch Solutions, 2021b, p. 34). There are a total of 23 refineries operational with a nameplate capacity that stands at 4.70 million barrels per day. There is also substantial new refining capacity being installed across the Middle East and North Africa (MENA), particularly in the United Arab Emirates, Saudi Arabia, Iraq, Oman and Bahrain (Fitch Solutions, 2021c, p. 32).

Fitch Solutions (2020, p. 36) has observed in relation to the retrenchment of Australian refinery capacity since 2012 that:

> *This is largely due to the country's inability to compete on cost against larger, more efficient refineries across the region, next to high cost structure and a subdued demand growth outlook. This has led Australia to become heavily reliant on imports. A large domestic fuels gap point to opportunities for new refineries, although scope for new, large-scale projects remains low, due to the prohibitive cost of greenfield developments in Australia (high labour cost, environmental sensitivities).*

In relation to the two continuing domestic refineries, Ampol (2020) announced in October last year that operations at its Lytton refinery in Brisbane would be reviewed. According to Ampol (2020):

> *Given the challenging operating conditions experienced during 2020, Ampol will commence a comprehensive review of the Lytton refinery and its related supply chains to determine the best operating model over the medium term. The review will consider all options for the facility's operations and for the connected supply chains and markets it serves. These options will include closure and permanent transition to an import model, the continuation of existing refining operations and other alternate models of operation, including the necessary investments required to execute each of these options.*

Ampol (2021, p. 14) has said the review will conclude during the first half of 2020.

Under the Australian Government's fuel security package, it has offered to pay refineries a minimum of 1 cent per litre for production of primary transport fuels in petrol, diesel and jet fuel (Department of Industry, Science, Energy and Resources, 2021b). Payments commenced on 1 January 2021 and will operate on an interim basis until long-term arrangements for the payments are developed no later than 1 July 2021.

To qualify to receive the payment, refineries must agree to continue to operate for the duration of the program (Taylor, 2020b). Support is also contingent on refineries committing to an open book process and long-term self-help measures.

Ampol has so far declined to accept the Australian Government's interim refinery production payment (Macdonald-Smith, 2021). Only Viva Energy (2021) has committed to accepting the interim Refinery Production Payment in relation to its Geelong refinery, in turn suggesting the Geelong refinery is the only domestic refinery guaranteed to continue operation in the short to medium term.

Recent retrenchment of refining capacity has not been isolated to Australia, but has occurred throughout the Asia-Pacific region. Refining NZ has announced that it is intending to convert New Zealand's only refinery at Marsden Point into a fuel import terminal following a period of prolonged low margins and competition from imports (Fitch Solutions, 2021d, p. 16).

Shell Singapore (2020) has also announced plans to halve the processing capacity at its Pulau Bukom refinery and aim to deliver a significant reduction in CO_2 emissions. In the Philippines Shell closed its

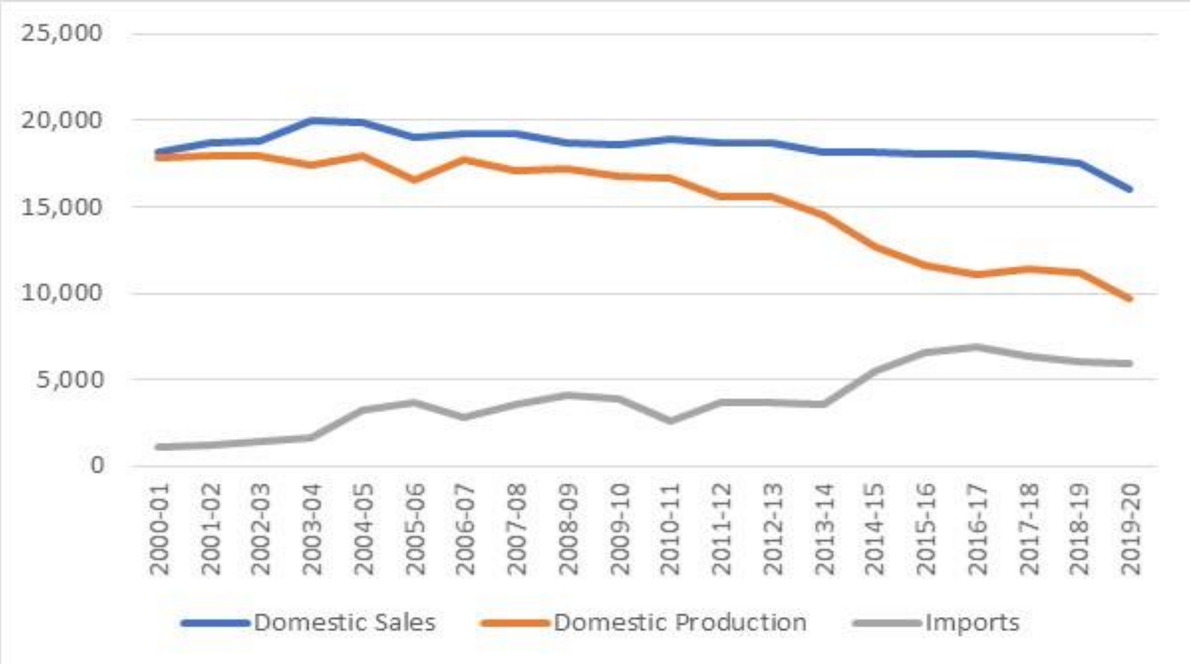
Tabangao refinery in July 2020, which effectively removed 40 per cent of the available refining capacity in the country, and in December 2020 Petron announced the decision to suspend output from its Bataan refinery indefinitely from mid-Jan 2021 until the economy improved accounting for the remaining refining capacity (Fitch Solutions, 2021e, p. 17).

If Australia can purchase and transport refined petroleum products from Asian refineries at lower cost than we can produce domestically, then it is a more efficient allocation of resources to source more product from overseas.

3.2 Liquid Fuel Supply and Pricing

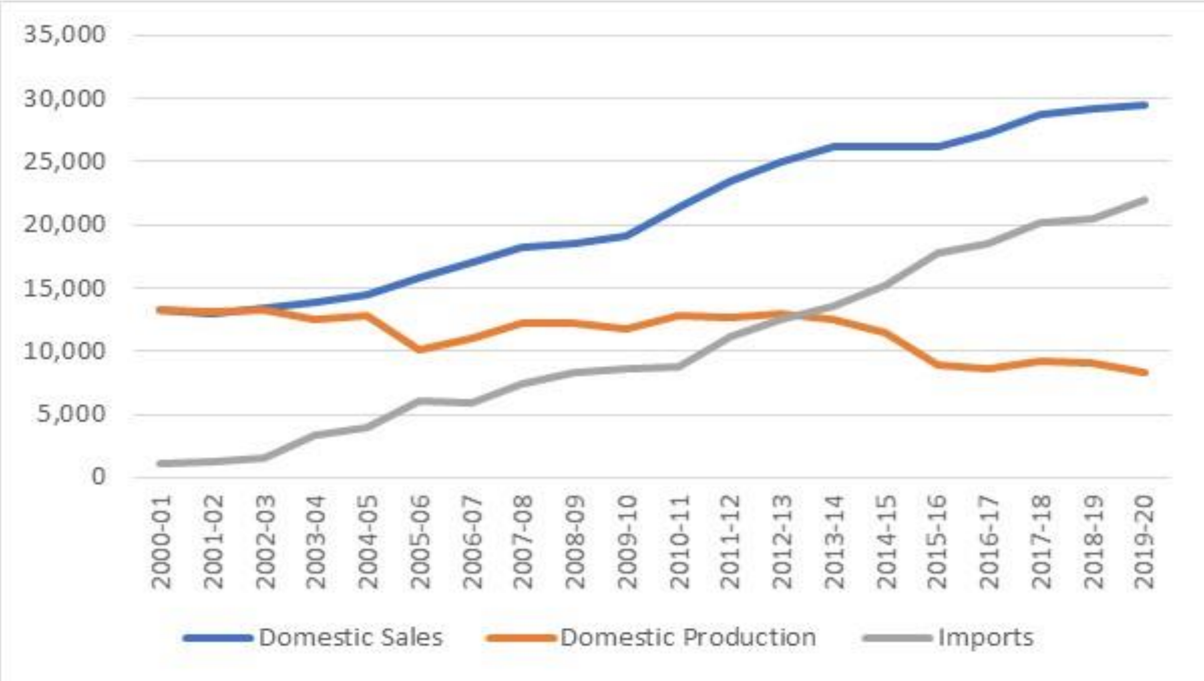
Within all three of the major Australian liquid fuels markets – diesel, petrol, and jet fuel – Australia is dependent on imports to fill the shortfall as domestic production and supply is unable to satisfy domestic demand. While domestic production was balanced with domestic supply around 2000-01, as demand for diesel and jet fuel has increased and domestic refinery capacity has been retrenched, imports have steadily increased to fill the shortfall. This is outlined in Figures 1, 2 and 3 below.

Figure 1: Domestic Sales, Domestic Production and Imports of Petrol – 2000-01 to 2019-20 (megalitres (ML) all grades)



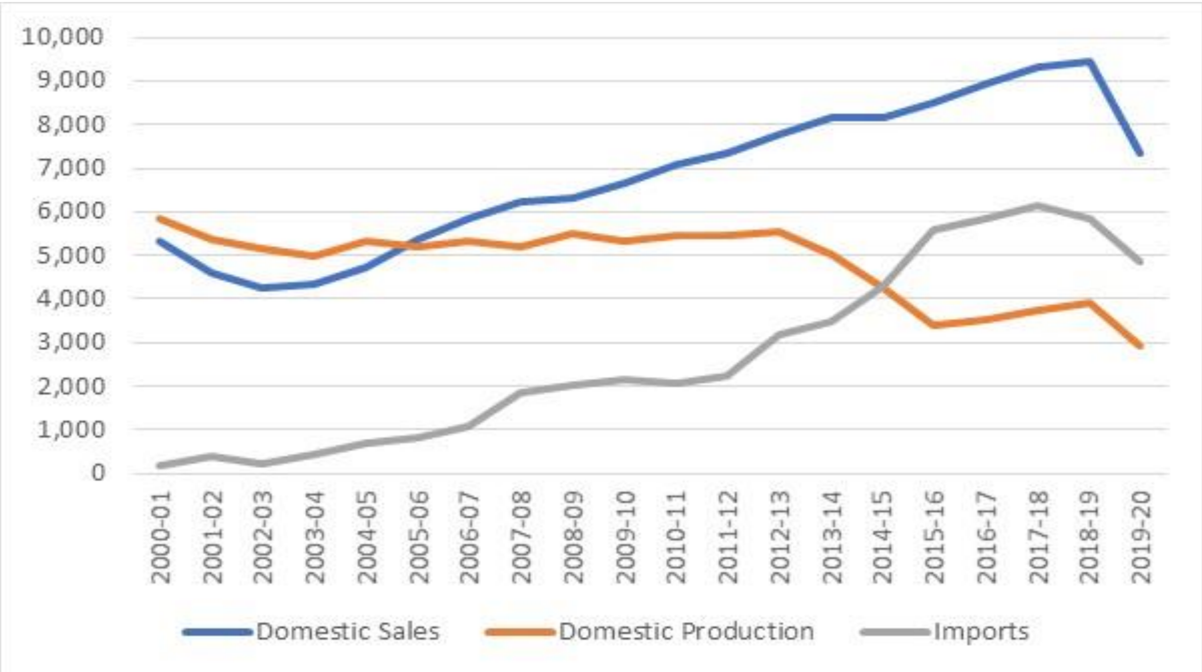
Source: Department of Industry, Science, Energy and Resources (2021).

Figure 2: Domestic Sales, Domestic Production and Imports of Automotive Diesel – 2000-01 to 2019-20 (ML)



Source: Department of Industry, Science, Energy and Resources (2021).

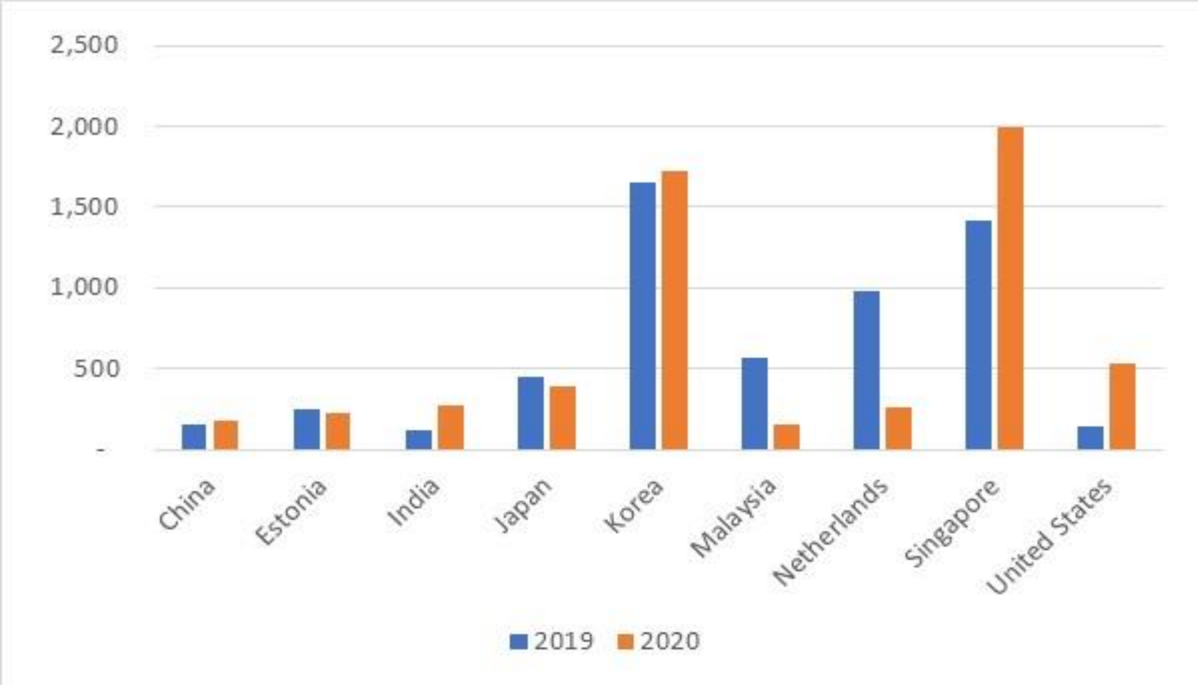
Figure 3: Domestic Sales, Domestic Production and Imports of Jet Fuel – 2000-01 to 2019-20 (ML)



Source: Department of Industry, Science, Energy and Resources (2021).

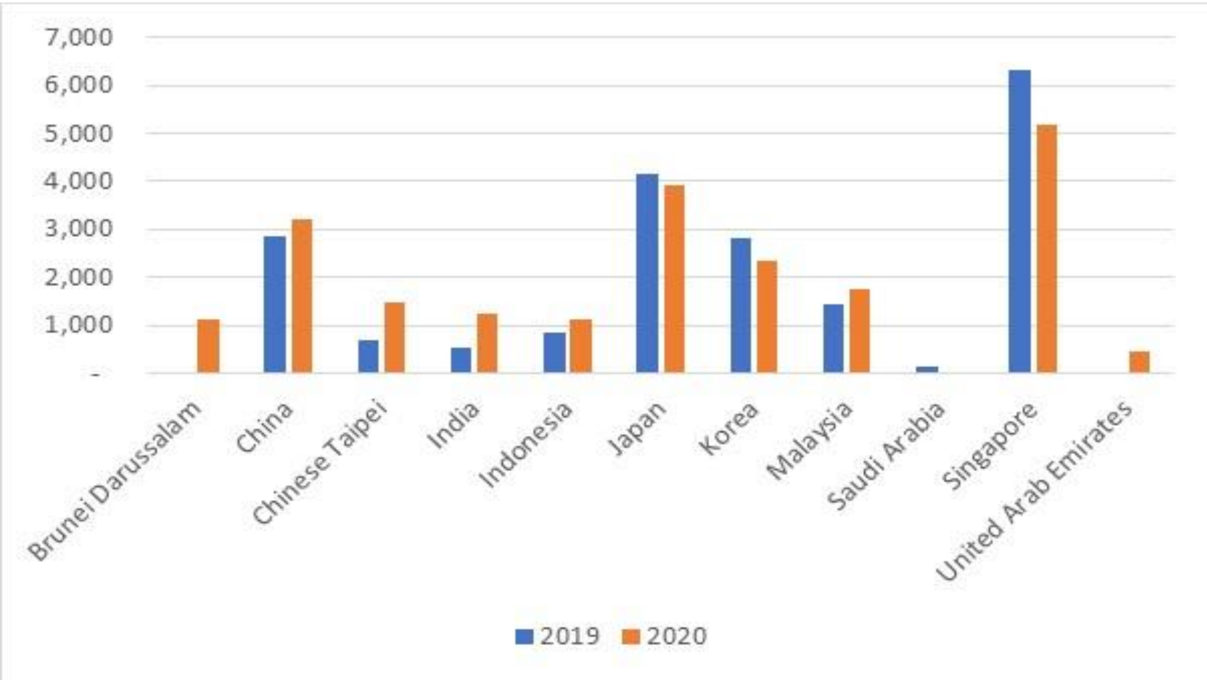
The main sources of imported liquid fuels to Australia are Singapore, Korea, Japan and China. This is outlined in Figures 4, 5 and 6 below.

Figure 4: Primary Origins of Australian Petrol Imports – 2019 and 2020 (ML all grades)



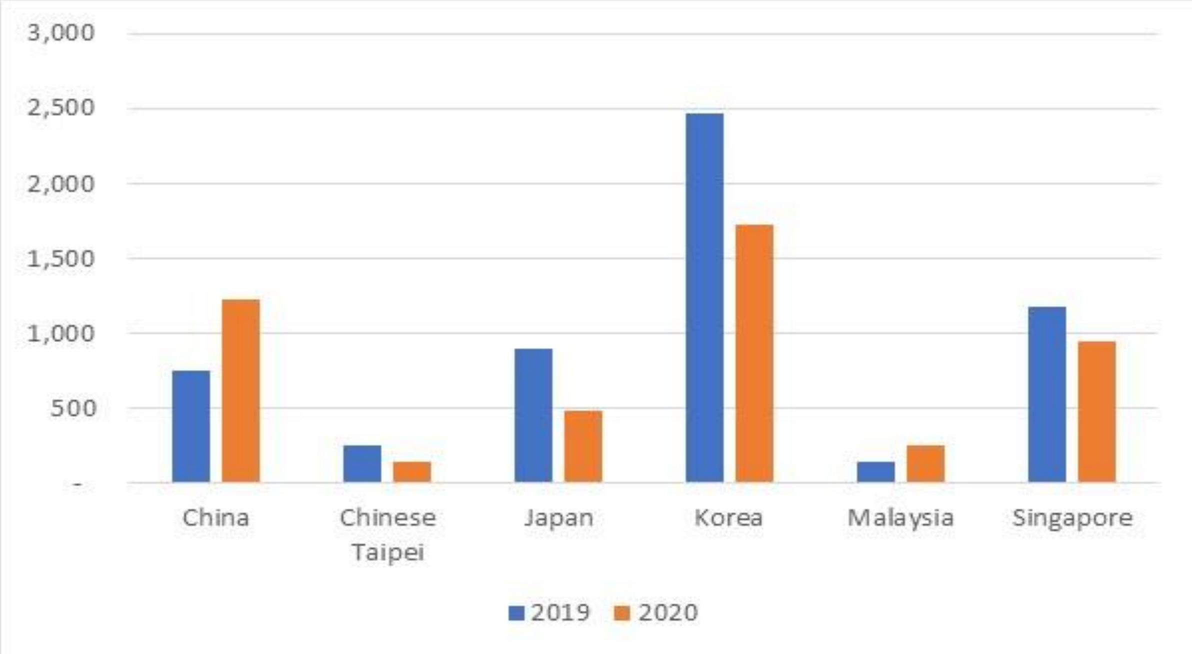
Source: Department of Industry, Science, Energy and Resources (2021).

Figure 5: Primary Origins of Australian Diesel Imports – 2019 and 2020 (ML)



Source: Department of Industry, Science, Energy and Resources (2021).

Figure 6: Primary Origins of Australian Jet Fuel Imports – 2019 and 2020 (ML)



Source: Department of Industry, Science, Energy and Resources (2021).

In a competitive market wholesale prices are based on the cost of the marginal source of supply that is the final component of supply needed to satisfy demand (Ofgem, 2016, p. 12). Whenever higher cost supply sources become the marginal supply of product, market prices rise to reflect these higher production costs (Farmer, 1991, p. 12). Australian petrol prices have traditionally been benchmarked to an import parity price as imports have represented the marginal source of supply (Davey, 2015, p. 155).

In its 2007 petrol inquiry, the ACCC (2007, pp. 207, 208) endorsed the import-parity approach to pricing as efficient where petrol imports are the marginal source of supply:

> *Evidence presented to the inquiry indicates that imports of refined petrol are the marginal source of supply. Without regular and on-going imports of refined petrol, the refiner-marketers would be unable to efficiently meet the demand for refined petrol in Australia.*
>
> *It is quite appropriate and desirable that wholesale petrol prices are based on the cost of importing petrol.*
>
> *For instance, in order for investors to make efficient decisions concerning the reduction, maintenance or expansion of domestic refining capacity or the expansion of import terminal facilities, the wholesale price should as accurately as possible reflect the cost of the alternatives. For example, a decision by a refiner-marketer to close a refinery will at least partly be based on a comparison of the cost of sourcing petrol by continuing to operate the refinery and the cost of buying petrol on the wholesale market. In order for this decision to be efficient, the wholesale price should reflect the cost of the alternative source of supply—importing refined petrol.*
>
> *…*
>
> *Import-parity pricing is efficient in markets, such as wholesale petrol markets, where imports are the marginal source of supply. …*

Wholesale petrol prices in Australia should be based on the cost incurred by the refiner-marketers in importing refined petrol.

More recently, the ACCC (2021, p. 8) has observed:

Retail petrol prices in Australia are primarily determined by international refined petrol prices (which in turn are influenced by international crude oil prices) and the AUD–USD exchange rate.

The same rationale applies in relation to diesel and jet fuel. Within various liquid fuels markets, Australia is now dependent on imported refined petroleum products to fill the shortfall as domestic supply has been unable to satisfy domestic demand. In this case, import parity pricing sets Australian product prices as imports represent the marginal source of supply provided the continuing domestic refineries remain lower cost sources of liquid fuels.

According to the ACCC (2021, p. 8) the relevant benchmark for the wholesale price of petrol in Australia is the price of Singapore Mogas 95 Unleaded (Mogas 95). Similarly, the ACCC (2021, p. 52) has observed the price of Singapore Gasoil with 10 parts per million sulphur content (Gasoil 10 ppm) is the appropriate international benchmark for the wholesale price of diesel.

Benchmarking Australian wholesale petrol and diesel prices to Singapore appears reasonable at it is the primary source of petrol and diesel product imported into Australia. However, Korea is the primary source of jet fuel.

Given that Australia is currently taking most of its jet fuel imports from Korea, one could mount an argument that jet fuel prices in Australian should be benchmarked to those in Korea. However instead, the benchmark price will reflect the closest trading market for that airport. Given there is no jet fuel trading market in Australia, the closest jet fuel trading market is in Singapore.

Singapore exerts enormous influence as a trading hub for refined petroleum products across the Asia-Pacific region. Singapore is the largest oil and petroleum product trading hub in the Asia-Pacific region, and one of the top three in the world along with the U.S Gulf Coast and Amsterdam-Rotterdam-Antwerp in North West Europe. According to McLennan Magasanik Associates (2009, p. 23):

In the Asia-Pacific region, there is nothing that approaches Singapore in terms of its ability to act as a trading hub. Singapore lies within one of the world busiest shipping routes, and has the busiest port and bunkering centre in the region. It has a natural deep water port capable of handling fully laden Very Large Crude Carriers... It is one of the world's largest refining locations, focused on exports of products, and is a major financial centre, with a majority of the first class banks represented in Singapore.

While various petroleum product price reporting services do report on ex-refinery product prices for Korea, these prices are provided on the basis of a premium or discount on Singapore product prices. Hence, Singapore serves as the primary product market for liquid fuels and all other markets in the Asia-Pacific region are benchmarked to it.

3.3 Do Refinery Closures Lead to Higher Fuel Prices?

The Australian Government has made claims to the effect that domestic refinery closures lead to higher fuel prices. According to the Prime Minister and the Minister for Energy and Emissions Reduction (Morrison & Taylor, 2020):

Modelling has shown that a domestic refinery capability is worth around $4.9 billion (over 10 years) in value to Australian consumers in the form of price suppression.

In turn, the Australian Government has contended that Australian fuel prices will increase by around 1 cent per litre if all domestic refineries close (Morrison & Taylor, 2020).

The ACCC (2021, p. 7) has expressed scepticism regarding the Australian Government's contention that domestic refining capacity leads to lower domestic fuel prices:

> *Given Australia's small contribution to refinery capacity in the Asia-Pacific region, and current excess refining capacity in the region, the ACCC's view is that the level of domestic refinery capacity is unlikely to have a material impact on Australian fuel prices.*

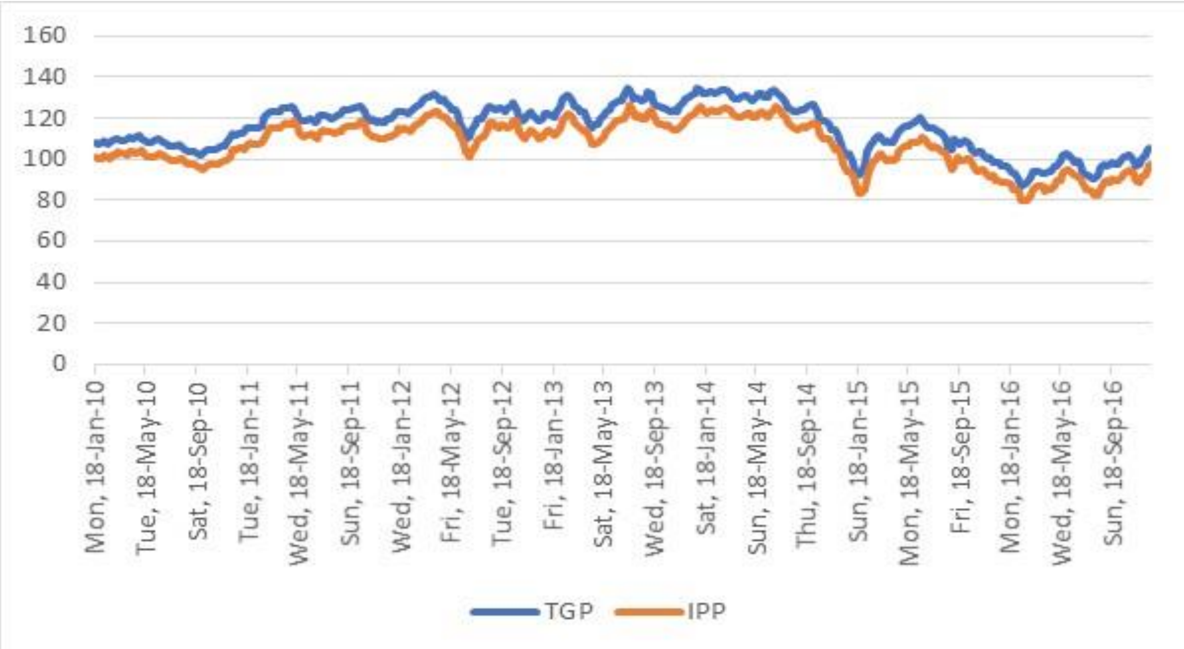
Pegasus Economics also has difficulty in reconciling how the continued operation of domestic refineries that are no longer price competitive with imported liquid fuels could possibly lead to lower domestic fuel prices.

Terminal gate prices (TGPs) are the spot prices at which petrol can be bought from a refinery or terminal (Australian Competition and Consumer Commission, 2014, p. 44). Most wholesale transactions are governed by a contract, and as such few transactions actually occur at the published TGPs. The ACCC (2013, p. 71; 2014, p. 47) has previously found that average wholesale prices are only marginally below that of the TGPs in most of the five major capital cities. On this basis, the ACCC (2017, p. 13) has declared that TGPs can be regarded as indicative of wholesale prices.

In order to determine the veracity of the Australian Government's contentions that refinery closures lead to higher fuel prices, Pegasus Economics has undertaken an analysis comparing weekly terminal gate prices (TGPs) for petrol and diesel in Sydney following the closure of the Clyde and Kurnell refineries and in Brisbane following the closure of the Bulwer Island refinery against a weekly import parity price (IPP) based on the Singapore benchmark price lagged one week.

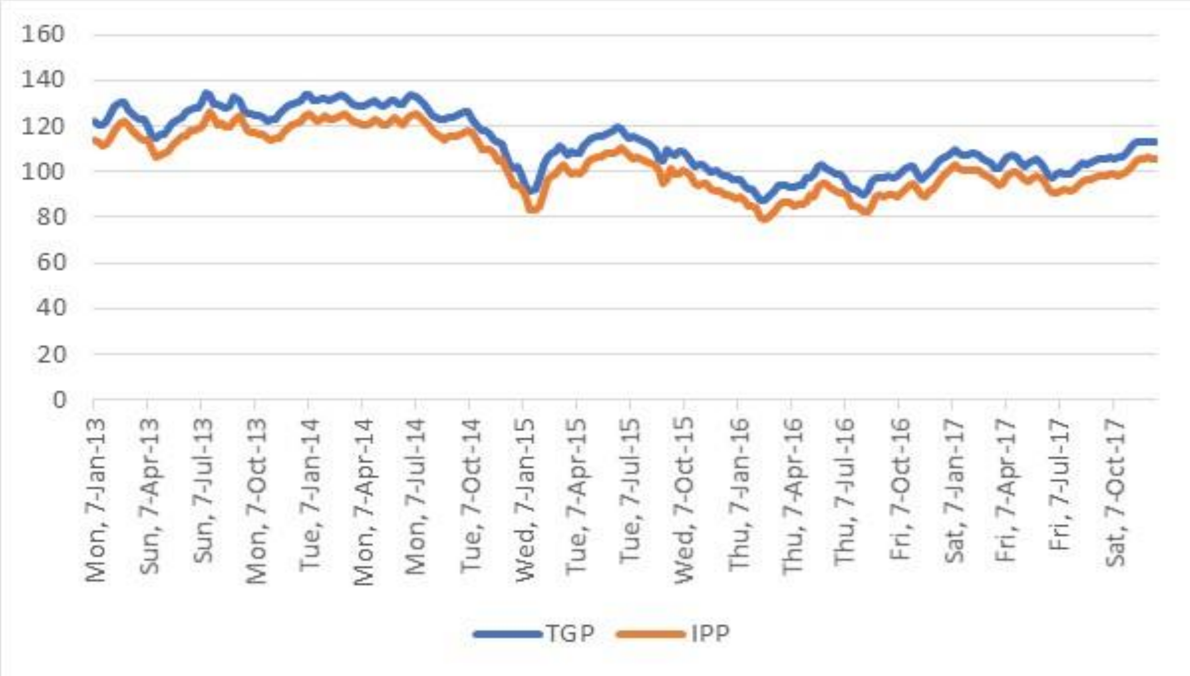
Figures 7 and 8 compares Sydney and Brisbane weekly petrol TGPs to the petrol IPP.

*Figure 7: Weekly Sydney Petrol Terminal Gate Prices (TGPs) and a Petrol Import Parity Price (IPP) Lagged One Week – 18 January 2010 to 19 December 2016 (cents per litre)**



Sources: Australian Institute of Petroleum and the Argus Media Group.
* The IPP has been constructed by taking a weekly moving average of daily spot prices for the Singapore benchmark price of petrol (MOGAS 95) for the previous week and adding shipping to Australia, and import duty (excise) but excluding GST. TGPs have been adjusted to remove the GST component.

*Figure 8: Weekly Brisbane Petrol TGPs and a Petrol IPP Lagged One Week – 7 January 2013 to 18 December 2017 (cents per litre)**



Sources: Australian Institute of Petroleum and the Argus Media Group.
* The IPP and the TGPs have been constructed in the same manner as outlined in Figure 7 above.

Figures 7 and 8 reveals a close correlation between petrol TGPs and the petrol IPP for both Sydney and Brisbane. The correlation coefficient (r) between TGPs and the IPP for Sydney is 0.994 and for Brisbane it is 0.995, while the coefficient of determination (r^2) for Sydney is 0.988 and for Brisbane it is 0.99.[6]

Modelling based on the data contained in Figure 7 reveals that while Sydney petrol TGPs rose by around 1.1 cents per litre (cpl) relative to the petrol IPP following the closure of the Clyde refinery, Sydney petrol TGPs actually fell by just over 0.5 cpl relative to the petrol IPP following the closure of the Kurnell refinery. Modelling based on the data contained in Figure 8 reveals that Brisbane petrol TGPs actually fell by around 0.6 cpl relative to the petrol IPP following the closure of the Bulwer Island refinery. Further details on the modelling are provided in the Statistical Appendix.

Figures 9 and 10 compares Sydney and Brisbane diesel TGPs to the diesel IPP.

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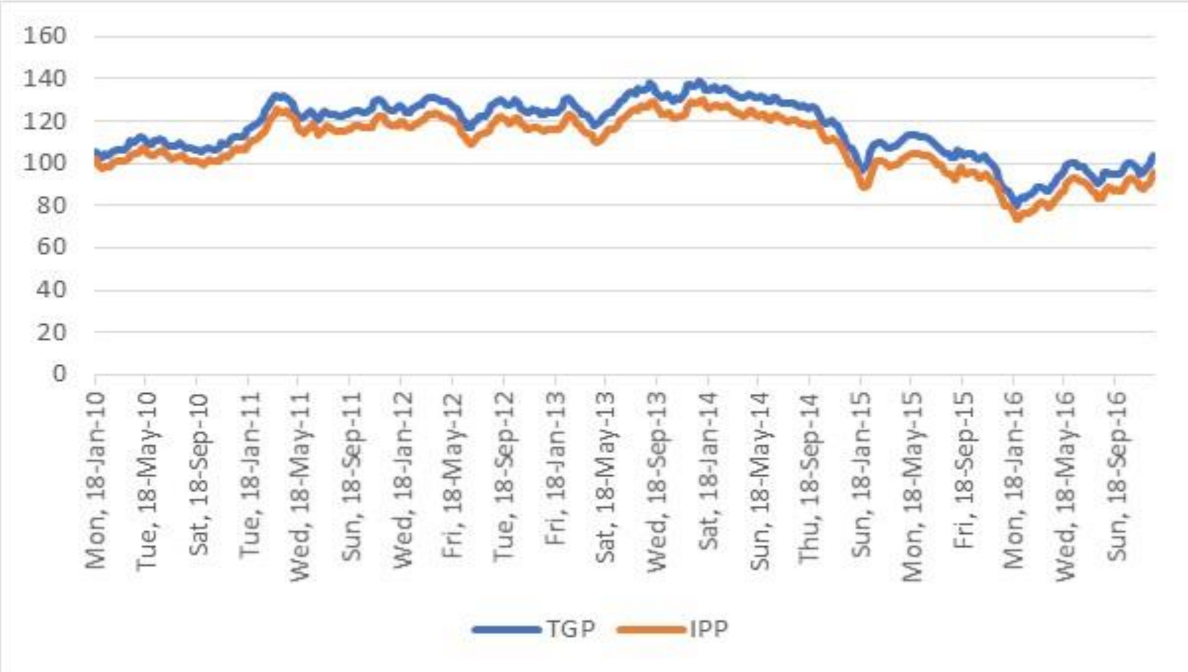
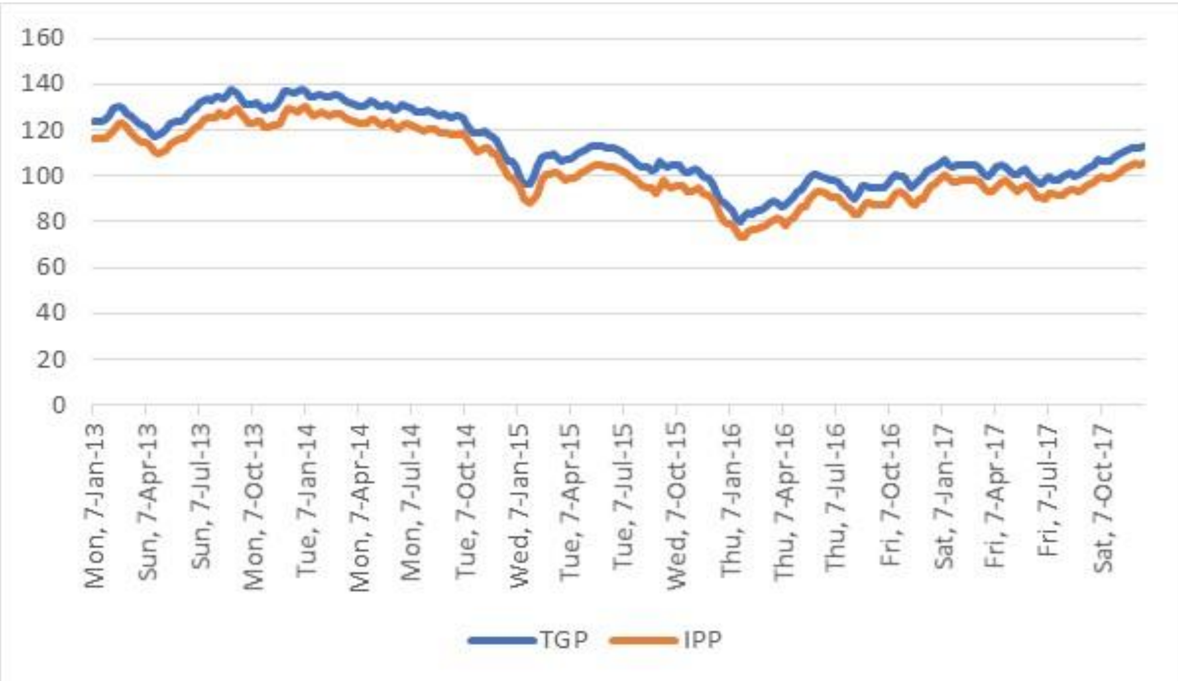
[6] Correlation refers to how closely two variables are related to each other. A correlation coefficient puts a value on the relationship and can range from 1 to -1. A "0" means there is no relationship between the variables, "-1" means there is a negative relationship (one goes up while the other one goes down, while "1" refers there is a positive relationship (they both increase or decrease in unison). A correlation coefficient of greater than 0.8 or less than -0.8 is generally referred to as a strong correlation. The coefficient of determination (r^2) is the square of correlation coefficient and gives the proportion of the variance (fluctuation) of one variable that is predictable from the other variable.

*Figure 9: Weekly Sydney Diesel TGPs and a Diesel IPP Lagged One Week – 18 January 2010 to 19 December 2016 (cents per litre)**



Sources: Sources: Australian Institute of Petroleum and the Argus Media Group.
* The IPP and the TGPs have been constructed in the same manner as outlined in Figure 7 above. The diesel IPP is based on Singapore Gasoil 10 ppm.

*Figure 10: Weekly Brisbane Diesel TGPs and a Diesel IPP Lagged One Week – 7 January 2013 to 18 December 2017 (cents per litre)**



Sources: Sources: Australian Institute of Petroleum and the Argus Media Group.
* The IPP and the TGPs have been constructed in the same manner as outlined in Figure 7 above. The diesel IPP is based on Singapore Gasoil 10 ppm.

As was the case in relation to petrol, Figures 9 and 10 reveals a close correlation between diesel TGPs and the diesel IPP for both Sydney and Brisbane. The correlation coefficient (r) between TGPs and the IPP for Sydney is 0.996 and for Brisbane it is 0.997, while the coefficient of determination (r^2) for Sydney is 0.991 and Brisbane it is 0.995.

Modelling based on the data contained in Figure 9 reveals there was no statistically significant change in Sydney diesel TGPs following the closure of the Clyde refinery relative to the diesel IPP, and there was no statistically significant change in the Sydney diesel TGPs relative to the diesel IPP following the closure of the Kurnell refinery. Modelling based on the data contained in Figure 10 reveals there was no statistically significant change in the Brisbane diesel TGPs relative to the diesel IPP following the closure of the Bulwer Island refinery. Further details on the modelling are provided in the Statistical Appendix.

Overall, our analysis suggests that wholesale fuel prices have not universally risen following the closure of domestic refineries.

Our modelling has not been extended to cover retail prices for petrol and diesel, however, the ACCC (2021, p. 56) has recently commented:

> *Past ACCC analysis of wholesale prices (as represented by terminal gate prices) and retail petrol prices in Adelaide and Sydney following the closure of the Port Stanvac and Clyde refineries … could not find evidence that the closure of the refineries led to higher wholesale or retail prices.*

In terms of the make-up of retail fuel prices, the ACCC (2007, p. 13) has previously observed:

> *The most important factor determining the retail price generally is the wholesale price at which the retailer purchased the fuel. Retail petrol prices in Australia will tend to reflect wholesale prices plus associated costs (such as branding and transport) plus a profit margin.*

Furthermore, any increase in retail prices for petrol and diesel relative to TGPs in Sydney and Brisbane that may have occurred over the period covering the closures of the Clyde, Kurnell and Bulwer Island refineries may not necessarily be associated with, or directly attributable to, refinery closures. For instance, the ACCC was extremely active in pursuing investigations and launching legal actions against fuel retailers over this period in relation to shopper dockets and the use of the Informed Sources real time retail price information service that may have impacted on retail fuel markets.

4. Australian Energy Security

4.1 Domestic Refining Capacity

The presence of domestic refining capacity does not necessarily guarantee ongoing Australian energy security. This is because refineries can be vulnerable to unplanned shutdowns. Unplanned refinery shutdowns in turn can result in tightness, sometimes shortages and even stockouts for various liquid fuels.

The Australian Institute of Petroleum (2008, p. 12) has previously acknowledged that since 2000 there have been supply disruptions due to major refinery outages, sometimes lasting for months at a time.

Shell Australia (2012), the former owner of the downstream liquid fuels business subsequently acquired by the Viva Energy, commented in relation to New South Wales energy security following the conversion of the Clyde refinery into an import terminal that:

For NSW, operating in terminal mode will provide an equivalent or better level of supply security for the NSW marketplace as we will not be required to source products at late notice during periods of unplanned refinery shutdowns.

In 2018 the operational availability of the Geelong refinery was impacted by unplanned outage of the residue catalytic cracking unit in the first quarter following an abnormal weather event and a total site power outage in August due to a lightning strike (Viva Energy Group Limited, 2019, p. 13).

More recently, Caltex Australia (2020) (now Ampol) commented that one of the factors contributing to its disappointing 2019 financial result were unplanned outages caused by a third-party power disruption at its Lytton refinery.

4.2 Availability of Overseas Liquid Fuels

The retrenchment of domestic refining capacity does not necessarily diminish Australia's energy security provided we have the means of procuring alternative sources of refined product from overseas.

As refineries close, domestic refining capacity and capability reduces and Australia becomes more reliant on imports of refined product (Laidlaw, 2020). Australia's fuel supply therefore becomes more reliant on industry's ability to source and ship the necessary fuels when required.

The recent closures of the Kwinana and Altona refineries means the product supply shortfall will have to made-up by overseas imported product. However, there appears to be more than enough refining capacity available in the Asia-Pacific region to fill any gap created by the retrenchment of refining capacity in Australia, even if Ampol shortly decides to close its Lytton refinery.

Asia's refining sector endured heavy hits over 2020 as refining runs and margins collapsed in the face of the COVID-19 pandemic (Fitch Solutions, 2021, p. 54). Total output of refined fuels came in at 31.9 million barrels per day, down 2.1 per cent from 2019, as reduced demand and restrictions placed over movement and labour forced many refineries to shut or cut production runs for extended periods.

Refining capacity within the Asian region is expected to continue to expand, with major additions expected in China, India and Malaysia. In particular, China's growth has potential to far outperform current projections, as the Chinese Government seeks to boost total domestic refining capacity to 20 million barrels per day by 2025 (Fitch Solutions, 2021a, p. 92). The current planned projects pipeline outside of China is similarly robust, as Asia's net fuel importing emerging nations such as India, Malaysia, Thailand and Vietnam, look to leverage low crude prices and the desire to cut imports in order to sanction newbuilds and expansion programs (Fitch Solutions, 2021, p. 54).

With an increase of refining capacity in the MENA region, the export of liquid fuels from the Middle East are also expected to increase (Fitch Solutions, 2021c, p. 32). Many of these new refineries will benefit from access to low-cost domestic feedstock and strong government support and this, combined with their high complexity and economies of scale, will position them well to take market share from other, legacy producers (Fitch Solutions, 2021c, p. 72).

As a consequence of continuing refining capacity expansion, the threat of a regional refining capacity overhang grows (Fitch Solutions, 2021a, p. 92). The surge in refining capacity looks set to compound an already large and growing oversupply of fuels in the region. The emergence of larger, more modern refineries does not bode well for refining margins, while excessive competition looks poised to force smaller and the less efficient plants out of the market. In 2020, refiners in Australia, New Zealand, the Philippines and Singapore confirmed plans to permanently close respective refining plants due to low margins, rising cost, and the trend looks prepared to persist over the coming years (Fitch Solutions, 2021a, pp. 92-93).

China has transformed itself into a significant net exporter of petrol, diesel and jet fuel owing to a significant ramp-up in domestic refining capacity, which has far outstripped recent sluggish growth in domestic demand (Fitch Solutions, 2021a, p. 40). The substantial growth in its exports has also been aided by the state-owned refiners' general reluctance to lower production runs, as healthy demand across main export markets helped to offset softer growth at home. A sombre outlook for the Chinese economy and Chinese domestic fuel consumption growth means that China's state-owned refiners will continue to depend on exports for meaningful growth (Fitch Solutions, 2021a, p. 29).

China's is expected to continue to abide by a policy, whereby any surplus output is exported rather than cutting production runs (Fitch Solutions, 2021a, p. 40). The surge in Chinese fuel exports has already hit fuel prices and fuel margins across the region, and look set to continue to do so over the coming years, as more refineries are commissioned over the next three to four years.

Competition in export fuel markets remains intense across Asia, spearheaded by rampant refining capacity additions in China, as well as refining capacity expansions planned across South and Southeast Asia (Fitch Solutions, 2021f, p. 14).

Consultants Hale & Twomey (Twomey & West, 2012) have previously examined the consequences of domestic refinery closures on Asian refineries for the Australian Government, including the retrenchment of all domestic refining capacity. In relation to diesel and jet fuel this report concluded:

> *Although diesel is now the highest demand grade in Australia, the Asian market will easily be able to adjust to supplying increased volumes if more Australian refineries close. Australia already imports nine billion litres of diesel and diesel has relatively similar specifications across the more advanced economies in Asia. The demand from Australia and other developed countries, along with the wider Asian system needing to export volumes into Europe from time to time, has resulted in many refineries upgrading to the capability to produce and export the higher quality diesel. This trend is continuing as China and India move their cities onto similar higher quality specification diesel.*
>
> *Along with diesel, the Asian refinery system has excess jet production and this is forecast to continue. (Twomey & West, 2012, p. iii)*

The only concern raised was in relation to petrol, but this was due initially to a mismatch between the Asian refinery configurations and Australian fuel standards for petrol, rather than a lack of refining capacity, and then due to Asia moving from surplus to being short on petrol. Despite this, consultants Hale & Twomey still concluded:

> *While product flows may change, there is not expected to be any problem securing petrol supply. (Twomey & West, 2012, p. iii)*

While geopolitical tensions between China and Australia along with other nations have risen since the outbreak of the COVID-19 pandemic, increasing Chinese exports of liquid fuels will simply displace and free up refining capacity elsewhere. On this basis, Australia's increasing reliance on imported liquid fuels does not necessarily translate into increasing dependency upon China. Indeed, during 2019-20 Australia received imports of liquid fuel from 69 countries. Furthermore, Singapore acts as the major trading hub for liquid fuels throughout the Asia Pacific region where many of the supply agreements are actually negotiated.

The available evidence suggests that there is more than sufficient refining capacity in the Asia-Pacific region to make up for the production shortfall arising from the closure of refineries in Australia.

4.3 Product Shipments to Australia

If Australia becomes more dependent on imported refined petroleum products, it will in turn have to rely on more regular product shipments from overseas.

However, with the retrenchment of domestic refining capacity, the required additional product shipments from overseas are largely replacing crude oil shipments from overseas. This is because Australian refineries were generally configured to run largely on imported crude oils with the exception of the Altona and Geelong refineries that were also able to process domestically produced crude oil largely from Bass Strait and to a lesser extent from the Cooper Basin. For example, the Lytton refinery typically sources Kimanis crude oil from Malaysia from the regional spot market (Vahn, Ramesh, & Tan, 2020). Even following the closure of the Altona refinery, freeing up the availability of crude oil from Bass Strait and the Cooper Basin, the Geelong refinery will still be reliant for at least 40 per cent of its crude oil from imports (Williams, 2021).

An oil tanker is a merchant ship designed for the transport of crude oil and refined petroleum products. For petroleum products, shipping is delineated into Clean Petroleum Products (CPP - generally petrol, jet fuel and diesel) and Dirty Petroleum Products (DPP - generally fuel oil and crude oil) (Hale & Twomey, 2013, p. 4).

A CPP tankers are usually much smaller than DPP. Tankers are categorised into a number of capacity categories as measured by the weight of cargo carried referred to as dead weight tonnes (DWT) (Hale & Twomey, 2013, p. 3).[7]

Tankers under 60,000 DWT are often referred to as MRs, which stands for medium range (Stopford, 2009, p. 774). Tankers over 60,000 DWT used for CPP trade are referred to as LRs, which stands for long range. Tankers between 60,000 and 80,000 DWT are referred to as LR1, while tankers between 80,000 and 120,000 DWT are referred to as LR2.

With the closure of Australian refineries, a critical issue will be the availability of CPP tankers. However, there is high degree of substitutability between clean tankers and dirty tankers. On this basis, developments in both the dirty and clean tanker market are relevant.

In light of the COVID-19 pandemic and the fall in liquid fuel demand, the short-term outlook for clean tanker demand is bleak (Loades-Carter, 2021). Clean tanker freight rates are heavily linked with refinery production runs, and falling demand has curtailed refinery production runs across numerous countries.

Although counter-intuitive during the initial onset of COVID-19 pandemic and the subsequent fall in demand for liquid fuels, both dirty and clean tanker rates actually surged in March and April 2020, reflecting growing demand for floating storage (United Nations Conference on Trade and Development, 2021, p. xxii). This was because petroleum markets were in a state of super contango where front-month prices were much lower than prices in future months, making storing crude oil and liquid fuels for future sales profitable.

However, after peaking in March–April, freight rates and vessel earnings in both segments declined sharply in May 2020, as about a third of total vessels locked in floating storage returned to active trade, inflating supply (United Nations Conference on Trade and Development, 2021, p. 54). Although many countries began easing up the lockdowns restrictions, CPP tanker rates remained depressed during June and throughout the second half of 2020.

In the CPP tanker market, floating storage peaked at 14 per cent of the CPP-trading fleet in May 2020, however, this was reduced to 4-5 per cent of the fleet during the second half of 2020, only slightly above pre-COVID-19 levels (TORM plc, 2021, p. 6).

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[7] DWT is the weight a ship can carry when loaded to its marks, including cargo, fuel, fresh water, stores and crew (Stopford, 2009, p. xxii).

There is currently a global overhang in the CCP tanker freight market. According to United Nations Conference on Trade and Development (2021, p. 54), clean and dirty tanker supply will remain high for some time. Tanker removals in 2020 (through scrapping or conversion to other vessel types) were at their lowest level in 30 years, which means the tanker market will enter 2021 with a growing surplus of tonnage (Simpson Spence Young, 2021, p. 15).

However, the market is expected to rebalance itself through the withdrawal of existing CPP tankers and a reduction in the construction of new CCP tankers. Demolition should accelerate given sustained weak earnings and a rise in scrap values and based on the age profile of the fleet, there is scope for many older ships to be removed in 2021 (Simpson Spence Young, 2021, p. 15). Furthermore, the order book to fleet ratio of CPP tankers is currently at a historically low level and only covers 7 per cent of the total fleet (TORM plc, 2021, p. 12). The ordering activity is expected to remain muted in the short- and medium-term on uncertainty around COVID-19, as well as future propulsion systems.

The closure of the Kwinana, Altona and Marsden Point refineries could potentially increase Australia's and New Zealand's combined liquid fuel imports by around 50 per cent from pre-COVID-19 levels (TORM plc, 2021, p. 11). If all additional imports are supplied from Asia, CPP tanker operator TORM (2021, p. 11) have estimated this would require an additional 35 MR vessels to supply Australia and New Zealand, with even more required if some of the product is sourced from refineries in the Middle East.

While product shipments from Singapore will be on MRs, product shipments from the Middle East, and the Far East will attract LR2 and LR1 as well as MR tankers (Integr8 Fuels, 2021). Integr8 Fuels (2021) have calculated that for every 100,000 barrels per day of refining capacity retrenched in Australia, the market will require an additional 5 LR2 tanker equivalents, although product shipments are likely to be spread across MR, LR1 and LR2 tankers. The chartering of product shipments in LR vessels will facilitate economies of scale in shipping and reduce the number of deliveries. The former domestic oil refineries converted into import terminals already have facilities able to accommodate shipments from the larger LR vessels that previously received shipments from larger DPP tankers.

According to President and director Robert Bugbee of Scorpio Tankers, refinery conversions in Australia have created new opportunities for clean tankers and that inquiries for tankers to discharge in Australia had increased in January 2021, likewise increasing ton-mile demand for clean tankers (Alsguth, 2021). Bugbee further commented that changes in the refining landscape would provide an opportunity for clean tanker owners as ton-miles rise for spot trades and more product is shifted around the world.

In relation to product shipments, consultants Hale & Twomey (Twomey & West, 2012, p. 24) have concluded in a report to the Australian Government that:

> *The petroleum shipping market has proved to be a reliable element in the supply chain; ships are always readily available (although at times they can be expensive) and the market tends to respond quickly if tightness in the market is indicated through rising rates, by bring in further shipping resource from other regions and ultimately commissioning new build vessels.*

4.4 Chokepoints

Another issue raised by increased reliance on regular product shipments from overseas is the security of sea lanes.

World oil supplies are characterised by a number of key chokepoints including the Straits of Hormuz in the Middle East and the Malacca Straits between Malaysia, Indonesia and Singapore. Chokepoints are narrow channels along widely used global sea routes that are critical to global energy security

(Barden, 2019). The inability of oil to transit a major chokepoint, even temporarily, can lead to substantial supply delays and higher shipping costs, resulting in higher world energy prices. Although most chokepoints can be circumvented by using other routes that add significantly to transit time, some chokepoints have no practical alternatives.

The Strait of Hormuz is the narrow mouth of the Persian Gulf which at its narrowest point is just 33 km wide (The Associated Press, 2019). The width of the shipping lane in either direction is only 3 km. The Strait of Hormuz separates Iran from the countries of Oman and the United Arab Emirates (Weitz, 2020).

The Strait of Hormuz is the world's most important oil chokepoint because of the large volumes of crude oil that flow through the strait (Barden, 2019). All shipping traffic from energy-rich Persian Gulf countries converges in the strait, including crude oil from Iran, Iraq, Kuwait, Bahrain, Qatar, Saudi Arabia and the United Arab Emirates (Weitz, 2020). It is estimated that 76 per cent of crude oil passing through the waterway is destined for Asian markets, with China, India, Japan, Korea and Singapore among the largest markets (Barden, 2019).

This maritime chokepoint became an arena of conflict during the Iran-Iraq War in the 1980s as each side in the so-called *Tanker War* tried to sink the other's energy exports (Weitz, 2020). During the Tanker War, the U.S. Navy resorted to escorting vessels through the Gulf (Ratcliffe, Lee, & Blas, 2021).

For decades, Iran has threatened repeatedly to obstruct naval traffic and disrupt the global energy market in the Strait of Hormuz, although these threats have rung hollow for the most part (Catalano Ewers & Tabatabai, 2020).

In May 2019, Iran conducted attacks against four tankers off the Emirati coast using mines (Catalano Ewers & Tabatabai, 2020). In June, the Iranian Revolutionary Guards Navy mined a Japanese tanker as well as a Norwegian tanker in the Gulf of Oman near the entrance of the Strait of Hormuz, leading to a spike in oil prices. A month later, it seized two British tankers in the same vicinity.

In 2019 the United States dispatched an aircraft carrier and B-52 bombers to the region (Ratcliffe, Lee, & Blas, 2021). The same year, the United States commenced Operation Sentinel in response to Iran's disruption of shipping. Nations including the United Kingdom, Australia, Bahrain and the United Arab Emirates have since joined the operation, known now as the International Maritime Security Construct. In January 2021, Iran seized a Korean tanker sailing through the area (Ratcliffe, Lee, & Blas, 2021).

There are limited options to bypass the Strait of Hormuz. Only Saudi Arabia and the United Arab Emirates have pipelines that can ship crude oil outside the Persian Gulf and have the additional pipeline capacity to circumvent the Strait of Hormuz (Barden, 2019).

According to Professor Rockford Weitz (2020), Director of the Maritime Studies Program at The Fletcher School of Tufts University:

> *In my view, Iran certainly would have trouble stopping all shipping through the Strait of Hormuz. Modern cargo vessels are massive and difficult to disable.*
>
> *Unlike in the 1980s, most oil tankers now have double hulls, making them harder to sink.*

According to naval warfare expert Dr Sidharth Kaushal (2020) from defence think tank the Royal United Services Institute for Defence and Security Studies in London, Iran could not shut down the Strait of Hormuz for very long even if it wished to and is unlikely to incur the substantial risks that an attempt would entail.

The Strait of Malacca, which flows between Indonesia, Malaysia, and Singapore, connects the Indian Ocean with the Pacific Ocean through the South China Sea. Many of the world's largest economies, which are now concentrated in the Asia-Pacific region, use the channel for trade with the energy-rich Middle East (Calamur, 2017). It is the shortest sea route between Persian Gulf suppliers and key Asian markets (Villar & Hamilton, 2017).

At its narrowest point in the Phillips Channel of the Singapore Strait, the Strait of Malacca is only about 2.8 km wide, creating a natural bottleneck with the potential for collisions, grounding, or oil spills (Villar & Hamilton, 2017).

While the Strait of Malacca is widely considered the most vulnerable chokepoint, it is perhaps the easiest to circumvent in the event of a disruption (Robert Strauss Center for International Security and Law, 2008). If the Strait of Malacca were blocked, nearly half of the world's shipping fleet would be required to reroute around the Indonesian archipelago, such as through the Lombok Strait between the Indonesian islands of Bali and Lombok or through the Sunda Strait between the Indonesian islands of Java and Sumatra (Villar & Hamilton, 2017). Rerouting would tie up global shipping capacity, add to shipping costs, and potentially affect energy prices.

While the Malacca Strait handles a significant proportion of shipments to Australia, efficient and established alternative routes are available if Malacca is threatened, including the Sunda and Lombok Straits (Australian Institute of Petroleum, 2017). Such alternatives routes (or any others) would simply be at a slightly higher cost due to the additional sailing time required.

Overall, maritime shipping routes are not easily disrupted (Stokes, 2020).

5. International Energy Agency

5.1 Origins of the International Energy Agency (IEA)

The employment of oil as a political lever or political weapon has been a recurring theme in Arab political thought and Middle East politics since the early 1940s (Itayim, 1974, p. 85). Ever since the 1950s, members of the Arab world had been talking about using the hazily defined *oil weapon* to achieve their various objectives regarding Israel, which ranged from its total annihilation to forcing it to give up territory (Yergin, 2008, p. 575).

The first attempt to use the oil weapon occurred following the 1956 Suez Crisis, when Britain along with France and Israel invaded Egypt in an attempt to recover control of the Suez Canal after Egyptian president Gamal Abdel Nasser nationalised the canal in late July.

On October 29, 1956, Israel initiated the attack from the Sinai Desert (Yergin, 2008, p. 472). The next day, the British and French announced their intention to occupy the Canal Zone and bombed Egyptian airfields on October 31.

In response to the attack, Egypt scuttled dozens of ships filled with rocks and cement and old beer bottles, effectively blocking the Suez Canal, and thus choking off the supply of oil to Europe, the security of which had been the immediate reason for the attack (Yergin, 2008, p. 472).

Aside from the Suez Canal being blocked, a number of other actions were taken by Arab states to withhold oil supplies from Western Europe. The flow of oil from North Iraq to the Mediterranean coast was interrupted as the result of the blowing up of one of the pump stations of the IPC pipeline system transiting Syria (Itayim, 1974, p. 85). In addition, Saudi Arabia instituted an oil embargo against Britain and France and in Kuwait acts of sabotage shut down that country's oil supply system (Yergin, 2008, p. 473).

Oil supplies were fully restored to Western Europe in December 1956 when an emergency supply program finally swung into operation (Yergin, 2008, p. 475). The Oil Lift, as it was called, was a cooperative venture of governments and oil companies in both Europe and the United States. The Oil Lift was complemented by rationing and other demand-restraint measures (Yergin, 2008, p. 475).

In June 1967, the Six Day War erupted between Israel and an alliance of Arab nations. In late May 1967 Jordan, Iraq, Saudi Arabia, Syria and Lebanon moved their military forces towards the Israeli border, and in reaction to Arab threats of wiping Israel out, the war began with an Israeli pre-emptive aerial strike on 5 June 1967 (Israel Ministry of Foreign Affairs, 2013). Israel succeeded in the very first hours in catching on the ground the entire air forces of Egypt and the other belligerent states and quickly obliterated them (Yergin, 2008, p. 536). With mastery of the air assured, Israeli forces threw back the Arab armies.

By June 8, the Israeli Army had completely traversed the Sinai and had reached the eastern bank of the Suez Canal. Over the next few days, cease-fires were hastily arranged, leaving Israel in command of the Sinai, all of Jerusalem and the West Bank, and the Golan Heights (Yergin, 2008, p. 537).

In reaction to the Six Day War, Saudi Arabia, Kuwait, Iraq, Libya, and Algeria banned crude oil shipments to the United States, United Kingdom, and West Germany (Gross, 2017). The flow of oil around the world was completely reorganised in response, with oil from non-Arab countries diverted to the embargoed countries in Europe. Closure of the Suez Canal during the war made this shift even more challenging, especially for European consumers. However, oil was abundant and cheap during this time and newly deployed supertankers conveyed oil to markets where needed.

The United States was the primary source of spare oil production capacity at the time (Gross, 2017). The United States increased production and Venezuela and Iran (prior to the Islamic Revolution) were able to make up the rest, ameliorating the shortage. The oil weapon largely failed in 1967, and was most harmful to the oil producing countries that gave up substantial revenue during the period of the embargo.

However, the oil market changed following the 1967 Six Day War in ways that made the oil weapon much more potent (Gross, 2017). Rapid demand growth consumed U.S. spare oil production capacity, and by 1970 net oil imports to the United States were rising rapidly. The United States was no longer the source of spare capacity and security margin in the oil market. At the same time, oil production in the Middle East was also growing quickly, meeting two-thirds of global demand growth between 1960 and 1970.

On 6 October 1973, hoping to win back territory lost to Israel during the Six Day War, Egyptian and Syrian forces launched a coordinated attack against Israel on Yom Kippur, the holiest day in the Jewish calendar (History.com Editors, 2018). Taking the Israeli Defence Forces by surprise, Egyptian troops swept deep into the Sinai Peninsula, while Syria struggled to throw occupying Israeli troops out of the Golan Heights. Israel counterattacked and recaptured the Golan Heights. A cease-fire went into effect on 25 October 1973.

By the time the first world oil crisis began in October 1973 the oil weapon was far more potent. An embargo was established when Arab oil ministers also agreed that they would use oil as a weapon to punish Western nations for their support of Israel in the Yom Kippur war in order to induce policy changes on the part of Western governments. Members of the Organisation of Arab Petroleum Exporting Countries (OAPEC consisting of Arab members of OPEC along with Egypt and Syria) took concerted action to reduce their oil production. These reductions were set to increase in monthly increments, until their economic and political objectives were achieved, and they were sufficiently implemented to increase oil prices dramatically (Scott, 1994, p. 28).

While friendly Western nations would continue to receive their previous level of supply, other Western nations would have their supply reduced or cut off altogether. Although the embargo was not uniformly applied, Saudi Arabia and Libya cut off virtually all supplies to the United States, while Denmark, The Netherlands, Portugal, Rhodesia and South Africa were also embargo targets (Scott, 1994, p. 28). Arab oil ministers eventually decided to lift the embargo in March 1974.

The response of Western nations to the embargo, initiated by the United States, led to the creation of the International Energy Agency (IEA) in November 1974, within the framework of the Organisation of Economic Cooperation and Development (OECD). The IEA carried a broad institutional mandate to foster improved energy security through cooperation on energy policy between major consuming nations (Kissinger, 2009).

In the aftermath of the first world oil crisis, virtually all of the industrial countries, responding to both price and security concerns, embarked on energy policies aimed at reducing dependence on imported oil (Yergin, 2008, p. 636). The mix of policies may have been different across different countries, but the elements were all the same: the use of alternative fuels, the search for diversified sources of oil, and conservation. All the Arab countries ultimately achieved from the embargo was reducing demand for their own oil production.

5.2 Australia's IEA Obligations

As a member of the IEA, Australia is required to participate in the IEA's oil security program. The IEA's emergency response mechanisms to oil supply disruptions were set up under the 1974 Agreement on an International Energy Program (IEP Agreement). The IEP Agreement requires that IEA member countries hold oil stocks equivalent to at least 90 days of net oil imports and – in the case of a major oil supply disruption – to release stocks, restrain demand, switch to other fuels, increase domestic production, or share stocks available if necessary (International Energy Agency, 2012, p. 3).

In March 1979 Australia signed the IEP Agreement, thereby becoming a member of the IEA.

An emergency response under the IEP Agreement has only been conducted on three occasions since the creation of the IEA (2021). The first was in January 1991 during the First Gulf War. The second was in 2005 following hurricanes Katrina and Rita damaged oil infrastructure in the Gulf of Mexico in the United States. The third was in 2011, during the Libyan crisis. On each occasion the volume of stock released was less than one day's global demand (Department of Industry and Science, 2015, p. 7).

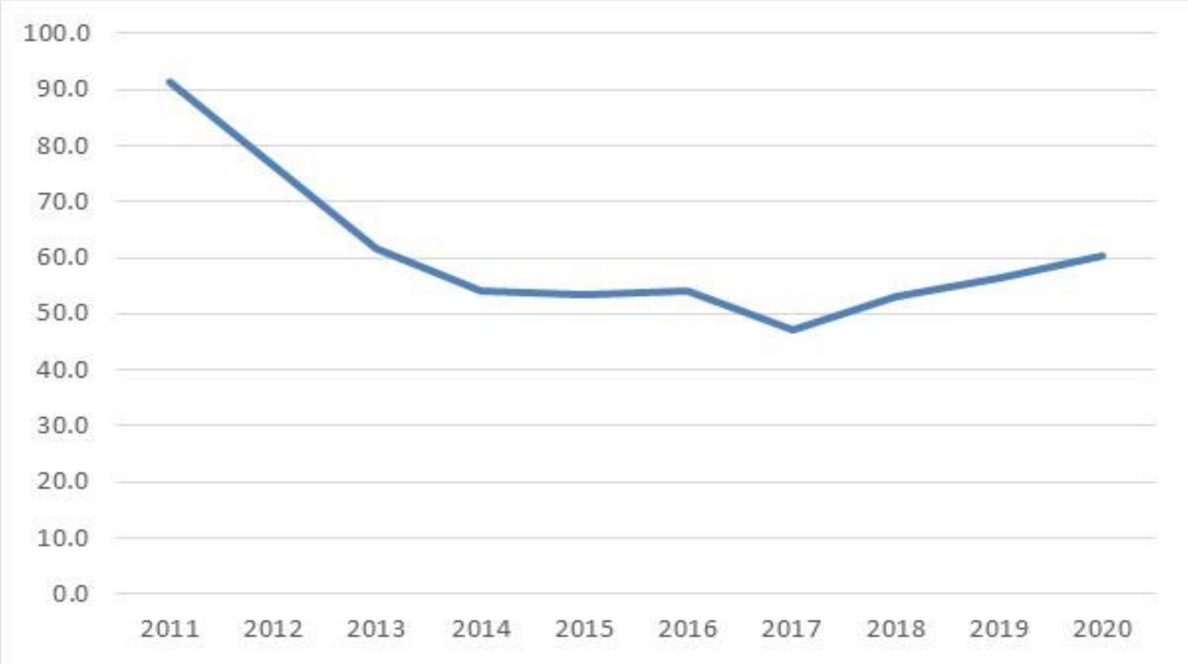
The IEA's collective emergency response system mechanism is designed to ensure a stabilising influence on markets and the global economy (International Energy Agency, 2021). The aim of the IEA (2014, pp. 21-22) is to mitigate the negative impacts of sudden oil supply shortages by making additional oil available to the global market, not necessarily to improve Australia's energy security.

5.3 Australia's Compliance with its IEA Obligations

Australia has not been compliant with its obligations under the IEP Agreement since 2011.[8] The deterioration in Australia's stockholding obligations under the IEP Agreement is outlined in Figure 11 below.

[8] See Department of Industry, Innovation and Science (2016).

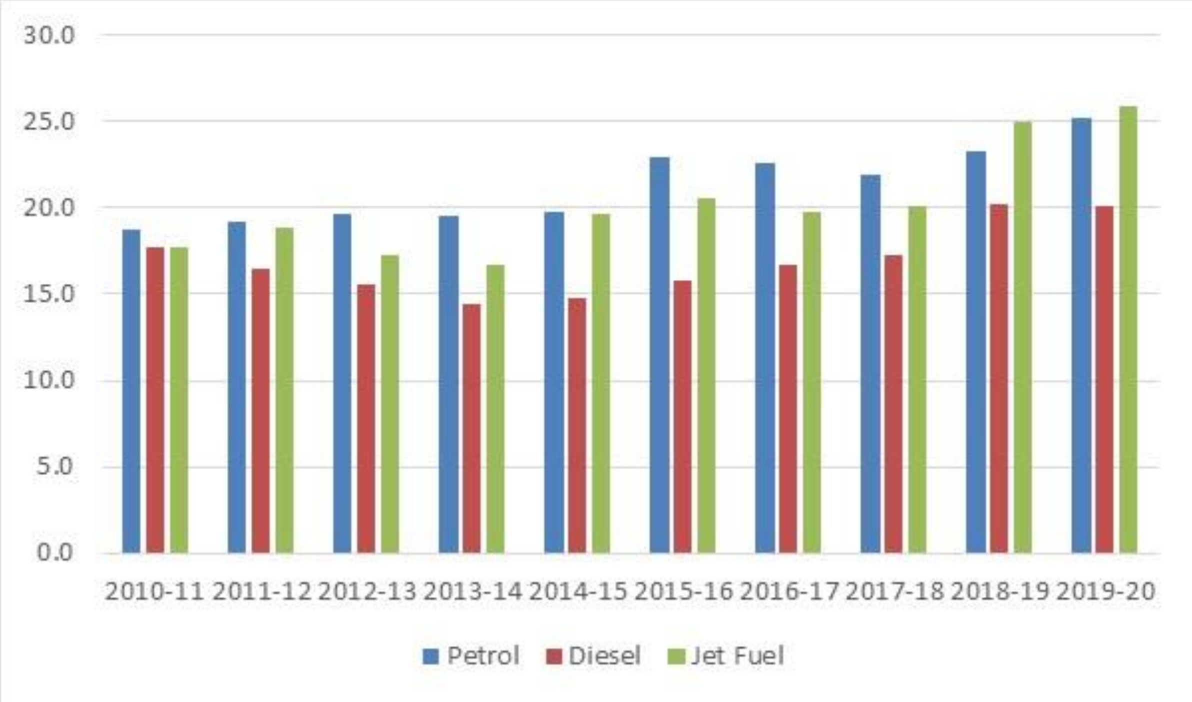
Figure 11: Australia's Days of Net Import Coverage under the IEA's IEP Agreement – 2011 to 2020 (Calendar Year Monthly Average)



Source: Department of Industry, Science, Energy and Resources (2021).

Australia's compliance with the 90 days of net oil imports stockholding obligation has fallen largely due to a decline in domestic crude oil production and increased product demand (Australian Institute of Petroleum, 2014, p. 8). Commercial stocks of fuel held in the domestic supply chain (e.g. stocks of petrol, diesel, jet fuel) have actually increased in response to demand growth and increasing product imports following refinery closures, although imports of crude oil have been trending downwards as a consequence. As such, the decline in Australia's 90 day stockholding obligation raises no heightened supply risk for the domestic liquid fuel markets nor for fuel users. The increase in commercial stocks held is outlined in Figure 12 below.

Figure 12: End of Month Stocks of Petrol, Diesel and Jet Fuel, Days of Consumption Cover (Calendar Year Average)



Source: Department of Industry, Science, Energy and Resources (2021).

However, the IEA's 90 day stockholding obligation is calculated using a complex methodology developed in 1974 for the highly regulated European market prior to the significant globalisation of the oil market and trade activity (Australian Institute of Petroleum, 2014, p. 7). As a result, this IEA methodology is not reflective of the way the Asia-Pacific market works, and is even becoming less reflective of how the European market operates (i.e. with the European market now increasingly relying on petroleum product imports and longer supply chains).

In particular, 'stock on water' and stocks held overseas awaiting delivery to Australia cannot be counted towards a member country's IEA stockholding obligation, despite this stock being integral to supply operations in Australia and in our region and representing around one quarter of total stockholdings directly owned/controlled by Australian companies.

Including fuel stocks that are managed, transported, and owned by Australian companies en route to Australia would dramatically reduce the shortfall in relation to Australia's IEP treaty obligation. Including these fuel stocks increased Australia's stockholdings to 81 days on average during 2020.[9] A vessel with a product shipment for Australia is unlikely to be diverted away for several reasons. First, operators have a commercial and contractual interest to maintain continuity of supply for customers. Second, fuel produced overseas to Australian fuel standards, especially petrol, are not readily compatible with fuel standards in other countries and thus not readily substitutable.

Ticketed stock (tickets) is the name given to a stockholding arrangement under which the seller agrees to hold (or reserve) an amount of oil on behalf of the buyer in return for an agreed fee (Twomey, 2012, p. 9). In essence the buyer is purchasing an option to purchase physical oil that can only be exercised in an oil supply emergency. The purchaser of the ticket gets the right to count the stock reserved as part of its stockholding and the seller of the ticket does not count the stock in its stockholding.

[9] See Department of Industry, Science, Energy and Resources (2021a).

In 2012 the Australian Government commissioned consultants to examine options to address Australia's non-compliance with the IEA 90-Day stockholding IEP treaty obligation (Department of Industry and Science, 2015, p. 8). The main options considered were:

1. **Government owned strategic stocks** – whereby the Government would institute a process to build physical stocks of petroleum which could be supplemented by holding ticket contracts to manage variations over time (Department of Industry and Science, 2015, p. 9). It was estimated that this option would cost around $5.7 billion over nine years with the costs funded either via a direct levy on fuel users, or indirectly from Government revenue via the taxation system.
2. **Government purchased oil/product "ticket" contracts sourced from the international market** – whereby the Government would seek to purchase oil "tickets" equivalent to the total Treaty compliance gap (Department of Industry and Science, 2015, p. 9). Tickets could be purchased from the international market (or domestically if available) and allow Australia to count ticketed stocks (but not own) as part of our total stockholdings. The cumulative cost of tickets over the period from 2014 to 2020 was estimated to be $2 billion (Twomey, 2014, p. 7).
3. **Industry obligated stockholdings** – whereby the Government would pass legislation that obligated industry to maintain oil stockholdings through both building physical stocks, and holding stocks through ticket contracts (Department of Industry and Science, 2015, p. 9). It was estimated that in the period from 2014 to 2024 that a total of $6.8 billion would have needed to have been invested in the storage facilities and stock necessary for the development of a ticket/physical emergency stock split capable of meeting the stockholding obligations (Twomey & Hale, 2013, pp. 32-33).

The Australian Government has committed to returning to full compliance with the International Energy Agency's 90-day oil stockholding obligation by 2026 (Department of Industry, Science, Energy and Resources, 2021b). It intends to achieve this through a combination of government-owned strategic stocks and industry obligated stockholdings.

In March 2020 the Australian Government signed a milestone Agreement with the United States that will allow Australia to lease space in the U.S. Strategic Petroleum Reserve (SPR) to store and access Australian owned oil during a global emergency, the world's biggest emergency stockpile of oil (Taylor, 2020). Under the Arrangement, Australian Government owned stocks held in the SPR can be counted towards Australia's IEP treaty obligations.

In April 2020 the Australian Government announced that it would establish the first Government-owned oil reserves for domestic fuel security (Taylor, 2020a). This included a deal with the United States to store Australian Government owned crude oil in the SPR, with Australia having access to hold oil in the SPR for an initial period of 10 years. The Australian Government also announced it was spending $94 million to purchase oil. According to the Minister for Energy and Emissions Reduction, the Hon. Angus Taylor (2020a):

> *The new measures will take advantage of the current low prices for oil and Australia's privileged position of access to the SPR, which is amongst the world's most cost-effective long-term oil storage facilities. This work is a down payment on a stronger and more secure fuel supply for Australian households, motorists, industry and the national economy.*
>
> *Today's announcement delivers immediate and medium-term measures that form a framework for a highly successful and domestically-centred approach to fuel security, which will underpin our economic prosperity for the next decade and beyond.*

While this initiative will certainly assist Australia in complying with its IEP treaty obligations, nevertheless it is difficult to see how the Australian Government holding oil reserves in the SPR over in the United States will necessarily assist in improving domestic fuel security back in Australia. Further, it does appear incongruous that fuel stocks that are managed, transported, and owned by Australian companies en route to Australia are not counted towards Australia's IEP obligations, but oil reserves held in the United States by the Australian Government are.

5.4 Industry Stockholding Obligations

Up until the present time the Australian Government has not required fuel industry participants to hold stocks of refined petroleum products. Instead, stocks have been held to accommodate short-term fluctuations in demand and have been based on commercial considerations (Smart & Davey, 2008, p. 135). Suppliers of liquid fuels have able to determine their own level of stockholding in order to maintain commercial operations and continuity of supply to their customers.

According to the Australian Government's *Liquid Fuel Security Review – Interim Report*:

> *Understanding the storage capacity within the commercial supply chain provides an insight into how much fuel can be held and made available. This storage acts as a redundancy that helps manage disruption. All storage in Australia is maintained by industry, except for some minor storage managed by the Department of Defence. Australia has no strategic government reserves. Experience suggests that there is currently sufficient storage in the supply chain to manage day-to-day variation in demand, as well as for predictable peaks such as school holidays. (Commonwealth of Australia, 2019, p. 32)*

The available evidence suggests the industry has responded to market signals and invested in new fuel storage capacity. Ensuring supply continuity as well as commercial viability are important considerations for fuel suppliers in deciding to expand storage capacity. In the period between 2012 and 2018 diesel storage increased by 44 per cent, jet fuel by 54 per cent and petrol by 28 per cent (Hale & Twomey, 2018 as cited by Commonwealth of Australia, 2019, p. 32). This partly included the conversion of the Bulwer Island, Clyde and Kurnell refineries into import fuel terminals. Excluding converted refineries, diesel storage capacity increased by 28 per cent, while jet fuel and petrol capacity both increased by around 9 per cent.

Furthermore, there have been no widespread or prolonged fuel shortages being experienced in Australia for decades (Australian Institute of Petroleum, 2014a, p. 12). Even during international crude oil and petroleum product supply disruptions, such as in the aftermath of Hurricane Katrina in 2005, and disrupted crude oil supplies from Libya in 2011, Australian fuel supplies were not disrupted.

Despite the industry increasing its fuel storage capacity and no recent experience of fuel supply disruptions, the Australian Government announced its intention to impose a minimum stockholding obligation on the fuel industry in September last year (Morrison & Taylor, 2020). While the minimum for Australia's jet and gasoline stocks will be held at current levels, the Government intends to increase the minimum level of diesel stocks by 40 per cent by 2024 (Department of Industry, Science, Energy and Resources, 2021b).

The imposition of stockholding obligations upon Australian fuel suppliers is not a costless exercise. There are four principal sets of expenses incurred by industry in imposing stockholding obligations, namely:

- set-up costs of the storage facilities: the capital costs and associated amortisation for construction of the storage facility and the purchase of the oil stocks, including material costs (storage tanks, pipelines, pumps and any discharge/loading terminal or equipment) and labour costs

- operating and maintenance costs, including labour costs, utility costs, and insurance
- refreshment costs for maintaining quality specifications of petroleum products
- costs for renting or buying the needed terrain (Stelter & Nishida, 2013, p. 6).

While the associated costs of stockholding obligations are initially imposed on fuel suppliers, economic theory suggests they will ultimately be borne by the final consumers (Stelter & Nishida, 2013, p. 35). Insights into the extent of the pass through can be obtained from tax incidence theory (Kosicki & Cahill, 2006). Tax incidence seeks to determine what portion of an increase in tax imposed on a producer is ultimately paid by the producer in the form of a lower after-tax price, and which portion is paid by buyers in the form of a higher price (Kosicki & Cahill, 2006, p. 630). The incidence of higher costs falls most heavily upon that side of the market that responds least to price (those that are most price inelastic). Transport fuels are widely perceived to be price inelastic and there is academic literature in support of this contention.[10]

If previous regulatory interventions into capital city fuel markets are any guide, such as the wholesale petrol price declaration and the Victorian terminal gate pricing scheme, then the imposition of a minimum stockholding obligation upon fuel suppliers can be expected to impose an across-the-board price increase on fuel consumers in the order of at least 3 cpl, even before the costs associated with holding additional quantities of diesel are taken into account.[11]

In seeking to impose a stockholding obligation on liquid fuel suppliers, the Australian Government should design a system that imposes the least cost on industry and ultimately consumers. This would include allowing for tickets. Because the establishment of domestic ticket market is likely to be very thin indeed, potentially putting fuel suppliers at the mercy of their competitors and exploitation, fuel suppliers should also be permitted to purchase tickets from overseas as well. Such arrangements provide some flexibility in strategic stockholding by offering a feasible alternative to physically acquiring stocks and building or renting additional storage capacity (Lukach, et al., 2015, p. 279).

It is critically important that the Australian Government imposes stockholding obligations in a non-discriminatory fashion upon all fuel suppliers alike – otherwise it risks distorting competition and creating an uneven playing field in fuel markets.

A stock obligation is usually apportioned by requiring each market participant to hold a minimum amount of stock equal to or above a number of days of their market supply (Twomey, 2013, p. 20). In order to ameliorate potential distortions created in fuel markets from industry stockholding obligations, it has been suggested that financing could be undertaken through an agency with fees related to the sales of final products in a transparent way in order to ensure a more neutral way of cost distribution (Lukach, et al., 2015, p. 280).

It is imperative that all fuel suppliers are treated fairly and equally. In the design of a compulsory stockholding obligation, no discounts nor special dispensations should be provided to any particular category fuel supplier – such as remaining oil refiners for example.

In order to minimise unnecessary cost imposts on fuel suppliers, in the event of changing and declining patterns of fuel consumption on the part of Australian consumers it is important that the Australian Government revises its stockholding obligations accordingly. For example, even before the onset of COVID-19 petrol consumption in Australia had been in long-term decline. It does nothing to improve energy security if fuel suppliers are compelled to hold constant levels of fuels where fuel consumption is in trend decline.

To ameliorate and defray the cost imposed on fuel suppliers from a stockholding obligation, the Australian Government is also providing financial support to the fuel suppliers to increase diesel fuel storage. Through the *Boosting Australia's Diesel Storage Program*, the Australian Government will

[10] See Breunig & Gisz (2009) and Li, Rose, & Hensher (2010).
[11] See Davey (2010) and (2013).

provide up to $200 million in competitive grants over three years to support the construction of an additional 780 megalitres of onshore diesel storage (Taylor, 2021). While the financial assistance will be welcome by fuel suppliers, it is the least the Australian Government can do given the financial impost it is going to impose on the industry in terms of the increase in working capital, reduced operational flexibility and higher costs to consumers.

While the imposition of a stockholding obligation will provide a small increase to a “security margin” as a buffer against supply shocks, it appears to have more to do with IEA IEP Agreement compliance rather than improving Australia’s energy security.

5.5 Is Compliance with the IEP Agreement Really Necessary?

It appears that tensions behind one of the root causes of previous attempts to use the oil weapon, the Arab-Israeli conflict, have eased considerably since the mid-1970s. In September last year, the United Arab Emirates and Bahrain signed the so-called Abraham Accords to normalise ties with Israel. This builds on previous peace treaties between Israel and Egypt in 1979, and between Israel and Jordan in 1994.

Furthermore, it appears that the world is coming to the end of the *Age of Oil* with oil demand set to peak and then go into decline within the foreseeable future. According to the Australian Government’s *Liquid Fuel Security Review – Interim Report*:

> *A range of forecasts show global demand for refined product will peak in the 2030s. The world is transitioning to other transport energy sources faster than Australia. (Commonwealth of Australia, 2019, p. 7)*

According to the IEA’s World Energy Outlook 2020:

> *The era of growth in global oil demand comes to an end within ten years, but the shape of the economic recovery is a key uncertainty. (International Energy Agency, 2020a, p. 19)*

The *bp Energy Outlook: 2020 edition* is somewhat more pessimistic in its outlook for oil demand:

> *Demand for oil falls over the next 30 years. The scale and pace of this decline is driven by the increasing efficiency and electrification of road transportation. (bp p.l.c., 2020, p. 6)*

Although not forecasting a drop in oil demand, nonetheless OPEC (2020, p. 91) is forecasting that oil demand will plateau during the 2030s.

Further attempts by Arab states to use the oil weapon are only likely to hasten the transition away from petroleum-based transport fuels. It is just not in the interests of Middle East oil producing countries to threaten to oil supplies as their economies are heavily dependent on oil revenues and any such moves would only likely hasten its demise.

Since it was enacted back in 1974, the provisions of the IEP treaty have never been seriously enacted. The available evidence suggests the IEP Agreement appears to be anachronistic and a relic of a bygone era. As such, rather than exhibiting an energy security problem, it has been suggested that Australia has an IEA problem instead (Stokes, 2020).

6. Supporting Refinery Production

6.1 Industry Policy

While the term *industry policy* is used in Australia, it is generally expressed as *industrial policy* elsewhere and in the relevant grey and academic literature.[12] There is wide divergence of opinions over exactly what exactly constitutes industry policy.

According to Professor Karl Aiginger (2007, p. 299) of the Austrian Institute of Economic Research, some of the definitions of industry policy disagree over the following issues:

- sectoral targeting versus horizontal measures which have a broad impact on many or all industries (sectoral versus horizontal)
- policies which restructure predominantly large firms, often decelerating the speed of change, versus the promotion of entry, entrepreneurs, spinoffs, new capabilities (passive versus active)
- boosting competitiveness via “framework” conditions versus micro intervention for specific firms, regions, and industries (general measures versus “picking the winners”)
- subsidies to prevent exits (out of political reasons) versus the promotion of innovation, training and other “dynamic activities” (restructuring versus promoting positive spillovers).

Professor Aiginer (2007, p. 300) has suggested that industry policy should be defined as a set of activities which create a favourable environment for business and for adapting production to changing domestic or international demand. However, many definitions of industry policy focus on government interventions that seek to change the structure of the economy.

The 2008 Nobel Laureate for economics Paul Krugman and Maurice Obstfeld (1991) have defined industry policy as:

> *... an attempt by a government to encourage resources to move into particular sectors that the government views as important to future economic growth.*

Professor Dani Rodrik (2004, p. 2) of Harvard University has defined industry policy as restructuring policies in favour of more dynamic activities generally, regardless of whether those are located within industry or manufacturing per se.

Well formulated industry policy should focus on addressing and correcting market failures. Of particular importance to industry policy are dynamic market failures originating from knowledge spillovers and innovation as well as informational externalities and co-ordination failures (Aiginger, 2007, p. 303).

The pursuit of industry policy in Australia has often been associated with protectionism. With the advent of trade liberalisation, the pursuit of Australian industry policy has more recently been pursued through the provision of *ad hoc* assistance packages directed towards assisting certain sectors, especially in manufacturing. Such assistance packages do not have a great track record of success.

6.2 Picking Winners

Arguably the most common criticism regarding industry policy centres around the ability of government to pick winners:

> *The most recurrent argument against industrial interventionism is that it is ‘picking winners’. According to this, government is, at best, ill-placed to assess*

[12] The terms industry policy and industrial policy will be used interchangeably and be taken to mean the same thing.

> *chances of commercial success more effectively than the market. At worst, government is captured by the interests that benefit from its intervention... (Aghion, Boulanger, & Cohen, 2011, p. 3)*

Professor Michael Grubb (2004), Research Director and Professor of Energy and Climate Change in the Institute for Sustainable Resources at University College London has observed:

> *As one cynic put it, 'governments are bad at picking winners, but losers are good at picking governments'.*

There is an informational objection to picking winners in that it is impossible for governments to identify with any degree of precision and certainty the relevant firms, sectors, or markets that are subject to market imperfections (Rodrik, 2008, p. 7). While Rodrik (2004, p. 3) acknowledges that government has imperfect information, he also recognises that the private sector has as well and it is the information externalities generated by this ignorance in the private sector that creates a useful public role.

According to Rodrik (2004, pp. 8-9), diversification of the productive structure requires "discovery" of an economy's cost structure – i.e., discovery of which new activities can be produced at low enough cost to be profitable. What is involved is not coming up with new products or processes, but "discovering" that a certain good, already well established in world markets, can be produced at home at low cost (Rodrik, 2004, p. 9).

Learning what one is good at producing is an important determinant of structural change, but it is also one that is unlikely to be adequately provided under laissez-faire (Hausmann & Rodrik, 2003, p. 628). If the entrepreneur fails in their venture, they bear the full cost of failure (Rodrik, 2004, p. 9). On the other hand, if the entrepreneur is successful, they will have to share the discovery with other producers who can imitate and flock into the new activity (Rodrik, 2004, p. 9).

The transfer of information arising from the cost discovery process gives rise to positive externalities as users and imitators accrue benefits from the discovery that is not captured by the entrepreneur. Because the entrepreneur will not be able to appropriate the full benefits of their information, and benefits will accrue to others, a gulf will exist between the private returns and the overall returns to society from the entrepreneur's learning. According to Rodrik (2007, p. 8):

> *Entrepreneurs who make investments in non-traditional economic activities provide valuable demonstration effects for prospective entrants, they train workers and managers who can be employed in other firms, they generate technological learning which they cannot fully appropriate, and they provide inputs (and demand) for other activities which may not have started up otherwise. The social value of such investments greatly exceeds their private value.*

Because the entrepreneur cannot fully capture the benefits of their successful cost discovery, the private incentives will be inadequate to ensure that a socially optimal level of discovery is attained. The more an entrepreneur believes that its rivals will capture some of the benefits of the successful cost discovery, the less inclined it will be to undertake the discovery activity in the first place. If there are inadequate private incentives, entrepreneurs will underinvest in cost discovery. Underinvestment in discovery leads to market failure as the market is unable to generate a socially optimal outcome. An externality is one type of market failure that is generally accepted as one of the grounds upon which government intervention is justified.

The information externality implies that investment levels in cost discovery will be sub-optimal unless the industry or the government find some way in which the externality can be internalised

(Hausmann, Hwang, & Rodrik, 2007, p. 2). This leads Ricardo Hausmann and Dani Rodrik (2003, p. 629) of Harvard University to the following policy recommendation:

> *... laissez-faire leads to underprovision of innovation and governments need to play a dual role fostering industrial growth and transformation. They need to encourage entrepreneurship in new activities ex ante, but push out unproductive firms and sectors ex post. This is of course easier said than done.*

According to Rodrik (2004, p. 11), the first-best policy response to the informational externalities that restrict self-discovery is to subsidise investments in new, non-traditional industries. However, Rodrik (2004, p. 11) observes that there is difficulty in implementing such a subsidy in practice because of the difficulty of monitoring – as the entrepreneur might use it to provide direct consumption benefits – renders the first-best policy intervention largely of theoretical interest.

Instead, Rodrik (2008, p. 28) suggests a two-prong approach to the conduct of industry policy:

- it needs to encourage investments in non-traditional areas (the carrots), but
- it also needs to weed out projects and investments that fail (the stick).

The emphasis in this approach is providing support for activities that are new, not those that are already established (Rodrik, 2004, p. 14).

If industrial policy is in part about self-discovery, which is inherently uncertain, then Rodrik (2008, p. 29) argues that many enterprises will necessarily fail. According to Rodrik (2008, p. 29) optimal policy under these conditions requires acceptance of a certain failure rate. This is because optimal cost discovery requires equating the social marginal cost of investment funds to the *expected* return of projects in new areas (Rodrik, 2004, p. 12). The realised returns on some of the projects will necessarily be low or negative, to be compensated by the high return achieved on the successes.

Rodrik (2008, p. 29) argues that governments shouldn't even try to pick winners, but should instead focus on the capacity to let the losers go through phasing out support. While Rodrik (2008, p. 29) recognises that this could still be hard to achieve, it is far less demanding of the government than full omniscience. Rodrik (2004, p. 12) concludes:

> *... a good industrial policy will prevent ... failures from gobbling up the economy's resources indefinitely, and it will ensure that they are phased out. The trick for government is not to pick winners, but to know when it has a loser.*

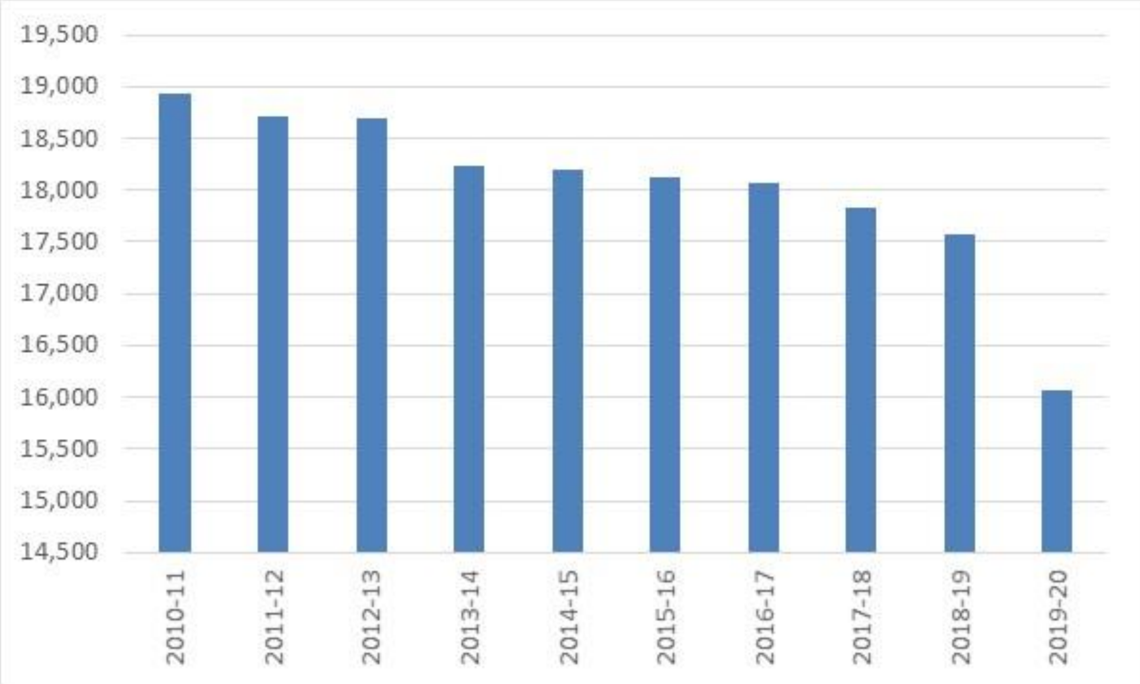
6.3 Refinery Production Payments

Pegasus Economics is concerned the design of the refinery production payments scheme does not meet the criteria for industry policy as articulated by Professor Rodrik. Instead, it appears to be a protectionist measure seeking to preserve a domestic refining capacity even if it is no longer commercially viable.

Pegasus Economics is also concerned that through the refinery production payments scheme the Australian Government is engaging in a forlorn attempt to preserve an industry that is in decline and the world is transitioning away from. While the world will require crude oil derived products for many decades to come, the world is shifting away from its reliance on fossil fuels (bp p.l.c., 2020, p. 5).

Indeed, petrol consumption in Australia was already in trend decline even before the onset of the COVID-19 pandemic, as outlined in Figure 13 below.

Figure 13: Australian Petrol Consumption – 2010-11 to 2019-20



Source: Department of Industry, Science, Energy and Resources (2021).

Even though petrol consumption will likely recover from the recent COVID-19 induced decline, the available evidence suggests the trend decline will be ongoing. The emissions intensity of the light-duty vehicle fleet is projected to experience the greatest reductions in emissions intensity (g CO_2-e/km) over the period to 2030 that is attributed to:

> *Changes in the emissions intensity of internal combustion engine (ICE) vehicles and uptake of, hybrid, electric and fuel-cell vehicles are the main drivers of reductions in the emissions intensity of the fleet. (Department of Industry, Science, Energy and Resources, 2020, p. 32)*

The reduction in emissions intensity infers that consumption of liquid fuels by the light-duty vehicle will continue to decline.

Another concern with the refinery production payments is that it may distort competition in various fuel markets, with the ACCC (2021, p. 7) observing:

> *… depending on its design, the scheme could impact on market competition and potentially affect Australian fuel prices.*

In relation to the interaction between the refinery production payments and the stockholding obligations the Australian Government is planning to impose on fuel suppliers, the ACCC (2021, p. 7) has warned:

> *While government is still finalising the full details, the package proposes payments to some parts of the fuel industry (domestic refiners) and potentially additional costs on other parts (such as fuel importers). These payments and costs imposed on vertically-integrated operators have the potential to alter the relative competitive dynamics in the wholesale and retail fuel markets in Australia and thus impact on consumers.*

6.4 Alternative Fuels

In announcing the closure of the Kwinana refinery, bp Australia (2020) also foreshadowed:

In addition to investing in an import terminal at Kwinana, bp is also exploring future options for the site including a potential clean energy hub to harness the existing and emerging technologies required for the decarbonisation of the Western Australian economy. A multiuse clean energy hub could produce and store lower carbon fuels, including sustainable aviation and marine fuels and waste-to-energy solutions such as renewable diesel.

Fluid catalytic cracking (FCC) is a process used in oil refineries to convert high boiling hydrocarbon fractions of crude oil to more valuable fractions of gasoline and olefinic compounds (Boust, Green, & Machi, 2015, p. 8). The FCC process vaporises and breaks long-chain molecules of high-boiling hydrocarbon liquids into smaller molecules by contacting the feedstock with a fluidised, powdered catalyst at a high temperature and moderate pressure.

The concept behind the FCC process can also be applied to converting a different type of feedstock, biomass, into valuable syngas (Boust, Green, & Machi, 2015, p. 8). These biofeedstocks that can be processed through FCC can be categorised as biomass-derived oils (both lignocellulosic materials and free carbohydrates) or triglycerides and their free fatty acids (Speight, 2019).

The advantage of using biomass is that any type of biomass can be used as a feedstock, and the cracked products are similar to those produced by the FCC process using petroleum-based feedstocks (Boust, Green, & Machi, 2015, pp. 8-9).

In terms of processability, triglycerides are the best suited biofeedstock for the catalytic cracker (Speight, 2019). These materials generally produce high-quality diesel and high-octane naphtha and are low in sulfur.

Due to growing awareness of rising CO_2 levels, global warming and securing energy supply it would be advantageous to use biofeedstock in existing oil refinery infrastructure (Primo & Garcia, 2014).

Biofeedstock is a renewable energy source that will reduce dependency on conventional fuels and provides significant environmental advantages over petroleum-based fuels (Tanneru & Steele, 2015, p. 268). It is greenhouse gas neutral because the CO_2 emitted from biofuels from which it is produced is recycled by photosynthesis. The availability of biomass in the world is 220 billion dry tons per year and is the world's largest and most sustainable energy resource.

bp Australia is currently exploring the opportunity to use the existing infrastructure at the Kwinana refinery, including its FCC unit, for the production of renewable fuels. The FCC unit at the Kwinana refinery has a processing capacity of 31,500 barrels per day (Oil & Gas Journal, 2020).

Under the Australian Government's fuel security package, it has offered to pay refineries a minimum of 1 cent per litre for production of primary transport fuels in petrol, diesel and jet fuel (Department of Industry, Science, Energy and Resources, 2021b). It would be desirable to ensure the refinery production payments scheme does not discriminate between petroleum-based fuels and biofuels, thus disadvantaging the production of biofuels. In turn, this could potentially improve the commercial viability of using the Kwinana FCC to produce biofuels.

Similar to FCC, hydrocracking is a process used in oil refineries to convert high boiling hydrocarbon fractions of crude oil in the presence of a catalyst and hydrogen gas to convert it into more useful products. Hydrocracking can also be used to produce biofuels. bp Australia still has a hydrocracker unit available at the former Bulwer Island refinery site in Brisbane.

The refinery production payments should be provided on a non-discriminatory basis to producers using renewable as well crude oil feedstocks alike. In this way it will assist in directing capital flows and investment towards the fuels of both today and tomorrow. If the objective of the refinery production payments scheme is to enhance Australia's energy security, then it shouldn't matter whether the feedstock is crude oil or biomass.

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Statistical Appendix

Modelling for Sydney

A data series for a notional wholesale margin for Sydney petrol (*SPNWM*) and Sydney diesel (*SDNWM*) was constructed by taking the Sydney terminal gate prices for petrol (*STGPP*) and diesel (*STGPD*) and subtracting a weekly import parity price for petrol (*IPPP*) and diesel (*IPPD*) respectively based on the Singapore benchmark price lagged one week. The import parity prices have been constructed by taking a weekly moving average of daily spot prices for the Singapore benchmark price of petrol (MOGAS 95) and Gasoil (10 ppm) for the previous week and adding shipping to Australia, and import duty (excise) but excluding GST.

Because the GST is applied to each transaction in a supply chain on an ad valorem basis, any difference between the import parity price and the terminal gate price will result in a discrepancy in the amount of GST applying to the import parity price as compared to the terminal gate price. Because the amount of GST applying to the import parity price and the terminal gate price could differ, the level of the notional wholesale margin could either increase or decrease directly as a result of the imposition of the GST, thus resulting in a distortion in the estimation of the notional wholesale margin. The GST component was not included in the estimation of the notional wholesale margin by removing it from the terminal gate price to ensure no such distortion.

Construction of the *SPNWM and SDNWM* is outlined in equations 1 and 2 below:

$$SPNWM = STGPP - IPPP \qquad (1)$$

$$SDNWM = STGPD - IPPD \qquad (2)$$

A series is stationary if its mean and variance is time invariant. However, any series that is not stationary is said to be nonstationary or to contain a unit root. If a first difference is taken of a nonstationary time series and found to be stationary then the series is said to be integrated of the first order or I(1), or to contain a unit root.

The price series *SPNWM* and *SDNWM* were tested for stationarity using the Phillips-Perron (PP) test. The PP test performs the test of a null hypothesis that a series contains a unit root against the alternative hypothesis that the series is stationary. The PP test was run using two specifications – with a constant, and a constant with a linear time trend. Results from the PP tests are provided in Table 1 below. The results reveal both series are stationary at level.

Table 1: Phillips-Perron (PP) Test on SPNWM and SDNWM

Variable	**PP Test with a Constant**	**PP Test with a Constant and Linear Time Trend**
SPNWM	-10.976*	-11.073*
	(0.000)	(0.000)
SDNWM	-8.892*	-10.095*
	(0.000)	(0.000)

Note: Figures in brackets are the corresponding probabilities. * indicates the null hypothesis of a unit root has been rejected at the 5 per cent level.

SPNWM and SDNWM covers a 7 year period from the week commencing 12 January 2010 until the week commencing 13 December 2016.

In order to test whether there is a statistically significant difference between the notional wholesale margins following closures of the Clyde and Kurnell refineries, it was decided to construct an empirical model for the notional wholesale margin using Box-Jenkins methodology, also known as autoregressive integrated moving average (ARIMA) modelling. In ARIMA modelling a variable is explained by its own past, or lagged, values and stochastic error terms. The number of observations is sufficiently large enough to enable ARIMA modelling to be used. The following general ARIMA process of the order (p, d, q) will be estimated as:

$$\emptyset_p(B)\Delta dZ_t = \theta_0 + \theta_q(B)a_t + \beta D_t \qquad (3)$$

where $\emptyset_p(B)$ represents a 'p'-order polynomial lag operator; Δd denotes an ordinary difference operator and 'd' is the number of times the difference is applied; Z is the notional wholesale margin; θ_0 is a constant; $\theta_q(B)$ denotes a 'q'-order polynomial lag operator; 'a' is a white noise process; 'p' is the number of autoregressive terms; 'q' is the number of moving average terms; 'D' represents the dummy variables; and 't' is the period of time.

As part of the ARIMA modelling process, appropriate values for 'p', 'd', and 'q' need to be chosen. The PP test has already determined that 'd' is zero. Values for 'p' and 'q' were determined using the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC) – with smaller values being preferred.

ARIMA models can also be extended to enable the intervention analysis proposed by Box and Tiao (1975) to be used. Under intervention analysis, an indicator (or dummy) variable is included in the model which takes only the values of 0 and 1 to denote the non-occurrence and occurrence of the intervention as long as the timing of the intervention is known.

Two dummy variables were used to test for the closure of Sydney based refineries on the notional wholesale margin:

- *ref1* which is a step function dummy variable that takes the value of 0 from the week commencing 12 January 2010 until the week commencing 24 September 2012 and 1 thereafter to account for the closure of the Clyde refinery in late September 2012
- *ref2* which is a step function dummy variable that takes the value of 0 from the week commencing 12 January 2010 until the week commencing 13 October 2014 and 1 thereafter to account for the closure of the Kurnell refinery in October 2014.

The models that were estimated are outlined as equations 4 and 5 below.

$$SPNWM = c + ref1 + ref2 + MA(1) \qquad (4)$$

$$SPNWM = c + ref1 + ref2 + AR(1) + MA(1) + MA(2) \qquad (5)$$

Equation 4 was initially estimated using ordinary least squares (OLS). The estimated Ljung and Box Q-statistics for serial correlation (up to 20 lags) was not statistically significant and the Breusch-Godfrey Lagrange multiplier test for serial correlation (Breusch-Godfrey LM test) up to 4 lags was not statistically significant. However, the White heteroskedasticity test for the non-presence of heteroskedasticity was rejected at the 5 per cent level and evidence of autoregressive conditional heteroskedasticity (ARCH) was found in the residuals based on the ARCH Lagrange multiplier (LM) test and the Ljung-Box Q-statistics of the squared residuals.

While the presence of heteroskedasticity for equation 4 does not cause bias nor inconsistency in the parameter estimates, it does invalidate the standard errors, t-statistics, and F-statistics because the standard errors and the confidence intervals calculated will be too narrow.

According to the 2003 Nobel Laureate for economics Robert Engle (2001, p. 158), provided the sample size is large, robust standard errors give quite a good estimate of standard errors even in the presence of heteroskedasticity which then allows statistical inferences to be made about the true parameter value. Equation 4 was re-estimated using heteroskedasticity-robust standard errors as proposed by White (1980).

Equation 4 was also re-estimated as equation 4a to take account of ARCH through an GARCH(1,1) configuration by the method of maximum likelihood (ML). The results are provided in Table 2 below.

Table 2: Estimated Variables for Equations 4 and 4a) (SPNWM)

Variable	**Equation 4***	**Equation 4a#**
Constant	7.737 (62.214)	7.659 (56.975)
ref1	1.118 (5.631)	1.148 (5.403)
ref2	-0.541 (-2.231)	-0.560 (-2.525)
MA(1)	0.559 (10.924)	0.554 (12.281)
α_0		0.074 (1.197)
ε_{t-1}^2		0.075 (2.068)
σ_{t-1}^2		0.864 (11.768)
R^2	0.340	0.339
Adjusted R^2	0.334	0.333
AIC	3.042	3.014
SC	3.085	3.088
Breusch-Godfrey LM test (4 lags)	5.460 (0.243)	
White heteroskedasticity test	20.742 (0.036)	
ARCH LM test (1 lags)	19.512 (0.000)	1.553 (0.213)

* For equation 4 the figures in brackets are the corresponding heteroskedasticity corrected t-statistics for each variable and the corresponding probabilities for the diagnostic tests.

For equation 4a the figures in brackets are the corresponding z-statistics for each variable and the probability for the ARCH LM test.

For the main variables of interest in equation 4 and 4a, *ref1* is statistically significant at the 1 per cent level while *ref2* is statistically significant at the 5 per cent level.

Equation 5 was initially estimated using OLS. The estimated Ljung and Box Q-statistics for serial correlation (up to 20 lags) and the Breusch-Godfrey LM test) up to 4 lags suggests the presence of serial correlation. Furthermore, the White heteroskedasticity test for the non-presence of heteroskedasticity was rejected at the 5 per cent level and evidence of ARCH was found in the residuals based on the ARCH LM test and the Ljung-Box Q-statistics of the squared residuals.

The equation 5 was re-estimated using robust standard errors using the heteroscedasticity and autocorrelation-consistent (HAC) standard errors as developed by Newey and West (1987). This ensures that the standard errors are robust in the event of both heteroscedasticity and autocorrelation of an unknown form. The results are outlined in Table 3 below.

Table 3: Estimated Variables for Equation 5 (SDNWM)

Variable	Equation 5*
Constant	8.298 (12.441)
ref1	0.289 (0.742)
ref2	-0.459 (0.115)
AR(1)	0.987 (165.087)
MA(1)	-0.495 (-8.828)
MA(2)	-0.496 (-7.747)
R^2	0.536
Adjusted R^2	0.529
AIC	2.644
SC	2.709
Breusch-Godfrey LM test (4 lags)	11.729 (0.020)
White heteroskedasticity test	45.450 (0.015)
ARCH LM test (4 lags)	5.671 (0.017)

* For equation 5 the figures in brackets are the corresponding HAC corrected t-statistics for each variable and the corresponding probabilities for the diagnostic tests.

For the main variables of interest in equation 5, neither *ref1* nor *ref2* is statistically significant at the 5 per cent level.

Modelling for Brisbane

A data series for a notional wholesale margin for Brisbane petrol (*BPNWM*) and Brisbane diesel (*BDNWM*) was constructed by taking the Brisbane terminal gate prices for petrol (*BTGPP*) and diesel (*BTGPD*) and subtracting a weekly import parity price for petrol (*IPPP*) and diesel (*IPPD*) based on the Singapore benchmark price lagged one week. The construction method is exactly the same as outlined in the modelling for Sydney above.

The price series *BPNWM* and *BDNWM* were tested for stationarity using the Phillips-Perron (PP) test. The PP test was run using two specifications – with a constant, and a constant with a linear time trend. Results from the PP tests are provided in Table 4 below. The results reveal both series are stationary at level.

Table 4: Phillips-Perron (PP) Test on BPNWM and BDNWM

Variable	PP Test with a Constant	PP Test with a Constant and Linear Time Trend
BPNWM	-9.422* (0.000)	-10.004* (0.000)
BDNWM	-8.921* (0.000)	-8.377* (0.000)

Note: Figures in brackets are the corresponding probabilities. * indicates the null hypothesis of a unit root has been rejected at the 5 per cent level.

BPNWM and BDNWM covers a 5 year period from the week commencing 7 January 2013 until the week commencing 18 December 2017.

In order to test whether there is a statistically significant difference between the notional wholesale margins following closure of the Bulwer Island refinery an ARIMA model was constructed.

As previously outlined above, part of the ARIMA modelling process involved determining appropriate values for ‘p’, ‘d’, and ‘q’. The PP test has already determined that ‘d’ is zero. Values for ‘p’ and ‘q’ were determined using the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC) – with smaller values being preferred.

One dummy variable was used to test for the closure of one Brisbane refinery on the Brisbane notional wholesale margin for petrol and diesel:

- *ref* which is a step function dummy variable that takes the value of 0 from the week commencing 7 January 2013 until the week commencing 1 June 2015 and 1 thereafter to account for the closure of the Bulwer Island refinery in June 2015.

The models that were estimated are outlined as equations 6 and 7 below.

$$BPNWM = c + ref + MA(1) \quad (6)$$

$$BDNWM = c + ref + AR(1) + MA(1) \quad (7)$$

Equation 6 was initially estimated using OLS. The estimated Ljung and Box Q-statistics for serial correlation (up to 20 lags) was not statistically significant and the Breusch-Godfrey LM test up to 4 lags was not statistically significant. However, the White heteroskedasticity test for the non-presence of heteroskedasticity was rejected at the 5 per cent level and evidence of ARCH was found in the residuals based on the ARCH LM test and the Ljung-Box Q-statistics of the squared residuals.

To address the problem of heteroskedasticity in equation 6, it was re-estimated using heteroskedasticity-robust standard errors as proposed by White (1980). Equation 6 was also re-estimated as equation 6a to take account of ARCH through an GARCH(1,1) configuration by the method of ML. The results are outlined in Table 5 below.

Table 5: Estimated Variables for Equations 6 and 6a (BPNWM)

Variable	Equation 6*	Equation 6a#
Constant	8.376 (46.050)	8.328 (56.353)
ref	-0.598 (-2.639)	-0.665 (-3.228)
MA(1)	0.537 (9.658)	0.056 (9.511)
α_0		0.086 (1.102)
ε_{t-1}^2		0.132 (2.193)
σ_{t-1}^2		0.804 (7.950)
R^2	0.281	0.279
Adjusted R^2	0.275	0.273
AIC	3.073	3.016
SC	3.115	3.099
Breusch-Godfrey LM test (4 lags)	3.156 (0.532)	
White heteroskedasticity test	15.637 (0.048)	
ARCH LM test (1 lags)	24.128 (0.000)	1.041 (0.308)

* For equation 6 the figures in brackets are the corresponding heteroskedasticity corrected t-statistics for each variable and the corresponding probabilities for the diagnostic tests.

For equation 6a the figures in brackets are the corresponding z-statistics for each variable and the probability for the ARCH LM test.

For the main variable of interest in equation 6 and 6a, *ref* is statistically significant at the 5 per cent level.

Equation 7 was initially estimated using OLS. The estimated Ljung and Box Q-statistics for serial correlation (up to 20 lags) was not statistically significant and the Breusch-Godfrey LM test up to 4 lags was not statistically significant, and the White heteroskedasticity test accepted the non-presence of heteroskedasticity at the 5 per cent level. However, evidence of ARCH was found in the residuals based on the ARCH LM test and the Ljung-Box Q-statistics of the squared residuals.

To address the problem of heteroskedasticity in equation 7, it was re-estimated using heteroskedasticity-robust standard errors as proposed by White (1980). Equation 7 was also re-estimated as equation 7a to take account of ARCH through an GARCH(1,1) configuration by the method of ML. The results are outlined in Table 6 below.

Table 6: Estimated Variables for Equations 7 and 7a (BDNWM)

Variable	**Equation 7***	**Equation 7a#**
Constant	7.858 (53.209)	7.842 (51.230)
ref	-0.321 (-1.551)	-0.376 (-1.732)
AR(1)	0.265 (2.113)	0.289 (2.351)
MA(1)	0.325 (2.655)	0.313 (2.600)
α_0		0.112 (1.325)
ε_{t-1}^2		0.143 (1.756)
σ_{t-1}^2		0.734 (4.751)
R^2	0.287	0.287
Adjusted R^2	0.279	0.278
AIC	2.756	2.697
SC	2.780	2.794
Breusch-Godfrey LM test (4 lags)	5.681 (0.224)	
White heteroskedasticity test	15.453 (0.280)	
ARCH LM test (1 lags)	7.258 (0.007)	0.006 (0.939)

* For equation 7 the figures in brackets are the corresponding heteroskedasticity corrected t-statistics for each variable and the corresponding probabilities for the diagnostic tests.

For equation 7a the figures in brackets are the corresponding z-statistics for each variable and the probability for the ARCH LM test.

For the main variable of interest in equations 7 and 7a, *ref* is not statistically significant at the 5 per cent level.