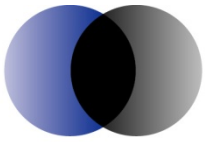
An Assessment of Australia's Liquid Fuel Vulnerability

Prepared for Department of Resources, Energy and Tourism

November 2008



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Executive summary

This assessment of Australia's liquid fuel vulnerability was commissioned by the Department of Resources, Energy and Tourism and developed under a Steering Committee including representatives from the National Oil Supplies Emergency Committee.

The terms of reference require this review to consider whether Australia's liquid fuels vulnerability in terms of adequacy, reliability and affordability has changed since 2004 and whether it is likely to undergo any further change leading up to 2020.

Findings

Australia's liquids fuels vulnerability has changed since the 2004 Energy White Paper. ACIL Tasman makes the following findings:

Adequacy

Despite a growing dependence on imported sources of oil and refined petroleum products, adequacy in terms of suppliers being able to keep up with demand has generally been maintained. This is likely to continue, although capacity constraints in global oil infrastructure may see continued upward pressure on prices.

Reliability

The biggest change since 2004 has been in regard to the reliability of the system. There have been some offsetting impacts on reliability of supply since the last assessment. While the incidence of refinery production disruptions has not changed, their impact can now be more severe. This is due to increased interdependency between refinery production units with the move to cleaner fuels. There is also little to no spare refining capacity left in the system to cover the loss of production capacity. The extent to which a production disruption becomes a supply disruption to end users depends on a refiner's stockholdings and ability to source alternative supply. Recent experience suggests refiners have become adept at managing production disruptions, with no major supply shortages in any market for which close substitutes were not available. This outcome also reflects the improved reliability of the international supply chain for crude oil and products imported to Australia. There remains, however, some pressure in the supply chain from bottlenecks in importing and distribution infrastructure. While the industry is responding to this pressure with plans for investment in new and upgraded infrastructure, the nature of this problem requires a more detailed investigation, as planned by the

Government, given our growing reliance on imports. Overall, while refineries will likely incur unplanned shutdowns in the period to 2020, the prospect of a major supply disruption to end-users arising from refinery problems in Australia or overseas is extremely low.

Affordability

Affordability on an individual and household level has deteriorated. However, if affordability is defined in terms of maintaining international competitiveness then, given that oil and refined petroleum products are commodity products traded on international markets, it is unlikely affordability has deteriorated since 2004 and is unlikely to change in the period leading up to 2020.

Factors influenced the assessment

Australia is now more likely to experience interruptions in the production and distribution of refined petroleum product that could impact on the supply of some products in the short to medium term. There are several reasons for this:

a) Adoption of tighter fuel standards has created greater interdependence between components of refinery processes so that a breakdown in one component tends to affect other production processes.

b) Reductions in Australian refining capacity, coupled with higher levels of demand for liquid fuels, has resulted in the elimination of spare refining capacity. This means that refineries have limited scope to increase production or divert export cargoes into the domestic market in the event of a breakdown. Domestic production losses resulting from an unplanned outage can be readily replaced with imported product, however, this may take time to organise and deliver due to the longer supply chains associated with imported petroleum products.

c) Infrastructure involved in the distribution of refined petroleum products, such as pipelines and terminals, is being worked harder and in some places is reaching the level of its capacity constraints, particularly in Sydney, increasing the likelihood and impact of breakdowns.

While Australia has produced sufficient crude oil, condensate and LPG to meet around 59 per cent of domestic demand in recent years, domestic supplies of crude oil and condensate account for 28 per cent of the domestic refinery input in volume terms. The ratio of domestic production of refined petroleum product to total demand for all refined petroleum product was around 73 per cent in 2005-06 but is projected to fall to around 69 per cent by 2019-20. Australia will face greater exposure to global crude oil and refined petroleum product markets as the margin between domestic production and domestic

demand for both crude oil (from declining domestic production) and refined petroleum products (from increasing domestic demand that outpaces any domestic production expansion) widens over the next 12 years:

1. Newer offshore oil fields in North West Australia tend to produce heavier crudes that are not suitable for processing in Australian refineries and condensates that are not attractive for processing in Australian refineries due to refinery product yield considerations and are consequently exported.
2. The production life of some of the newer oil fields is too short to justify further investment by domestic refineries to process heavy crudes.
3. Imports of refined petroleum products are subject to variations in global markets.

Interruptions to supply from domestic refineries or from problems at receiving terminals and pipelines will have a greater impact than in the past due to:

1. less spare capacity resulting in supply interruptions having a greater impact on the market
2. replacements of refined petroleum products coming increasingly from imported cargoes rather than diverting cargoes from Australian production, therefore increasing supply chain delays for products by between three to six weeks.

Potential sources of interruption

The major sources of interruption to supplies are more likely to be from:

1. breakdowns at Australian refineries
2. breakdowns at terminals and associated infrastructure
3. interruptions to imported crude oil supplies and a possible supply side constraint in the period up to 2015 from a lack of spare capacity rather than a lack of petroleum resources
4. global problems in crude oil and refined petroleum product markets resulting from natural and/or geopolitical factors.

Interruptions to global supplies of crude oil and refined petroleum products are likely to lead to price spikes in liquid fuels in the short to medium term, which will affect individual affordability, but not necessarily the competitiveness of the economy on those occasions.

The establishment of further refining capacity in the Asian region, such as the mega refinery which is being constructed at Jamnagar in India by Reliance Petroleum, will reduce Australia's exposure to interruptions from both world and domestic problems.

Australia will however need more investment in product storage at terminals, associated pipeline infrastructure and at some consumer sites in response to greater volatility in supplies:

- to manage commercial and supply risks identified above; and
- in order to meet International Energy Agency (IEA) obligations.

There appears no lack of willingness to invest in new storage capacity for refined petroleum products, however, concerns have been raised in regard to a number of impediments to further investment. In particular, lengthy and complicated regulatory approval processes, compliance with competition law requirements and land constraints at port locations around the country are impeding efficient investment.

Concerns were raised by wholesale customers of the domestic refiners that there were significant information asymmetries in the event of a supply disruption. There was also an acknowledgement by the domestic refiners that they now communicate with each other less in the event of a supply disruption for legal and commercial reasons.

A commercial risk is posed to the future viability of domestic refineries from imported fuel if overseas refineries do not share the same cost burden from the introduction of an emissions trading system as domestic refiners.

The following analysis provides the background to this assessment.

Domestic demand

Australia's consumption of petroleum fuels has grown at 3 percent per annum on average from 2002-03 to 2006-07. The important trends are:

- Significant growth in diesel and aviation turbine fuel (jet fuel)
  - 5.2 percent per annum for automotive diesel
  - 8.3 per cent per annum for jet fuel
- Moderate growth in automotive gasoline (petrol)
  - 0.5 per cent per annum
- Slower growth in liquefied petroleum gas (LPG) and fuel oil
  - 1.7 per cent per annum for LPG
  - 1.5 per cent per annum for fuel oil.

The Australian Bureau of Agricultural and Resource Economics (ABARE) estimates that demand for petroleum products (which excludes LPG) will increase by 24 per cent between 2005-06 and 2019-20. The products expected to contribute most to increased demand will be diesel and jet fuel while growth in demand for petrol is expected to be incremental.

ABARE estimates that demand for LPG will increase by 51.5 per cent between 2005-06 and 2019-20. Overall, ABARE's national projections are consistent with the views of industry stakeholders consulted by ACIL Tasman as part of this study.

Global oil supplies

Peak oil

Crude oil is a finite resource that will eventually be depleted if it continues to be produced. As a consequence, world crude oil production will eventually peak and then begin to decline. Views are mixed as to when global crude oil production will peak. There are those predicting an imminent peak in crude oil production if it hasn't already occurred. Proponents of an imminent peak in world oil production believe that: (i) there is little remaining crude oil to be discovered; (ii) existing estimates of crude oil reserves, both discovered and undiscovered, are over-inflated, particularly those in the Middle East; and (iii) extrapolations of the pre-existing pattern of crude oil production suggest that production is about to peak.

Sceptics of an imminent peak criticise the proponents by claiming the methodology used to predict peak oil is fundamentally flawed. They argue imminent peak oil proponents are doing nothing more than fitting a curve to a pre-existing trend which has consistently resulted in the under-estimation of production and a revision in the timing of peak oil. For example, the most prominent proponent of peak oil, geologist Dr Colin Campbell has been making predictions of an imminent peak since 1989.

ACIL Tasman concludes that while there will be a peak in production of crude oil at some time, internationally accepted information from authoritative sources suggests that this peak is still some decades away and will occur beyond 2020. It is not anticipated to be a significant factor that will affect Australia's liquid fuels vulnerability prior to 2020.

In the event that a peak world oil production should occur sooner than is generally predicted, that is in several decades time, then it will most likely result in a dramatic increase in crude oil prices as supply is unable to keep pace with increasing demand. A dramatic and ongoing real increase in the price of crude oil will result in adaptation that will likely manifest itself through four main avenues:

- It should trigger an increase in the technical efficiency of processes using and reliant on liquid fuels.
- It should provide an incentive to a shift to alternative energy sources.

- During the transition process involved in the pursuit of increased technical efficiency and the shift towards alternative energy sources, it should lead to a moderation or short-term contraction in the rate of economic growth.
- It should encourage a transition to a less oil intensive economy.

The arrival of a peak oil situation would not result in a sudden absence of oil for the Australian economy. This is because peak oil indicates that worldwide production of oil has only peaked, not that it is about to run out altogether. From a policy perspective, the best preparation for the time when the peak does occur is for governments to encourage transparency of price signals in order for the necessary adjustments to occur in good time.

Constraints on production capacity

While peak oil production is not expected to occur prior to 2020, the International Energy Agency (IEA) has raised concerns over the lack of spare capacity, particularly with respect to the Organisation of Petroleum Exporting Countries (OPEC) production.

Projections based on the IEA's world energy outlook suggest that world oil demand will increase from 84.7 million barrels in 2006 to around 104 million barrels per day by 2020 and to 116.3 million barrels by 2030.

According to the IEA, world oil resources are sufficient to meet the projected growth in demand to 2030. OPEC countries will collectively take an increasing share of world oil supplies rising from 42 per cent in 2006 to 52 per cent in 2030.

However, while there appears to be sufficient world oil resources to meet the projected growth in world demand to 2020 and beyond, the ability to meet this demand depends critically on investment and production policies in key OPEC countries.

The IEA raises concerns over the availability of spare capacity, which is expected to decline. Based on an average decline rate of 3.7 per cent per year from fields currently in production, the IEA estimates that there could be a shortage of supply capacity after 2012. The IEA notes that a decline in spare production capacity could lead to a supply side crunch in the period up to 2015. Should this occur it is likely to result in an increase in world oil prices until such time as the investment bottlenecks are removed.

While supply will continue to expand, a risk for Australian energy security is presented by the prospect that global production expansion may not be sufficient to satisfy global demand growth in the period from 2012 onwards. Ongoing tightness on world oil markets between supply and demand will put

upward pressure on prices that would inevitably flow through into Australian prices for refined petroleum products.

Reliability of overseas crude oil supplies

Around 64 per cent of Australia's consumption of crude oil and other refinery feedstock was met by imports in 2006-07. Energy security issues have traditionally focussed on crude oil supply disruptions in the Middle East. However, Australian imports of Middle Eastern crude have declined since the mid 1990s and been partially replaced by crude oil from the South East Asian region. While this has reduced Australia's dependence on Middle Eastern crude oil, growing demand for crude oil from Asian countries may lead Australian refiners to look further afield to West Africa, north Asia (Russia) and Latin America for new sources of supply.

All Australian oil refiners consulted by ACIL Tasman during the course of stakeholder consultations rated the current reliability of overseas crude oil suppliers as extremely high. While tightness in the market from capacity constraints is likely in the period to 2020, and there remains the prospect of geopolitical conflict in the Middle East, it is considered unlikely that supplies would be cut off altogether over this period. Shorter term price spikes and supply constraints are however possible over the 2008 to 2020 period.

Reliability of overseas product supplies

Supply from overseas suppliers of refined petroleum products is considered extremely reliable – with significant supplies available from South East Asian refineries. However, the increase in fuel standards that has progressively been introduced in Australia between 2002 and 2006 has made it far more difficult to source compliant petrol from within the Asian region than was previously the case, particularly on a spot basis. However, there appears to be little difficulty sourcing diesel and jet fuel compatible with Australian standards from the Asian region.

Most stakeholders noted that the supply situation for Australia in being able to source petrol from the Asian region was gradually improving as fuel standards in the Asian region catch-up with Australian fuel standards. The Australian Government has recently opined that Australia's fuel standards are already aligned to international standards when taking into account environmental and other objectives and moves in recent years by Asian countries to adopt more stringent standards (Rudd & Bowen, 2008). It would improve further following the opening of new refinery capacity, notably in India and Vietnam. It is expected that Australia's dependency on Singapore refineries will reduce once the Reliance refinery in Jamnagar India is opened in late 2008. This would be

reinforced if reported plans by Reliance to increase its product storage capacity in Singapore are realised.

Sea Lane Security

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. Australia's oil supply security is dependent on the maritime supply routes through the Indonesian archipelago with over 60 per cent of crude oil imports and 75 per cent of refined petroleum products transiting Indonesian sea channels.

While security of sea lanes from piracy and military action is a risk that must be managed, it is not considered a critical risk by stakeholders consulted by ACIL Tasman. International cooperation to reduce the risk of piracy has increased in South East Asia and the security of the Straits of Hormuz is closely monitored.

Should problems arise in the Malacca Straits, alternative routes are available at the cost of additional sailing times.

Shipping

It would appear that concerns regarding possible tightness in the supply of tanker shipping resulting from the phase-out of single hulled tankers in 2010 have been largely addressed through a significant construction program of tanker shipping as well as through the ongoing conversion of single hulled tankers into double hulled tankers.

Australian oil supply

Crude oil and condensate

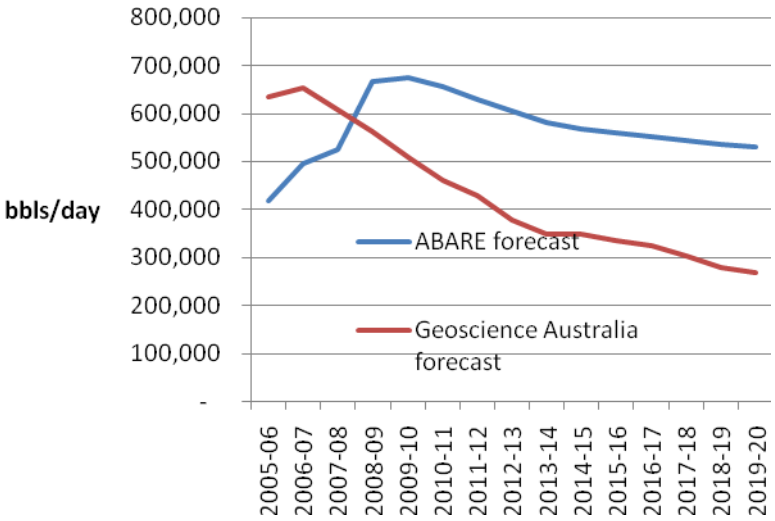
Identified economic resources of crude oil and condensate are estimated by Geoscience Australia to be of the order of 431 GL (2.7 billion barrels) as at 1 January 2006. This is around 12 times the annual production of crude oil and condensate in Australia in 2006.

The majority of Australia's indigenous production of crude oil, condensate and naturally occurring LPG comes from the Carnarvon Basin that is currently accounting for 63 per cent of total Australian production of naturally occurring petroleum liquids. The mature Gippsland Basin accounts for 19 per cent of total Australian production of naturally occurring petroleum liquids.

While production from the Gippsland Basin peaked in the mid-1980s and has declined steadily since, in June 2007 a joint operator of the Gippsland Basin predicted that the region still has more than 20 years of oil production left.

Production of Australian crude oil and condensate is forecast to taper off in the period leading up to 2020. Forecasts from Geoscience Australia and ABARE are provided below.

Figure 1 **Geoscience Australia and ABARE forecasts of Australian crude oil and condensate production**



Note: Geoscience forecasts are in calendar years while the ABARE forecasts are in financial years.
Data source: Geoscience Australia (2006); Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke (2007)

Both Geoscience Australia and ABARE forecast a decline in production in the period leading up to 2020. Many of Australia's newer fields, located offshore in North West Australia, also produce crudes that are not suitable for Australian refineries, as currently configured, and will be exported.

Refinery products

There are currently seven major oil refineries operating within the vicinity of five capital cities with the capacity to produce around 43,000 ML per year. There are a range of views on the future of the Australian refining sector and its productive capacity.

Consistent with ABARE's assumptions regarding Australian refining capacity up to 2030, and based on ACIL Tasman's consultations with stakeholders, there is universal agreement that it is extremely unlikely there will be any new major additions to Autralia's refining capacity in the period to 2020.

The major change in supply security from refineries since 2004 is that the impact of unexpected refinery maintenance and shutdowns is more severe than earlier periods, due to the increased level of interdependence of refinery operating units to meet higher Australian fuel specifications. Additionally, with no spare refining capacity left in the system to cover the loss of production due

to unexpected refinery maintenance and shutdowns, disruptions to refinery production from such events have become more severe which could in turn impact on supply.

Furthermore, it appears that infrastructure supporting the downstream market in some locations around the country, particularly in Sydney, has reached the level of its operating capacity.

ABARE has projected that through efficiency improvements, domestic refinery output as a percentage of domestic demand will only decline from 73 percent in 2005-06 to 69 per cent by 2020.

The Australian Institute of Petroleum has outlined the range of options available to refiners in the event of a supply disruption:

1. in-refinery options including repair of production unit or truncate maintenance program
2. sourcing supplies from other domestic refiners
3. sourcing supplies internationally
4. allocating bulk fuel supplies to customers.

For most disruptions, such actions should provide an appropriate response to maintaining supply while the disruption is being addressed.

Production disruptions arising from unexpected refinery maintenance and shutdowns are likely to continue in the outlook to 2020 which could in turn impact on supply.

With less spare capacity, responses will depend more and more on replacing lost production with imported product – resulting in longer delays in rectifying production shortfalls.

However, it does appear that participants in the downstream petroleum industry, including refiners, independents and terminal operators are responding to the incentives presented to them through market signals and are investing in maintaining and upgrading existing infrastructure as well as constructing new infrastructure. This should help to respond to refinery production disruptions and to ease pressure in the supply chain from infrastructure bottlenecks in regard to terminals and pipelines that are beginning to emerge.

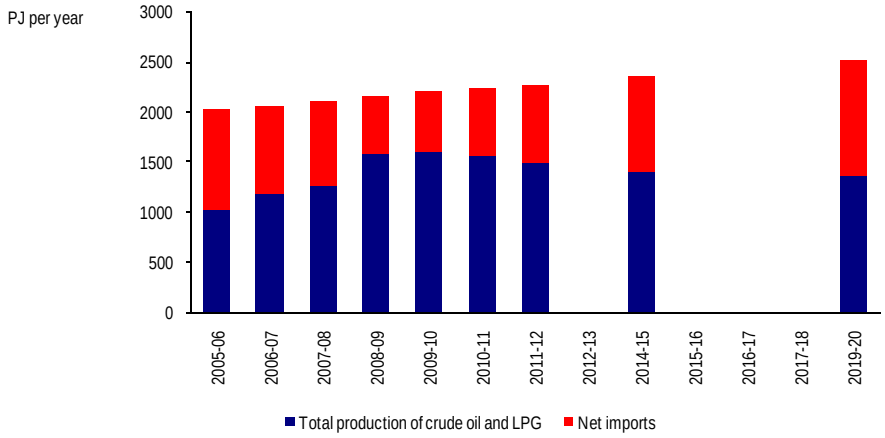
While ongoing incremental expansion of existing domestic refineries will probably occur, it is extremely unlikely that any new refineries will be constructed in Australia. Given the importance of economies of scale in oil refining and the relatively small scale of the domestic refineries, there may be

some further retrenchment of refining capacity coupled with the expected increasing reliance on overseas production of refined petroleum products.

Liquid fuels self sufficiency

In energy terms, domestic production of crude oil, condensate and LPG represented around 59 per cent of Australia's available refinery feedstock and petroleum products in 2006-07. While ABARE's energy projections indicate that the ratio of domestic production to total consumption of petroleum fuels increases to around 73 percent by 2010-11 (a broadly equivalent measure in energy terms), the ratio declines again to 54 per by 2019-20 (Figure 2).

Figure 2 **Australian oil and LPG production and net imports**

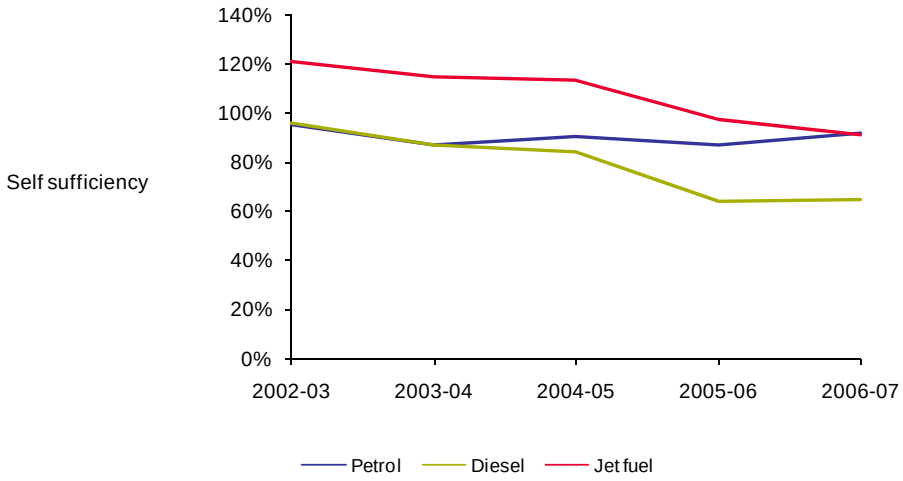


Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, (2007)

Domestic supplies of crude oil and condensate accounted for only 28 per cent of the domestic refinery input in 2006-07 in volume terms. Australian refineries import some crude oil to meet the product demand mix in Australia. Crude oil and condensates are also exported, notably from North West Australia. These factors mean that self-sufficiency in specific product areas is of more interest than an overall measure.

Australia's level of self-sufficiency in its three main petroleum products of petrol, diesel and jet fuel has been declining as shown in Figure 3 below, and is likely to continue to decline as demand rises and refinery capacity does not increase to the same degree.

Figure 3 **Self sufficiency in petroleum products**



Data source: Australian Bureau of Agricultural and Resource Economics (2008)

In terms of refining capacity, Australia maintained over 90 per cent self-sufficiency in petrol and jet fuel in 2006-07. The most significant recent decline in the level of self-sufficiency has been in regard to diesel, which has fallen from 96 per cent in 2002-03 to 65 per cent in 2006-07. While some of the decline in the level of diesel self-sufficiency is due to the reduction in Australian refining capacity, most of it is due to increasing demand for diesel, particularly from the expansion in the mining industry.

There are regional disparities in regard to the extent of self-sufficiency of refined petroleum products depending on the proximity of an operating refinery. The Northern Territory, North West Australia and north east Australia and South Australia are dependent on overseas imports of refined petroleum products to a significant extent. On the other hand, other parts of Australia are much closer to being in balance and not as dependent on imports of refined petroleum products.

The gradual fall in the overall level of self-sufficiency to 2020 does not constitute an increase in Australia's liquid fuels vulnerability. Diversity of supply is an important factor. Significantly, an increase in imports can lead to an increase in the diversity of sources of potential supply in the event of disruptions to domestic production. Such diversity is important to energy security. By the same token, the continuing presence of domestic refineries is also a contributing factor towards ongoing energy security in the period leading up to 2020 as it increases the number of supply options available. While an analysis of self-sufficiency is informative, it is not correct to conclude that a decline in self-sufficiency necessarily leads to an increase in vulnerability.

Outlook to 2020 for supplies of refined product

The major change in the outlook since 2004 is that the impact of unexpected refinery maintenance and shutdowns is more severe than was previously the case due to the increased level of interdependence of refinery operating units associated with Australian fuel specifications. With little to no spare refining capacity left in the system, the impact of production disruptions from unexpected refinery maintenance and shutdowns has become more severe. In addition, it appears that infrastructure supporting the downstream petroleum industry in some locations around the country, particularly in Sydney, have reached the maximum level of their operating capacity and further investment is required.

Production disruptions of refined petroleum products arising from unexpected refinery maintenance and shutdowns are likely to continue in the period to 2020. However, it appears that participants in the downstream petroleum industry are responding to the incentives presented to them through market signals and are investing in maintaining and upgrading existing infrastructure as well as constructing new infrastructure. This should help ease pressure in the supply chain from infrastructure bottlenecks that are beginning to emerge and assist the market in managing the impact of production disruptions. Australia's reliance on imported refined petroleum products will also gradually increase in the period to 2020.

Vulnerability assessment

Petrol

The greatest recent risk posed for the supply of petrol comes from a domestic production disruption as it may be difficult to source product compatible with Australian fuel specifications from overseas refineries in a timely period. This risk has moderated over time and will moderate further once the Reliance refinery in India and new refinery capacity in Vietnam comes on stream.

Provided Australian fuel specifications are not tightened further, it should become progressively easier to source petrol compatible with Australian requirements. Overall, it is assessed that a major disruption to the supply of petrol and product shortfall should only be short-term in nature and would be overcome through a combination of overseas imports and restoration of the situation leading to the domestic supply disruptions (that is, unexpected refinery maintenance and shutdowns).

Diesel

The greatest risk posed to the supply of diesel comes from both domestic and overseas supply disruptions. However, based on stakeholder consultations, it is understood that diesel compatible with Australian fuel specifications is commonly traded in the Asian region and relatively easy to procure. Similarly to the case with petrol, it is assessed that a major disruption to the supply of diesel and product shortfall should only be short-term in nature and would be overcome through a combination of overseas imports and restoration of the situation leading to either an overseas or domestic supply disruption.

Jet fuel

The risk posed to the supply of jet fuel comes from both domestic and overseas supply disruptions. However, based on stakeholder consultations it is understood that jet fuel compatible with Australian fuel specifications is commonly traded in the Asian region and relatively easy to procure. It is considered that a major disruption to the supply of jet fuel and product shortfall would only be short-term in nature and would be overcome through a combination of overseas imports and restoration of the situation leading to either an overseas or domestic supply disruption.

Regional vulnerabilities

– Northern Territory, North Western Australia and South Australia

The main risk of supply disruptions to these regions come from problems with overseas refineries, problems with shipments and sea lanes, and problems with berthing and terminal storage facilities.

On the basis of consultations, it is assessed that the prospect of a major supply disruption to these regions of Australia, that are largely dependent on overseas supplies of refined petroleum products, is extremely low.

– Tasmania

The main risk of a supply disruption comes from problems with the Geelong and Kwinana refineries, problems with product shipments, and problems with berthing and terminal storage facilities.

On the basis of consultations, it is assessed that the prospect of a major supply disruption to Tasmania of refined petroleum products is extremely low.

– Western Australia

Concerns have been expressed regarding congestion at common user berths at Kwinana. As a result of the tighter fuel specifications operating in Western Australia compared to the rest of the country, there is a heightened level of risk in regard to the supply of petrol in that State, particularly in the event of an unexpected refinery outage at Kwinana.

Given Western Australia's specific fuel standard requirements, there is an increased difficulty in sourcing petrol from overseas refineries able to comply with the Western Australian fuel specifications.

On the basis of consultations it is assessed that the prospect of a major supply disruption to Western Australia of refined petroleum products is extremely low. However, due to the tighter fuel specifications operating in Western Australia there may be a heightened level of risk to the supply of petrol in that state in the event of an unexpected refinery outage at the Kwinana refinery. This is due to the increased difficulty of sourcing petrol from overseas refineries able to comply with the Western Australian fuel specifications.

– Queensland, New South Wales and Victoria

The main risks of a supply disruption come from problems with the supply of domestic and imported sources of crude oil for the operation of domestic refineries, problems with domestic and overseas refineries, problems with sea lanes and shipments for overseas sourced crude oil and refined petroleum products. Problems arising from breakdowns with domestic critical infrastructure such as berthing facilities, terminals and pipelines are also relevant risks.

Concerns have been expressed regarding congestion at common user berths for the discharge of refined petroleum products at Port Botany in Sydney.

Overall, on the basis of consultations it is assessed that the prospect of a major supply disruption to these regions of refined petroleum products is extremely low.

Minimising vulnerability

Australian governments and suppliers have a number of strategies for minimising Australia's exposure to a liquid fuel supply disruption.

Greater diversity of imports

Australia has always had some dependence on imported crude oil and refined petroleum products. The increasing reliance upon imported sources of refined

petroleum products has increased the diversity of supply options for Australia and thus improved energy security rather than relying primarily upon domestic refining capacity. Given recent problems with domestic refineries, diversity of supply provided through access to the production of overseas refineries has certainly assisted in mitigating the prospect of a major product supply disruptions in Australia.

Improving the flexibility of supply chains

Further investment in import and distribution terminals, pipeline infrastructure and storage will be necessary as increasing quantities of product are sourced from abroad.

Regulatory and planning constraints should be further examined and impediments identified and addressed in order to facilitate more timely approvals and subsequent delivery of infrastructure.

Stocks

In Australia stocks are held to accommodate short-term fluctuations in demand and are based on commercial considerations. Refineries and marketers of refined petroleum products determine the level of stockholding consistent with risk management associated with commercial operations and continuity of supply to their customers. Stocks of imported crude oil typically provide around 5 to 15 days cover of refinery consumption and refineries and terminals typically hold between 5 and 10 days of consumption cover.

With increasing dependence on imported crude oil and the ongoing prospect of unplanned interruptions in domestic refineries, it is possible that these levels of cover may not be sufficient to ensure adequacy of supply in domestic markets in the event of a major supply disruption. For example, it was reported to take up to at least three weeks to locate and import a shipment of product in an emergency. This however is not sufficient evidence to conclude that these levels of cover will not be adequate in future. Importing is only one of a number of strategies available to manage risks associated with interruptions to supply.

As a member of the IEA, Australia has a commitment to maintain emergency stocks of liquid petroleum fuels equivalent to at least 90 days of net imports. Stocks can include crude oil, refined petroleum products and LPG.

Over recent years, as demand for refined petroleum products has increased the level of stocks held at refineries and terminals in Australia has not increased at a sufficient rate to maintain earlier levels of cover. Australia's stocks of petroleum product have declined from the relatively high level of 209 days of net imports in 2000 to around 110 days in 2006.

Stock levels fell below the IEA minimum requirement in 2007 and again in 2008. The recent fall in cover is understood to be a result of the planned and unplanned shutdowns in refineries and the associated normal drawdown in stocks that would accompany such shutdowns and the impact of the cyclones on production in North West Australia.

Industry consultations indicated that further investment in terminal infrastructure is being planned. Delays in planning approvals have been identified as a constraint in this respect.

ACIL Tasman notes that the Commonwealth Government is planning to undertake an audit of terminal capacity for petrol in response to a recommendation from the inquiry into petrol prices by the Australian Competition and Consumer Commission (ACCC). ACIL Tasman strongly endorses the Commonwealth Government's decision to undertake this audit but believes the scope of this audit should be extended to cover all existing and planned storage capacity of any facility capable of storing crude oil and other refinery feedstock as well as all refined petroleum products to provide sufficient data to form a judgement on the ability for Australia to continue to meet its IEA commitments in the medium term.

It is also important that State Governments address the planning and environmental processes and procedures applying to expanding terminal storage facilities. The multitude of planning processes and approvals required to construct new infrastructure facilities increases transaction costs.

Alternative liquid fuels

Alternative liquid fuels to refined petroleum products will not provide a material contribution to supply risk management over the period to 2020:

- LPG will continue to provide a useful complement to petrol as a source of fuel for the passenger vehicle fleet.
- LNG will probably emerge as a useful complement and alternative to diesel for the heavy duty vehicle fleet leading up to 2020.
- Current generation biofuels provide a useful extender of fuel supplies but are limited in their ability to substitute for supplies of conventional petroleum based fuels in an emergency.
- Gas-to-liquids and coal-to-liquids could offer potential substitution of diesel but in relatively modest quantities in the period leading up to 2020. Their regional impact in high growth areas of Queensland and Western Australia however could be significant.

Improving information available to the market

With increased dependence on imports of refined petroleum products and the likelihood of ongoing unplanned interruptions in domestic refineries, it will be important that the market is adequately informed of the future outlook. Greater information on demand projections, stock levels, planned and unplanned maintenance at refineries, import facilities and terminals would assist major consumers and suppliers to plan production schedules and investments to manage supply chain risks and implement business continuity plans. Such information should be integrated at a single web site in a bulletin board.

There may initially be concerns that the release of certain information might be commercially sensitive or create unnecessary panic in the market. In addition, the release of certain information may also have implications for the operation of competition law. However, in relation to concerns over panic buying, if more information is regularly provided to the market place then it is envisaged that the possibility of any initial over-reactions would eventually abate. Information included on the website should contribute to efficient market responses and behaviour by both fuel suppliers and users. Issues associated with the competition law and commercial sensitivities should be carefully considered but are not expected to limit the information necessary to keep the market adequately informed.

Recommendations

In order to improve Australia's energy security in regard to the supply of liquid fuels and lessen the level of vulnerability, ACIL Tasman makes the following recommendations:

- ACIL Tasman recommends reform to planning and approvals processes to ensure the timely and efficient delivery of storage and associated infrastructure by the petroleum industry and business consumers.
- ACIL Tasman recommends several measures to improve the flow of information to the market so that participants are in a better position to assess their own level of risk and vulnerability in regard to the supply of liquid fuels and thereby improve the operation and functioning of markets.
  - provision of forecasts of demand of refined petroleum products by product by ABARE or an appropriate forecasting body
  - provision of forecasts of demand in harvest periods by ABARE or an appropriate forecasting body to allow suppliers of refined petroleum products to make better projections of peak demand from the agriculture sector and to ensure that major customers are aware of the overall supply pressures

… these might be undertaken as part of the quarterly Commodity Statistics released by ABARE

- notification by the Australian Defence Force to major regional suppliers of refined petroleum products of upcoming major defence force exercises
- provision of planned maintenance periods at refineries, terminals, pipelines and port facilities
- notification of unplanned shutdowns of critical infrastructure including refineries, terminals, pipelines and port facilities that would cause a disruption to normal supplies
- information on stock levels of refined petroleum products on a regional basis
- the supply of information should be made voluntary in the first instance through a code of practice for industry participants with the information integrated in a single government endorsed website. If an industry code of practice should prove inadequate in improving information flows, then consideration should be given to imposing more formal information disclosure requirements upon the industry through a regulatory mechanism.

- It is noted that the Government has accepted the recommendation of the ACCC that an audit of terminals suitable for importing petrol into Australia be conducted. ACIL Tasman recommends that the scope of this audit be extended to include existing and planned storage capacity of any facility capable of storing crude oil and other refinery feedstock as well as all refined petroleum products.
- ACIL Tasman recommends that the Council of Australian Governments ensure that State Governments align their fuel standards with national fuel standards to increase the level of supply chain flexibility in the event of a supply disruption.
- ACIL Tasman recommends the Commonwealth Government should consider accepting the recommendations of the Economic Associates study on lowering fuel quality standards during a Liquid Fuel Emergency.
- ACIL Tasman recommends that the Commonwealth Government take steps to ensure that domestically produced refined petroleum products are not put at a commercial disadvantage compared to overseas sourced product in the implementation of an emissions trading scheme in order to maintain a diversity of supply options.

1 Introduction

ACIL Tasman was contracted by the Commonwealth Government Department of Resources, Energy and Tourism to conduct a liquid fuels vulnerability assessment. This study was recommended by the 2004 ACIL Tasman review of the *Liquid Fuel Emergency Act 1984* (recommendation 1) and supported by the Commonwealth Government and the Ministerial Council on Energy in December 2005.

The terms of reference for this review are at Appendix B.

1.1 Outcomes

The key outcomes required by this report are:

- an assessment of Australia's current level of vulnerability to disruptions and/or heightened risks to the supply of liquid transport fuel, both in the short and longer terms. This analysis includes both the risk of a national liquid fuel emergency (NLFE) occurring and its likely impact;
- an assessment of whether Australia's liquid transport fuel vulnerability has changed since the 2004 Commonwealth Government Energy White Paper *Securing Australia's Energy Future*;
- an assessment of whether Australia's liquid transport fuel vulnerability is likely to change in the period to 2020;
- identification of the most likely scenarios which might escalate into a NLFE in Australia;
- an examination of the key areas of change to Australia's liquid transport fuel vulnerability and factors underpinning the change, including whether there are different levels of vulnerability for different products and regions across Australia; and
- an assessment of what Australian and/or State Government policies or practices and/or industry policies or practices should be adopted to address any change to Australia's liquid transport fuel vulnerability in the period up to 2020. This includes an assessment of the effectiveness of market based demand restraint policies, as currently adopted by Australia, compared with other more regulatory based policies.

The vulnerability assessment will be utilised by the National Oil Supplies Emergency Committee (NOSEC), a committee of the Ministerial Council on Energy, for further informing the management response to a NLFE.

2 Energy security

2.1 Definitions

The request for tender for this project defined energy security as the adequacy, reliability and affordability of the provision of energy.

The International Energy Agency (IEA) has defined energy security in the following terms:

> Energy security, broadly defined, means adequate, affordable and reliable supplies of energy. (International Energy Agency, 2007c, pp. 160-161)

The IEA observes that no energy system can be entirely secure in the short-term due to unexpected disruptions or disruptions due to a number of factors (International Energy Agency, 2007c, p. 161). Over the longer term, the IEA comments that under-investment in crude oil production, refining or transportation capacity can lead to shortages that put upward pressure on prices (International Energy Agency, 2007c, p. 161). Overall, the IEA characterises 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 any adverse long-term trends (International Energy Agency, 2007c, p. 161).

According to the IEA, there is no single universally recognised way of measuring a country's level of energy security (International Energy Agency, 2007c, p. 164). Despite this, the IEA observes that concerns regarding the level of energy security revolve around the following set of indicators:

- Diversity of the primary fuel mix.
- Import dependence and fuel substitutability.
- Market concentration (the dominance of a small number of producing countries in total trade of any one fuel).
- Share of politically unstable regions in imports. (International Energy Agency, 2007c, p. 165)

The Commonwealth Government's 2004 Energy White Paper did not specify exactly what is meant by the term *energy security*, however, it did outline several characteristics of what attributes contribute towards energy security (Commonwealth of Australia, 2004). According to the Energy White Paper:

> Australia has a high degree of in-built energy security flowing from its extensive energy resource endowment, existing infrastructure and access to imported fuels. Ensuring adequate investment in energy infrastructure will be critical to maintaining

> Australia's future energy security. Energy security policies also need to be mindful of the need to maintain competitive energy prices as very high levels of security impose high costs. (Commonwealth of Australia, 2004, p. 43)

and

> Energy security involves balancing of supply reliability versus cost—increasing energy reliability can be expensive. This expense flows onto prices and lowers the competitiveness of the Australian economy. Therefore, energy security policies must pursue enhanced reliability while maintaining competitive energy prices. (Commonwealth of Australia, 2004, p. 117)

The United Nations has defined energy security as the availability of energy at all times in various forms, in sufficient quantities, and at reasonable and/or affordable prices (United Nations Development Programme, 2000).

The World Bank has identified three key pillars to achieving energy security:

- Energy efficiency - where the impact and return are large and the risks relatively low. The key is likely to lie in appropriate and consistent long-term objective setting with the right policy and pricing frameworks to achieve these.
- Diversification of energy supplies – where a complex set of issues need to be addressed on a fuel-by-fuel basis, but where some of the keys are going to be a cooperative approach between energy importers and exporters, the facilitation of international trade and investment, and a long-term, globally consistent approach to environmental issues (including climate change).
- Dealing with volatility – where mitigation and effective management of its consequences is a more realistic objective in the short run than its removal. And where appropriate macro-policies, burden sharing and support for the weakest, and cooperation, transparency and information sharing are ways forward. (World Bank, 2005, p. 1)

Jan Kalicki, of the Woodrow Wilson International Center for Scholars, and David Goldwyn, an international energy consultant, have defined energy security as:

> … the provision of affordable, reliable, diverse, and ample supplies of oil and gas (and their future equivalents) … and adequate infrastructure to deliver these supplies to market. (Kalicki & Goldwyn, 2005, p. 9)

Dr Daniel Yergin, the Chairperson of Cambridge Energy Research Associates (CERA), has written extensively on the subject of energy security and has taken an expansive view of what constitutes energy security:

> … the very concept of "energy security" is taking on wider dimensions. No longer does it mainly encompass just the flow of oil, as central as that is and as it has been for more than three decades. It now extends to the entire infrastructure of energy supply

> that supports … the global economy – offshore platforms and pipelines and tankers as well as refineries, storage, generating facilities, transmission lines, and distribution systems. This vast network was not designed with terrorism in mind. But its operation now has to be managed with that continuing danger in view. (Yergin, 2005, p. 52)

Dr Yergin has set out ten principles of energy security that are outlined below:

1. The first principle of energy security is diversification of supply as it lessens the impact of any particular disruption and provides opportunity for compensating supplies (Yergin, 2005, p. 55).
2. The second principle is recognition that there is only one oil market (Yergin, 2005, p. 9). Joel Darmstadter from the Resources for the Future think tank in Washington DC has opined that there is an integrated and fungible world oil market whereby a price spike anywhere will spawn price spikes everywhere (Darmstadter, 2006, p. 3). According to Darmstadter, fungibility means that oil and oil products will be routed across the globe so as to equalise the price everywhere (Darmstadter, 2006, p. 3).
3. The third principle is possessing a security margin which means having the availability of extra supply that can replace supplies that have been disrupted (Yergin, 2005, p. 9). A security margin can be achieved through many factors, including sufficient spare production capacity, strategic reserves, backup of supplies of equipment, adequate storage capacity along the supply chain, and the stockpiling of critical parts for electric power generation and distribution, as well as carefully conceived plans for responding to disruptions that may affect large regions (Yergin, 2007).
4. The fourth principle is ensuring flexibility in the market (Yergin, 2005, p. 10). Yergin contends that intervention and controls can be highly counterproductive, hindering the supply system from swiftly shifting supplies around to adjust to changes in the market or disruptions in supply (Yergin, 2005, p. 10). This leads Yergin to recommend that governments should resist political pressure and the temptation to micromanage markets otherwise problems will occur (Yergin, 2005, p. 10).
5. The fifth principle is to build cooperative relations, based on common interest, between nations that produce and export energy with those who import and use energy (Yergin, 2005, p. 10). Yergin believes that producers and consumers have a mutual dependence upon each other which creates the framework for a continuing dialogue between them (Yergin, 2005, p. 10).
6. The sixth principle is to create ongoing dialogue and cooperative energy relations between importing nations (Yergin, 2005, p. 11). Yergin observes that the IEA serves this purpose at the moment amongst members countries of the Organisation for Economic Cooperation and Development. To further this end, Yergin advocates the active engagement of both China and India (Yergin, 2007).

7. The seventh principle is a proactive security framework that involves both producers and consumers to prevent or respond to physical threats to or attacks on the entire supply chain (Yergin, 2005, p. 11).
8. The eighth principle is for governments and the private sector to provide good-quality information to the public in order to avert to prevent panic buying when markets become tight or disrupted (Yergin, 2005, p. 11). According to Dr Yergin, the IEA has led the way in improving the flow of information about world markets and energy prospects (Yergin, 2007).
9. The ninth principle is for a healthy and technologically driven energy industry that can explore and produce operating under reasonable and predictable rules that can invest regularly in technological change (Yergin, 2005, p. 11).
10. The tenth principle is a commitment to research, development and innovation to achieve a more broadly based diversification of energy sources and the eventual transition to new energy systems (Yergin, 2005, p. 11).

The Australian Bureau of Agricultural and Resource Economics (ABARE) has defined energy security at its simplest to be mean the security of energy supply which comprises three interrelated elements:

- Security of primary energy availability
- Security of energy transportation infrastructure and systems
- Security of energy production and conversion facilities. (Hogan, Fairhead, Gurney, & Pritchard, 2005)

Energy security has also been defined as a resilient energy system that is capable of withstanding threat through a combination of active and direct security measures and passive or more indirect measures such as through redundancy, duplication of critical equipment, diversity in fuel, other sources of energy, and reliance on less vulnerable infrastructure (Brown, Rewey, & Gagliano, 2003, p. 7).

A recent report by the Asia Pacific Energy Research Centre has defined energy security as:

> The ability of an economy to guarantee the availability of energy resource supply in a sustainable and timely manner with the energy price being at a level that will not adversely affect the economic performance of the economy. Thus, there are several factors that can influence the 'security' of energy supply, such as: (1) the availability of fuel reserves, both domestically and by external suppliers; (2) the ability of an economy to acquire supply to meet projected energy demand; (3) the level of an economy's energy resource diversification and energy supplier diversification; (4) accessibility to fuel resources, in terms of the availability of related energy infrastructure and energy transportation infrastructure; and (5) geopolitical concerns

surrounding resource acquisition. (Asia Pacific Energy Research Centre, 2007, p. 6)

The World Bank has observed that the precise meaning of energy security will vary by country (World Bank, 2005, p. 3). Hence for energy producing and exporting nations concerns regarding energy security will focus on the security of energy demand and the need to protect export revenues. The Secretary General of the Organisation of Petroleum Exporting Countries (OPEC), Abdalla Salem El-Badri, has defined energy security in the following terms:

- Energy security should be reciprocal. It is a two-way street. Security of demand is as important to producers, as security of supply is to consumers;
- It should be universal, applying to rich and poor nations alike, with the focus on the three pillars of sustainable development and in particular the eradication of poverty;
- It should focus on providing all consumers with modern energy services;
- It should apply to the entire supply chain. Downstream is as crucial as upstream;
- It should cover all foreseeable time-horizons. Security tomorrow is as important as security today;
- It should allow for the development and deployment of new technologies in a sustainable, economic and environmentally-sound manner; and
- It should benefit from enhanced dialogue and cooperation among stakeholders. (El-Badri, 2008)

In regard to poor countries, the World Bank observes that energy security is a vital ingredient in lifting them out of poverty (World Bank, 2005, p. 3). The World Bank observes that energy increases poor people's productivity and incomes; lighting and power improve their health and education and help them connect to the global market (World Bank, 2005, p. 3).

The notion of energy security arguably encompasses a broader range of factors than the standard definition of adequacy, reliability and affordability. For a country it also appears to take on a different complexion depending on whether the country is a net importer or net exporter of energy resources.

2.1.1 Energy Independence

Energy security should not be confused with energy independence or self-sufficiency, which is essentially when a nation relies entirely on its own resources for its energy requirements. Domestic production of crude oil coupled with a domestic refining capacity can improve energy security through increasing the diversity of supply options. However, what energy security is certainly not is energy independence or self-sufficiency, which essentially

means that a nation relies entirely on its own resources for its energy requirements. In the case of liquid fuels it would mean eliminating the importation of oil and liquid fuels altogether.

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.

As an editorial in the *Oil and Gas Journal* warned in 2002: "excessive worry about oil breeds the worst proposals" (Anonymous, 2002). Similarly, the 2004 Commonwealth Government Energy White Paper warned:

> One major international lesson is that policies which seek to pre-empt or override market forces rarely work in the longer term. (Commonwealth of Australia, 2004, p. 116)

Unless Australia is willing to pay more for its liquid fuels than the rest of the world, it will remain dependent on imports in order to satisfy its demand in the foreseeable future. The main problem with pursuing energy independence in liquid fuels is that it will come at the expense of affordability and may also reduce reliability.

A potential reduction in reliability is a generally misunderstood consequence of independence, particularly where that independence is achieved with few sources of supply. The development of diverse import supply relationships increases the options available to respond in the event of domestic supply disruptions.

2.2 Adequacy, reliability, affordability

2.2.1 Adequacy

The request for tender for this project defined adequacy as the provision of sufficient energy to support economic and social activity. Adequacy in this context refers to the ability of liquid fuel suppliers to keep up with customer requirements under normal conditions. Hence, adequacy means that there is a

sufficient supply of liquid fuels to satisfy end user demand.

There are both short-term and long-term perspectives in regard to the issue of adequacy. From a short-term perspective, adequacy requires that there are sufficient supplies of liquid fuels to satisfy the immediate demand of end users. From a long-term perspective, adequacy requires that there has been sufficient investment in necessary production facilities and infrastructure to ensure that there is sufficient future supply of liquid fuels in order to satisfy end user demand through time.

Adequacy appears to be appropriate criterion upon which to assess energy security.

2.2.2 Reliability

The request for tender for this project defined reliability as the provision of energy with minimal disruptions. Reliability can be taken to encompass two key attributes in adequacy and resilience. Adequacy has already been dealt with above. Resilience includes consideration of responses to any unexpected supply interruption and the capacity to endure them. Together, adequacy and resilience describe the overall reliability of the liquid fuel supply chain which can be broadly taken to mean the ability to supply liquid fuel products in the quantities required by users when needed. Jan Kalicki and David Goldwyn have defined reliable energy supply as predictable supplies that are increasingly less vulnerable to disruption (Kalicki & Goldwyn, 2005, p. 9).

Reliability also appears to be appropriate criterion upon which to assess energy security.

2.2.3 Affordability

The request for tender for this project defined affordability as the provision of energy at a price that does not adversely impact on the competitiveness of the economy, whilst supporting continued investment in the energy sector. This definition encompasses two aspects: in the first instance the provision of energy at a price low enough to be supportive of continued economic activity rather than so high that it inhibits activity; and, in the second instance, the price paid by final end users is sufficient to earn energy suppliers a rate of return on their project to make ongoing investment attractive to provide for future energy requirements. Since the first world oil crisis in 1973 and the second world oil crisis in 1979 preceded worldwide global economic downturns, it has been recognised that significant increases in world oil prices can stifle economic activity and growth. Edward Morse, a US energy company executive, and Amy Myers Jaffe, a US academic, have recognised that

increasing oil prices can have several detrimental effects on the economy of an oil consuming nation:

> Rising oil prices threaten consumer-country national interests in several ways. Oil price volatility can inhibit investment, economic growth and spur inflation. (Morse & Myers Jaffe, 2005, p. 66)

Jack Blunn, a former consultant to the United Nations Centre on Transnational Corporations, has warned that a perceived lack of affordability could have other consequences that extend beyond economics, even to the extent that the very nature of civil society could be put in jeopardy:

> ... an unacceptable high price of oil would cause riots, economic disruption, and all kinds of other problems.(Blunn, Saudi Arabia, Iraq and the Gulf, 2005, p. 202)

The definitions of affordability discussed here are far broader than is usually the case where it is generally taken to refer to the capacity of purchasers to acquire products within their budget/financial constraints. Jan Kalicki and David Goldwyn have defined affordable energy as the ability to buy supply at relatively stable as well as reasonable prices (Kalicki & Goldwyn, 2005, p. 9). Whether a broad or narrow definition is adopted, affordability is arguably a subjective notion.

Another dimension of affordability could be consideration of how much one is prepared to pay to achieve a certain level of energy security. One may be prepared to pay considerably more for liquid fuels if they could be guaranteed continuity of supply and ongoing access to the product without suffering the possibility of a supply disruption.

The definition of affordability related to the competitiveness of an economy may not be the most appropriate criterion upon which to assess energy security. This is because the relative competitiveness of an economy is never likely to be adversely affected in the event of a sudden increase in energy prices where economies are open and energy products are freely traded on world markets as is generally the case in the world today as all countries would presumably be paying similar prices for their energy products.

2.3 Liquid fuels emergency arrangements

2.3.1 International

As a member of the IEA, Australia is required to participate in the IEA's oil security program. The IEA is the energy forum for 26 industrialised countries whose national governments are committed to taking joint measures to meet oil supply emergencies.

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, 2007a). In March 1979 Australia acceded to the IEP Agreement.

While IEA member countries are required to hold total oil stocks the equivalent of 90 days of net imports, there is flexibility in meeting this requirement through using both crude and refined products. Countries may guarantee this minimum obligation by holding stocks as government emergency reserves, through specialised stock holding agencies, or by placing minimum stock holding obligations on industry. Australia currently meets its IEA commitment through commercial stocks held by fuel suppliers. In the 2004 Energy White Paper, the former Commonwealth Government stated that a government-owned stockpile was not currently needed but that the issue may need to be re-examined if circumstances changed significantly in the future (Commonwealth of Australia, 2004, p. 126).

In considering whether to initiate emergency coordinated action under the IEP Agreement, the IEA considers multiple factors beyond the gross peak supply loss caused by an event. The decision depends on the expected duration and severity of the oil supply disruption, and also takes into account any additional oil which may be put on the market by producer countries. An emergency response team has been activated four times: during the 1991 Gulf War when a supply shortfall of 4.3 million barrels a day (mbpd) occurred at one point; during the millennium (Y2K) when there were concerns that computer systems might fail in the move from 1999 to 2000; during the Venezuelan shutdown at the end of 2002 and the beginning of 2003; and in response to the loss of oil supplies in the Gulf of Mexico due to Hurricane Katrina in August 2005. The only actual release of emergency stocks has occurred twice. During the 1991 Gulf crisis, the IEA activated a contingency plan to make available to the market the equivalent of 2.5 mbpd of oil. Australia's contribution was 46,000 barrels per day (bpd) that was met through increased production and demand restraint. In September 2005, the 26 member countries of the IEA agreed to make available to the market the equivalent of 60 million barrels through a combination of emergency response measures, including the use of emergency stocks, increased indigenous production and demand restraint. IEA collective action was responsible for bringing 59.5 million of oil equivalent to the market in response to the supply disruption.

2.3.2 Domestic

Australia's dependence on transport fuel makes it vulnerable to oil supply disruptions and Australian governments have acknowledged a clear responsibility to prepare contingency plans against a possible liquid fuels supply emergency.

The Commonwealth *Liquid Fuel Emergency Act 1984* (LFE Act) establishes the legislative basis by which the Commonwealth Government can plan for and respond to a liquid fuel supply shortfall. Australian Government policy is, where possible, to allow industry to manage fuel supply disruptions without government intervention. If a regulatory response is required, Australia's State and Territory Governments have constitutional responsibility for planning and coordinating emergency responses within their territorial boundaries in the first instance.

In determining whether there is a need for implementation of a national regulatory response under the LFE Act, the liquid fuel supply shortage must have national implications. In considering whether there is a NLFE, the severity, impact and duration of the fuel supply shortage will be considered and it is expected that more than one jurisdiction would be affected. In addition, advice from the petroleum industry would be sought regarding its ability to deal independently, through its normal commercial operations, with the supply shortage.

The LFE Act provides the Commonwealth Government with the authority needed to prepare for and manage a national liquid fuel supply emergency. The Australian Government Minister for Energy is the responsible Minister under the Act. Furthermore, the Act provides the authority for the Commonwealth Government to implement measures to meet Australia's commitments as a member of the IEA.

Part II of the LFE Act provides the powers to plan for an emergency and take contingency actions, as necessary, at times before an actual emergency is identified. These powers include requiring relevant fuel industry organisations to maintain minimum levels of reserve stocks, develop certain emergency procedures and to maintain and provide statistical information.

Part III of the LFE Act provides the Governor-General with the power to declare a NLFE during periods of shortfall in liquid fuels. A national emergency can only be declared if the Governor-General is satisfied that the situation meets the following criteria: the use of emergency powers is in the public interest; there is no real prospect of averting the shortage through voluntary augmentation of supplies by oil companies; and the minister has

provided the opportunity for prior consultation with the relevant ministers for energy in all Australian states and territories. The emergency powers have never been invoked.

Part III also provides the Commonwealth Government with emergency powers, in consultation with State and Territory Governments, to:

- regulate supplies of liquid fuels to bulk and retail customers;
- regulate maintenance of stock levels and their transfer;
- direct the sale of liquid fuels to specified customers; and
- regulate refinery operations.

Many of the powers conferred by the LFE Act can be delegated to Commonwealth officials, and State and Territory Ministers and officials. The LFE Act also provides for the implementation of a national system to ration fuels consistent with Australia's obligations under the IEA's EAP Agreement.

Declaration of a NLFE would normally only be considered in the event of a severe disruption or if Australia was required to meet its obligations to the IEA.

The LFE Act gives the Minister for Resources and Energy wide-ranging powers to control the drawdown, transfer and sale of industry stocks of crude oil and liquid fuels, and to control bulk and retail sales of fuel across Australia. However, a supply disruption requiring the powers under Part III of the LFE Act to be invoked has never occurred to this point in time.

In addition to the LFE Act, State and Territory Governments have in place their own legislative and administrative arrangements to address a supply disruption occurring within their own jurisdictions.

The Commonwealth Government has a range of systems in place to constantly monitor any potential shortages and disruptions in fuel supply. The Government maintains NOSEC which is the main executive channel through which the Commonwealth, State/Territory Governments and industry stakeholders formulate their overall management responses to fuel supply issues. NOSEC comprises representatives from each of the government jurisdictions as well as the major petroleum supply companies and the Australian Institute of Petroleum.

NOSEC has agreements in place which require fuel companies to meet a number of reporting requirements on fuel stocks and any infrastructure issues which may arise in the fuel supply chain. NOSEC is also responsible for monitoring Australia's commitment to the IEA's IEP Agreement on behalf of

the Commonwealth Government.

NOSEC actively monitors the supply of petroleum products in Australia. In the event of a widespread fuel emergency or if Australia was required to respond to an meet its obligations under the IEP Agreement, NOSEC would be convened to advise Governments and coordinate the national response including the adoption of any emergency arrangements. A NLFE Response Plan has been developed by the NOSEC and endorsed by the Ministerial Council on Energy (MCE). The objectives of the measures described in the Response Plan are to:

- ensure that essential users have sufficient fuel to attend to their duties;
- ensure other fuel users receive petroleum supplies for as long as possible;
- ensure fuels are distributed equitably and efficiently between all of Australia's States and Territories;
- assist in minimising the effects of a fuel shortage on industry and commerce; and
- support Australia in meeting its obligations as a member of the IEA.

2.4 Vulnerability

The request for tender for this project defined vulnerability as the degree of exposure of the Australian liquid fuel supply chain to supply disruptions.

Australia along with the rest of the world is heavily dependent on petroleum based liquid fuels manufactured from oil, particularly in regard to providing energy for transportation purposes. ABARE estimates that oil accounted for 35.5 per cent of primary energy consumption in Australia during 2005-06 which is projected to fall only marginally to 34.5 per cent by 2019-2020 (Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, 2007, p. 22). The vital role played by oil in economic development has been described by Professor Michael T Klare of Hampshire College in the following terms:

> Economies – all economies – run on energy. Energy is needed to produce food and manufacture goods, to power machines and appliances, to transport raw materials and finished products, and to provide heat and light. Since World War II, economic growth around the world has been fuelled largely by abundant supplies of hydrocarbons: petroleum and natural gas... And because no other source of energy is currently available to replace oil and gas if these resources become scarce, the future health of the world economy rests on the planet's ability to produce more and more hydrocarbons. (Klare, Geopolitics Reborn: Oil, Natural Gas, and Other Vital Resources, 2007a, pp. 204-205)

Similarly, Eshita Gupta from the Energy and Resources Institute in India has described the important role played by oil in the world economy in the

following terms:

> Oil is the fuel that drives the economy, and its regular supply is vital for sustainable economic and social development of countries. The world is heavily dependent on oil for meeting its energy requirements—it fulfils about 35% of the global energy demand. (Gupta, 2008, p. 1195)

The vital role which oil plays in supporting economic activity makes the world, including Australia, vulnerable to supply disruptions. Gupta has defined oil vulnerability as a state that makes oil-consuming countries extremely vulnerable to international developments such as higher oil prices and oil supply disruptions (Gupta, 2008, p. 1197). According to Gupta there are three major risks that contribute to the overall oil vulnerability of an economy:

- Market risk of an economy refers to the risks of macroeconomic effects due to erratic price fluctuations in oil markets.
- Supply risk of an economy refers to the risks of physical disruptions in oil supplies.
- The environmental risk of an economy refers to the risks related to climate change, global warming, accidents, and polluting emissions due to increased oil usage. (Gupta, 2008, p. 1197)

The consequences arising from a prolonged disruption to oil supplies could be severe and dire. Jack Blunn, a former consultant to the United Nations Centre on Transnational Corporation has predicted:

> So what happens if there is a real disruption in supply? There is economic chaos. There is political chaos. Nobody wants it. (Blunn, 2007, p. 222)

Given the vital role that energy plays in supporting economic activity, the vulnerability of energy supply systems is a legitimate area for attention, policy action and contingency planning on the part of government.

3 Australian domestic demand for liquid fuels

3.1 Trends

Focusing on the three main transport liquid fuel products of gasoline (more commonly referred to as petrol in Australia), diesel and aviation turbine fuel (also known as jet fuel), since 1999-2000 demand for diesel and jet fuel has been ratcheting up in trend terms while it appears that demand for petrol has moderated, peaking in 2003-04.

Some of the rate of growth in the use of diesel can be attributed to the increase in the number of registered motor vehicles using diesel. The rate of growth of registered motor vehicles using diesel between 2003 and 2007 increased by 35.5 per cent while the rate of growth of registered motor vehicle using petrol rose by only 9.8 per cent over the same period (Australian Bureau of Statistics, 2007). The increase in demand for diesel has also coincided with the increase in mining activity in Australia which uses diesel powered engines and unregistered diesel motor vehicles for off road purposes. Between 2003-04 and 2006-07 the value of Australian mining exports has doubled from $31.3 billion to $62.7 billion while employment in the mining industry has increased from 83,717 in 2002-03 to 112,288 in 2005-06, an increase of 34 per cent in three years (Australian Bureau of Statistics, 2008b). Demand for diesel has been steadily increasing since 2002-03 with annual growth averaging 5.2 per cent per annum.

Recent contractions in demand for petrol may be reflective of one aspect of a significant change in the type of vehicles demanded by consumers as there has been a switch in preferences in the Australian vehicle market from large passenger cars and large medium vehicles towards smaller and lower fuel consumption vehicles (Review of Australia's Automotive Industry, 2008, p. 1).

Australian demand for jet fuel has been subject to volatility arising from events such as the 2000 Sydney Olympics that led to a temporary upturn, the terrorist attacks on the United States on 11 September 2001 that led to a worldwide downturn in the aviation sector in its aftermath, the collapse of domestic aviation carrier Ansett Airlines in September 2001, the outbreak of the severe acute respiratory syndrome virus (SARS) between November 2002 and July 2003 in China that spread throughout the Asia-Pacific region that led to a further global downturn in the aviation sector. On the other hand, recent boosts to the domestic aviation sector have come from the expansion of Virgin Blue following the collapse of Ansett Airlines and the entry of Tiger Airways.

Fuel oil and liquefied petroleum gas (LPG) are two other major transport liquid fuel products. Australian consumption of fuel oil has been trending downwards since 1999-2000. Similarly, demand for LPG appears to have been tapering in recent years and trending downwards although there may be issues in regard to data collection in regard to LPG usage.

Details on recent Australian consumption of liquid fuels are outlined below in Table 1.

Table 1 **Australian consumption of petroleum products in megalitres (ML)**

Product	2002-03	2003-04	2004-05	2005-06	2006-07
	ML	ML	ML	ML	ML
LPG	4327	4253	3862	4643	4632
Petrol	18872	19962	19876	19048	19251
Avgas	90	90	91	86	90
Jet fuel	4250	4329	4730	5359	5837
Kerosene	24	22	12	27	31
Heating oil	48	46	34	25	15
Automotive diesel	13888	14462	15185	15804	17028
IDF	18	17	15	19	15
Fuel oil	1423	1466	1595	1586	1513
Lubes & greases	569	618	470	451	421
Bitumen	671	742	812	805	808
Other*	5309	5812	7085	7230	6956
Total Products	49489	51819	53767	55083	56598
Refinery fuel**	2180	1828	2351	2164	2122
Total	51669	53647	56118	57247	58722

Note: * Includes other refined products, bitumen, crude oil used as a fuel and specialty feedstocks. ** Fuel oil equivalent.

Data source: Australian Bureau of Agricultural and Resource Economics (2008)

3.2 Projections

Medium to long-term projections of demand for liquid fuels in Australia come from ABARE which make projections up to 2029-2030 (Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, 2007). ABARE estimates that demand for other petroleum products (which exclude LPG) will increase by 24 per cent between 2005-06 and 2019-20. The products expected to contribute most to increased demand will be diesel and jet fuel while growth in demand for petrol is expected to be incremental.

ABARE projects that demand for LPG will increase by 51.5 per cent between

2005-06 and 2019-20. Overall, ABARE's national projections are consistent with the views of industry stakeholders consulted by ACIL Tasman as part of this study.

ABARE's demand forecasts for other petroleum products and LPG are contained in Table 2 below.

Table 2 **Final energy consumption in Australia by fuel in petajoules (PJ)**

Product	2005-06	2011-12	2019-20
	PJ	PJ	PJ
Other petroleum products (excluding LPG)	1729	1918	2141
Petrol	602	609	610
Other petroleum products (excluding petrol and LPG)	1127	1309	1531
Liquefied petroleum gas	97	131	147

Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, (2007)

Both ABARE projections and industry stakeholders suggest that the major growth in liquid fuels is expected to be in diesel and jet fuel, while growth in demand for petrol is expected to be only modest if not flat. These views are consistent with comments by the Managing Director of Caltex, Des King, who stated in a speech on 3 April 2008 that over the next decade demand for petrol is projected to be fairly flat but demand for diesel and jet fuel is projected to grow strongly at 3 to 4 per cent per annum (King, 2008).

According to the ABARE projections, the industries expected to make the most significant contribution towards the increase in demand for other petroleum products between 2005-06 and 2019-20 are the mining industry (110 per cent increase), air transport (67 per cent increase), agriculture (17 per cent increase) and road transport (11 per cent increase). The projected growth in demand by industry strongly suggests that the other petroleum products experiencing the greatest growth in demand leading up to 2019-2020 will be diesel and jet fuel. ABARE's projections of Australian end use of other petroleum products is provided below in Table 3.

Table 3 **Australian end use of other petroleum products**

End use	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2014-15	2019-20
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture	83.9	84.7	86.3	87.5	88.6	89.8	93.8	98.4
Mining	123.9	130.8	140.7	149.8	159.0	168.7	207.7	259.6
Wood, paper and printing	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.4
Chemical products	60.1	59.7	59.5	59.1	58.7	58.3	56.7	54.9
Iron and steel	2.7	2.8	3.2	3.3	3.4	3.5	3.5	3.5
Basic nonferrous metals	47.0	47.5	48.9	49.8	50.5	51.3	42.0	44.4
Nonmetallic mineral products	4.9	4.9	5.1	5.1	5.1	5.1	4.9	4.7
Other Manufacturing	44.2	44.7	45.8	46.5	47.2	47.9	50.0	52.4
Road transport	982.0	988.7	1000.2	1008.7	1017.2	1025.2	1054.8	1089.8
Rail transport	28.1	28.1	28.2	28.3	28.4	28.4	28.6	28.8
Air transport	201.9	208.9	220.8	230.1	239.8	249.6	287.8	336.9
Water transport	53.5	53.9	54.5	55.0	55.4	55.8	57.1	58.4
Commercial and services	21.5	21.7	22.7	23.2	23.7	24.1	25.1	26.3
Residential	1.3	3.0	1.4	1.5	1.5	1.6	1.7	1.9
Other	72.0	72.5	73.4	74.1	74.7	75.3	77.6	79.9
Total	1728.7	1752.0	1723.3	1823.4	1854.9	1886.2	1992.6	2143.3

Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke (2007)

In the opinion of many stakeholders consulted, the main risk to the ABARE forecasts are on the upside in regard to further increasing demand for diesel from continued rapid expansion in the mining industry.

In regard to future increasing demand for LPG between 2005-06 and 2019-20, ABARE expects that the greatest contribution will come from road transportation (65 per cent increase). ABARE's projections of Australian end use of LPG are provided below in Table 4.

Table 4 **Australian end use of liquefied petroleum gas**

End use	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2014-15	2019-20
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
Agriculture	1.6	1.6	1.8	1.8	1.9	2.0	2.4	2.9
Mining	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.7
Wood, paper and printing	0.9	0.9	0.9	1.0	1.0	1.0	0.9	0.8
Chemical products	12.7	12.7	12.9	12.9	12.9	12.8	12.3	11.8
Iron and steel	0.5	0.6	1.4	1.9	2.4	3.0	1.5	1.2
Basic nonferrous metals	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Nonmetallic mineral products	5.2	5.8	7.8	8.8	9.7	10.5	7.4	6.7
Other Manufacturing	2.6	2.7	2.9	2.9	3.0	3.1	3.1	3.2
Road transport	60.1	63.3	69.1	73.3	77.5	81.1	86.7	99.3
Commercial and services	3.1	3.3	4.1	4.5	4.9	5.2	4.5	4.6
Residential	10.0	10.6	11.6	12.3	12.9	13.4	13.9	15.2
Total	97.3	102.0	112.9	119.9	126.8	132.8	133.3	146.6

Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke (2007)

3.3 Regional

According to ABARE projections the largest increase in demand for other petroleum products (including petrol but excluding LPG) between 2005-06 and 2019-2020 will occur in Queensland (44 per cent increase) and Western Australia (41 per cent increase). Over the same time period, demand is projected to grow by a significant amount in New South Wales (19 per cent increase) with more modest increases expected to occur in Victoria (8 per cent increase), South Australia (5 per cent increase) and Tasmania (4 per cent increase). On the other hand, ABARE is projecting a contraction in demand for the Northern Territory (15 per cent decrease). ABARE projections on future demand for liquid fuels by state are outlined in Table 5 below.

Table 5 **Final energy consumption in Australia by state by liquid fuel**

State and Product	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2014-15	2019-20
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
NSW LPG	25.7	26.6	29.1	30.6	32.1	33.3	31.6	32.5
NSW Other Petroleum Products	511.0	516.6	527.0	534.4	542.0	549.4	576.6	610.2
Vic LPG	38.6	40.3	43.3	46.0	48.4	50.6	54.8	63.4
Vic Other Petroleum Products	384.2	386.2	390.1	392.7	395.4	397.8	406.5	416.3
Qld LPG	14.5	15.5	18.1	19.7	21.2	22.4	20.9	22.5
Qld Other Petroleum Products	408.8	417.6	433.3	445.5	458.1	470.9	520.9	587.8
WA LPG	8.9	9.5	10.9	11.8	12.6	13.3	13.4	14.8
WA Other Petroleum Products	246.1	252.1	260.2	267.8	275.2	282.6	311.8	347.2
SA LPG	8.1	8.4	9.3	9.9	10.5	10.9	10.7	11.5
SA Other Petroleum Products	102.6	103.0	103.8	104.3	104.8	105.2	106.5	107.9
Tasmania LPG	1.2	1.3	1.4	1.5	1.6	1.7	1.5	1.4
Tasmania Other Petroleum Products	39.6	39.5	39.9	40.1	40.3	40.5	40.8	41.0
Northern Territory LPG	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5
Northern Territory Other Petroleum Products	36.5	37.0	38.0	38.6	39.2	39.7	29.6	30.9

Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, (2007)

The ABARE projections are generally consistent with the views of industry stakeholders with a couple of notable exceptions. Industry stakeholders believe that demand for liquid fuels in South Australia is likely to exceed the ABARE projections in the event that the proposed expansion of the Olympic Dam underground multi-mineral ore mine operated by BHP Billiton in South Australia goes ahead. The increased mining activity associated with the expansion of the Olympic Dam mine is expected to significantly increase demand for diesel in South Australia. Similarly, some industry stakeholders were of the opinion that demand for liquid fuels would continue to increase in

the Northern Territory through further expansion of the mining industry due to current successful exploration activity eventually being translated into future mining production.

4 Global liquid fuels supply

4.1 Peak oil

4.1.1 Background to Peak Oil

Crude oil is a non-renewable resource. As such there is only a finite amount of conventional crude oil available to be extracted and, given ongoing production, it is inevitable that supply will eventually one day be exhausted.[1]

M King Hubbert originally came up with the idea of peak oil in 1949 which essentially proposed that with a finite resource such as fossil fuels that an exponential rate of production growth could only be sustained for a limited period of time before production growth began to moderate, level off and then peak from which it would go into decline dropping as fast as it rose (Hubbert, 1949). Hence, the rate of production of fossil fuels followed a bell curve akin to a normal distribution curve. It should be noted that peak oil does not mean running out of oil. It means there is only as much oil left as has been used so far.

In 1956 Hubbert made extrapolations based on the shape of curves to make predictions on when the production of conventional crude oil for the United States and the world would peak (Hubbert, 1956). Hubbert predicted that US crude oil production in the lower 48 states would peak sometime around either 1965 or 1970 depending on the level of crude oil reserves (Hubbert, 1956, pp. 24-25) while world crude oil production would peak sometime around 2000 (Hubbert, 1956, p. 22). In spite of the development of new crude oil fields in Alaska, Hubbert's prediction of peak oil in US production turned out to be remarkably accurate with US crude oil production peaking in 1970 according to production figures published by the US Energy Information Administration (EIA).

Although Hubbert correctly predicted the date when US crude oil production in the lower 48 states would peak, he wasn't entirely correct in all his predictions. The level of peak production Hubbert estimated was 20 per cent below the actual level of peak production in 1970 (Witze, 2007, p. 16). In addition, because of unforeseen discoveries in the Gulf of Mexico, the amount of US crude oil produced in the lower 48 states following the peak was much greater than Hubbert had predicted (Witze, 2007, pp. 16-17). Furthermore, the

[1] Conventional crude oil refer to product that is found in a liquid state utilising traditional oil well methods of extraction.

amount of crude oil produced in Texas has been twice the amount estimated by Hubbert back in 1956 (Lynch, 2002, p. 377).

Ronald Charpentier from the US Geological Survey has speculated that the method developed by Hubbert for predicting peak oil has become popular for two reasons (Charpentier, 2002). First because it only requires modest data and human resources whereas geological analyses at a more detailed level have very large data and staff requirements. Second because it tends to suggest relatively low limits on resources and production.

4.1.2 Contemporary Peak Oil Debate

Debate over Methodology

Since the mid-1990s several analysts have made updated forecasts of peak oil in world conventional crude oil production based on Hubbert's methodology and attracted increasing levels of public attention with predictions that peak oil was not too far away. The most prominent analysts making these forecasts have been geologists Dr Colin Campbell, Professor Emeritus Kenneth Deffeyes of Princeton and Jean Laherrere. In 2005 IEA observed:

> Soaring oil prices have again spotlighted the old question. Are we running out of oil? The doomsayers are again conveying grim messages through the front pages of major newspapers. "Peak oil" is now part of the general public's vocabulary, along with the notion that oil production may have peaked already, heralding a period of inevitable decline. (International Energy Agency, 2005a, p. 3)

In 2000 Campbell founded the Association for the Study of Peak Oil and Gas (ASPO), which is a network of scientists, affiliated with a wide array of global institutions and universities, having an interest in determining the date and impact of the peak and decline of the world's production of oil and gas.

In 1996 Campbell predicted that:

> … compelling evidence points to a pending oil supply shortfall, possibly before 2000, which could trigger a third and permanent radical rise in oil prices. There is a certain scepticism because people have cried wolf before, but this time the situation is totally different from that which allowed the oil shocks of the 1970s. (Campbell, 1996)

Writing in the *Scientific American* in 1998, Campbell and Laherrere made the following prediction regarding peak oil:

> Barring a global recession, it seems most likely that world production of conventional oil will peak during the first decade of the 21st century. (Campbell & Laherrere, 1998, p. 81)

In 2003 Campbell wrote in the *Oil & Gas Journal* that:

> … what we do face is an imminent peak and the onset of decline from resource constraints. The precise date of peak depends very much on the level of demand, which is hard to predict. It may have been passed in 2000 if wars and deep recessions curb demand and in any case is unlikely to be delayed beyond 2010. (Campbell, 2003, p. 44)

Writing in *Time* magazine in 2005, Deffeyes wrote:

> World oil production is about to reach a peak and go into its final decline. For years, a handful of petroleum geologists, including me, have been predicting peak oil before 2007, but in an era of cheap oil, few people listened… M. King Hubbert, a geophysicist, correctly predicted in 1956 that oil production in the US would peak in the early 1970s – the moment now known as "Hubbert's Peak." I believe world oil production is about to reach a similar peak. (Deffeyes, 2005)

Most recently a report by the Energy Watch Group has declared that "[p]eak oil is now" (Energy Watch Group, 2007, p. 12).

On the other hand, there are other forecasts that suggest world peak oil could still be some decades away. According to the EIA:

> A peak in world oil production is decades away ... not years away. (Caruso, 2005)

Modelling undertaken by the EIA suggests that world peak oil for conventional crude oils will probably occur within a 37 year range between 2031 and 2068, most likely in 2044 (Caruso, 2005).

The IEA opined back in 2005 that global oil reserves exceeded the cumulative projected production between 2005 and 2030, but that reserves of crude oil will need to be "proved up" in order to avoid a peak in production before the end of 2030 (International Energy Agency, 2005b, p.45). Cambridge Energy Research Associates (CERA) has concluded that peak oil for conventional crude oil will not occur before 2030 (Cambridge Energy Research Associates, 2006). Drawing on both conventional and unconventional proven crude oil reserves[2], energy company BP has concluded that there is the equivalent of more than 40 years of oil reserves at current production levels (Ruehl, 2007, p. 14).

Many critics have called into question the Hubbert methodology for forecasting peak oil, arguing that there is no reason as to why the production of conventional crude oil should in fact follow a bell curve shape. According to John Wood, Gary Long, David Morehouse of the EIA:

[2] Unconventional crude oil refers to product that has not been extracted using the traditional oil well method. Unconventional crude oils include tar sands, heavy oil, shale oil, and the conversion of gas and coal to liquid oil.

> While symmetry appeared to be a reasonable choice at the time Hubbert made his estimates for the United States (which, unlike the world, was not a closed supply-demand system) and later elected (perhaps unfortunately) to apply the same approach at world scale, there is no strong physical or economic rationale that supports a symmetrical outcome for the entire world, particularly in view of the more drawn out time scale of worldwide development. (Wood, Long, & Morehouse, 2004)

Similarly, CERA has opined:

> The global production profile will not be a simple logistic or bell curve postulated by geologist M. King Hubbert, but it will be asymmetrical – with the slope of decline more gradual and not mirroring the rapid rate of increase – and strongly skewed past the geometric peak. It will be an undulating plateau that may well last for decades. (Cambridge Energy Research Associates, 2006)

Dr Thomas Ahlbrandt, formerly Project Chief for the World Energy Project of the US Geological Survey (USGS) commented in 2003 that:

> The symmetric rise and fall of oil production is not technically supportable, as Hubbert, Laherrere and others have published, although generally not recognised by (Colin) Campbell, (Kenneth) Deffeyes, and others who have been making draconian end-of-civilisation claims since 1989 and every year since. (Williams, 2003, p. 20)

Resource economist Professor Emeritus Richard Porter of the University of Michigan has also queried the methodology of arriving at estimates of peak oil used by Hubbard:

> … the Hubbert's Peak procedure puts a heavy burden on a statistical form that is very weak in its conceptual foundations – applying a model developed to study the limits to population growth directly to the limits to resource depletion ignores the many factors that differentiate living beings from inanimate objects, and assuming that production begins to decline when half the world's recoverable reserves have been extracted ignores any influence of price on the rate of production. Moreover, the resulting parameter estimates are highly dependent on the data years used – adding or subtracting a decade of data to the regression changes the estimated date of the Hubbert's Peak by about a decade. (Porter, 2006, p. 187)

Similarly, Michael Lynch, an energy consultant and former academic at the Massachusetts Institute of Technology, has opined "that oil production rarely follows a bell curve" (Lynch, 2003, p. 39). Lynch further comments:

> Virtually all of the work of Campbell, Laherrere, and Kenneth Deffeyes relies heavily on graphs, with claimed correlations but no statistical results provided, and it appears that the authors fall prey to statistical illusions. (Lynch, 2003, p. 41)

Lynch suggests that Campbell and Laherrere are doing nothing more than curve fitting, akin to stock market chartists. Lynch argues the Hubbard modellers have done precisely what he predicted back in 1996: produce a series

of predictions of near term peak and decline, which have had to be repeatedly revised upwards and into the future (Lynch, 2003, p. 46). Lynch has also criticised Campbell and Laherrere in publishing their results without any accompanying research, thus making it nearly impossible to reproduce or check their results (Lynch, 2003, p. 40).

Charpentier has observed that Campbell has had to repeatedly revise his estimate of the impending peak, making his first such prediction back in 1989:

> Colin Campbell, currently the best-known user of the Hubbert methodology, has had to repeatedly revise his predictions because the forecast date of the peak has passed. (Charpentier, 2002)

Similarly, Leonardo Maugeri of Italian Energy company Eni has observed in regard to Campbell's predictions of peak oil:

> According to Campbell and others, the world will achieve its peak production point some time during this decade, and will then face a rapid depletion of its oil reserves, causing prices to skyrocket and triggering an urgent need to develop alternative sources of energy.
>
> However, Campbell made subsequent revisions of his own estimates of ultimate recoverable petroleum resources – respectively in 1989, 1990, 1995, 1996, and 2002 – each time increasing it; once his predictions proved wrong, he simply moved forward his doomsday projection of peak oil production. (Maugeri, 2006, p. 206)

While there is disagreement about the actual timing of peak oil, there is a consensus that conventional crude oil is a finite resource and that global production will eventually peak and then go into decline. Energy consultants Dr Robert Hirsch, Roger Bezdek and Robert Wendling have observed that:

> When world oil peaking will occur is not known with certainty. A fundamental problem in predicting oil peaking is the poor quality of and possible political biases in world oil reserves data. (Hirsch, Bezdek, & Wendling, 2005, p. 5)

Disagreement over the Level of Crude Oil Reserves

A critical area of difference between those who claim that world peak oil is imminent if it hasn't already occurred and those who claim that it is still some decades away, is the remaining level of ultimately recoverable resources (URR) in the world.[3] A major part of this discrepancy is that information on crude reserves and rates of production by field are not publicly available and are somewhat shrouded in mystery as it is highly sensitive commercial information.

At the end of 2005 Campbell forecast that total URR were 1,900 billion barrels (bb), with 967 bb having already been produced and 933 bb left to be

[3] URR refers to the amount of oil thought to be recoverable.

produced. More recently the Energy Watch Group has estimated that there is only 854 bb left to be produced (Energy Watch Group, 2007).

On the other hand, there are others who have arrived at significantly higher estimates of total URR. In 2000 the USGS estimated total URR were 3,012 bb with some 710 bb having already been produced, with the estimated total amount of future technically recoverable oil to be about 2,152 bb (USGS World Energy Assessment Team, 2000). Similarly, in 2006 CERA estimated total URR of both conventional and unconventional crude oil were 4,820 bb with some 1,078 bb having already been produced and the remaining global oil resource base being some 3,740 bb (Cambridge Energy Research Associates, 2006).

Those who purport that peak oil is imminent, if it hasn't already occurred, claim that upgrades in previous estimates of URR have been made for economic and political reasons and have no basis in reality. On the other hand, those who purport that world peak oil is still some decades away claim that upward revisions made to the level of URR have a legitimate basis.

In 1998 Campbell and Laherrere claimed that estimates of reserves conducted annually by the *Oil & Gas Journal* and *World Oil* journal contained systematic errors and many of the reported figures were unrealistic (Campbell & Laherrere, 1998, p. 79). In particular, Campbell and Laherrere argued that members of OPEC faced strong incentives to raise their level of estimated reserves:

> The members of OPEC have faced an even greater temptation to inflate their reports because the higher their reserves, the more oil they are allowed to export. National companies, which have exclusive oil rights in the main OPEC countries, need not (and do not) release detailed statistics on each field that could be used to verify the country's total reserves. There is thus good reason to suspect that when, during the late 1980s, six of the 11 OPEC nations increased their reserve figures by colossal amounts, ranging from 42 to 197 percent, they did so only to boost their export quotas. (Campbell & Laherrere, The End of Cheap Oil, 1998, p. 79)

Laherrere has attributed the upgrade in conventional crude oil reserves in the Middle East during the second half of the 1980s to the OPEC decision to base production quotas on reserves "so most of the OPEC members increased their reserves by 50% to get higher quotas" (Williams, 2003, p. 22).

Campbell observes that discoveries of conventional crude oil peaked in the 1960s and have been falling relentlessly ever since, despite all the advances in technology and a worldwide search (Campbell, 2003, p. 40). Similarly, Alekett and Campbell contend that the world has been searched extensively for new deposits of conventional crude oil and that little remains to be discovered and

produced in any event:

> …the world has been thoroughly explored by an industry using advanced technology and well established scientific knowledge… If more could have been found, it would have been, implying that the long decline in discovery since the 1960s … reflects the limits imposed by Nature. (Aleklett & Campbell, 2003)

Laherrere has contended that the belief held by some economists that the Middle East has a great potential for future discoveries of conventional crude oil is wrong (Laherrere, 2002, p. 19).

On the other hand, the USGS has argued that reserve growth on estimates of conventional crude oil is real: "the general phenomenon of reserve growth is common to fields of all sizes and types" (US Geological Survey, 2000). The USGS contends there are three factors contributing to reserve growth that are not independent of each other. First, there can be upward revisions of reserve calculations, which refers to the difference between early estimates of recoverable resources (based on limited data and tend to be on the conservative side), with later estimates based on more comprehensive knowledge of the field. Second, there can be upward revisions due to increases in the amount of oil that can be extracted from a given field due to improvements in technology. Third, there can be upward revisions due to the delineation of additional in-place oil; this refers to the occurrence that when a field is developed, drilling tends to extend the field's boundaries and, as each additional increment of production capacity is added to the field, estimates of reserves also increase in turn. According to the USGS:

> The phenomenon of reserve growth is an important component of predictions of future production capacity because it is an integral part of estimates of the world's ultimate supply of petroleum. Recent estimates incorporating reserve growth suggest that the world's ultimate supply of petroleum might be larger than has generally been appreciated. (US Geological Survey, 2000)

Ahlbrandt, previously of the USGS, commented in 2003 that:

> We have documented detailed reserve growth in the world and have published detailed reserve growth studies in the West Siberian basin, the Volga-Urals, Middle East, and, most recently, presented reserve growth studies for the North Sea… (Williams, 2003, p. 25)

Geoscience Australia also concurs with the views of the USGS that the phenomenon of reserve growth is real:

> It is well known that oil and gas reserves tend to increase over the life of a field. (Geoscience Australia, 2004, p. 31)

While acknowledging the motives of every OPEC country in the Middle East

can be questioned in regard to raising the level of crude oil reserves, Ahlbrandt has opined:

> …when I look at the data, I see larger, not smaller, resources there than already stated. Most of the world hasn't had to worry about reserve growth much, but it is coming and is adding significant volumes already, as we have documented in a number of international studies. (Williams, 2003, p. 24)

Saudi Arabia through its national oil company, Saudi Aramco, has also defended the upward revision in its crude oil reserves during the late 1980s, commenting in 2004 that:

> The reserve revisions were long overdue because of the extremely conservative nature of the company's reserves calculations. The company realised that with solid new evidence coming in based on actual field performance and advanced diagnostics, it had to revise its reserves upward. For example, Abqaiq, Saudi Aramco's most mature field, has been in production for 60 years and continues to produce 400,000 barrels per day – and it will probably be producing about 200,000 barrels a day many years down the road.
>
> If original proved reserves figures had been maintained, Abqaiq production would have finished a decade ago; at the end of 2003, 2 billion barrels more than the reserves originally estimated in 1970 have already been produced from Abqaiq. Another big field, Safaniya, has already produced 1 billion barrels more than its 1970 original reserves estimate. So, there is a lot more oil to recover than originally thought. (Saudi Aramco, 2004)

In its assessment of world crude oil reserves in 2000, the USGS arrived at reserve growth of 612 bb outside of the United States (USGS World Energy Assessment Team, 2000).

Lynch has criticised those who claim that the reserve growth phenomenon is mythical, arguing that this assertion has been repeated on many occasions but without any corroborating evidence (Lynch, 2006, p. 10).

Lynch has also taken issue with those who contend that most of the existing conventional crude oil reserves in the world have already been discovered, rejecting arguments that the drop in global crude oil discoveries proves scarcity (Lynch, 2003). According to Lynch, while global oil discoveries fell during the 1970s from their previous rate, this was largely attributable to two main factors:

- A drop in exploration in the Middle East as governments nationalised foreign exploration operations and cut back on exploration as demand for their oil fell by half (Lynch, 2003, p. 43).
- The fall-off in discoveries since the 1970s has been due primarily to government decision making in the Middle East rather than a lack of

> geological opportunities (Lynch, 2003, p. 43). According to Lynch, the fall in exploration activity in the Middle East was entirely rational, as they didn't need to waste money exploring for something they would not have to use for decades (Lynch, 2003, p. 43).

Central to these conflicting viewpoints regarding the remaining level of world crude oil reserves is the state of URR in the Middle East, particularly in Saudi Arabia, the world's largest producer of conventional crude oil.

Matthew Simmons, an oil industry consultant and investment banker, has been prominent in raising concerns regarding the level of crude oil reserves in Saudi Arabia and the Middle East. In 2006 Simmons commented in regard to the Middle East:

> The high quality light oil coming from some of the most productive reservoir rocks ever discovered is now rapidly being depleted. A high percentage of what were once key Middle East crude grades now come from shrunken sources. Current production targets in countries like Saudi Arabia and Kuwait are tapping pockets of oil left behind from the massive water injection program designed to sweep out all the "easy" oil these great fields could produce. Other new sources of oil supply are from thin oil "streaks" or oil being produced from very tight rocks or a combination of both.
>
> The Golden Age of abundant and cheap Middle East oil is long gone. Middle East oil is now facing its Twilight Era. Saudi Arabia's great oil reserves are increasingly scarce: seven key fields produce 90 percent of Saudi oil, but the "sweet spots" of each of these fields are almost depleted. Abqaiq, the third-largest Saudi field is now relying for its key extraction on previously bypassed "pockets" of oil. Current rates of decline approximate 8 percent each year, and spare production capacity has dropped from more than 5 million barrels per day in 2002 to less than 1 million this year. (Simmons, 2006, p. 63)

In researching for his book titled *Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy*, Simmons reviewed more than 200 Society of Petroleum Engineers research papers written since 1961 by the company responsible for crude oil production in Saudi Arabia, currently Saudi Aramco and formerly Aramco. In his book, Simmons outlines that five miracle giant oilfields have created more than 90 per cent of Saudi Arabia's oil, but that these giants are now very mature and massive water injection has been used to keep rates of crude oil production high (Simmons, 2005). Simmons also claims that Saudi Arabia has been thoroughly explored but that Saudi Aramco have failed to find more crude oil (Simmons, 2005). Simmons central thesis is that these key fields face the risk of going into a very rapid production decline, and that once Saudi Arabia's rate of crude oil production has peaked, so has the world crude oil production.

On the other hand, Saudi Arabia and its national oil company, Saudi Aramco, have vigorously denied Simmons claims. Saudi Aramco commented in 2004 that:

> Saudi Aramco is committed to maintaining its pre-eminent role as a reliable, cost-effective and environmentally friendly global oil supplier. If called upon, the company can sustain daily crude production levels of 10, 12 and 15 million barrels per day through 2054 and beyond…
>
> Saudi Aramco's oil and gas reserves conform to industry standards – Society of Petroleum Engineers (SPE), World Petroleum Congress (WPC) and American Association of Petroleum Geologists (AAPG). Reserves attributable to enhanced oil recovery (EOR) are excluded, underscoring the conservative nature of the company's reserves. Year-end 2003 proved oil reserves totalled 260 billion barrels. Incremental probable and possible reserves (over and above the 260 billion barrels) are estimated to be 103 billion barrels…
>
> The Kingdom's average state of reserves depletion for all its fields is just 28 percent. The oldest field, Abqaiq, is 73 percent depleted, and the world's largest field, Ghawar, has produced 48 percent of its reserves. By contrast, Shaybah, one of the Kingdom's youngest fields, has 95 percent of its proven reserves remaining. (Saudi Aramco, 2004)

Saudi Aramco also rejects suggestions that there is nowhere left for it to explore for new crude oil reserves, commenting that it has a lot of acreage to explore and the potential to find a lot more oil (Saudi Aramco, 2004). In terms of the veracity of previous claims regarding proven reserves of crude oil, the think tank the Center for Strategic and International Studies (CSIS) based in Washington DC has commented:

> In the case of Saudi Arabia, Saudi Aramco has proven to be highly credible over the years with its statements. (Cordesman, Obaid, & Al-Radhan, 2005, p. 18)

Lynch has also rejected Simmons claim that Saudi Arabia has been thoroughly explored for new crude oil reserves, pointing out that few exploratory wells have been drilled in Saudi Arabia in recent decades as existing fields have proven to be more than adequate to provide necessary oil (Lynch, 2006, p. 5). Lynch strongly refutes the claims made by Simmons that Saudi Arabian oil production is about to peak:

> The actual evidence presented by the Simmons work suggests that (a) the Saudis are at the beginning of their resource curve, (b) they are developing their fields in a very careful manner, and (c) they have faced and overcome numerous technical challenges. Nowhere is there anything to support his conclusions that their production is going to peak, and historical evidence refutes this hypothesis quite clearly. (Lynch, 2006, p. 22)

While recognising that Simmons raises some legitimate concerns regarding the state of crude oil reserves in Saudi Arabia, the CSIS have observed that Simmons argument is based more upon an analytic "chain of negatives" than

the provision of any definitive proof (Cordesman, Obaid, & Al-Radhan, 2005). Furthermore, CSIS observes that for Simmons to be correct:

> … depends on the Saudi managers Aramco being wrong or covering up massive risks and development problems, and virtually all of the other analysts examining world oil reserves and production potential being wrong about both the size of the world's oil reserves and the ability of modern technology to provide future significant gains in ultimate recovery. (Cordesman, Obaid, & Al-Radhan, 2005, p. 7)

Robinson West, a US energy consultant, has summed up the debate on the level of Saudi Arabia's oil reserves in the following terms:

> Although some analysts have raised questions about the integrity of the limited data Saudi Aramco has provided on its reserves, it appears from the vast majority of accounts, whether compiled by international oil companies like BP, government organisations such as the US Energy Information Administration or various geological experts, that Saudi Arabia has proven reserves of almost 300 billion barrels. At one of the first public disseminations of Aramco proprietary data, executives from the Saudi oil company pointed out that this number encompassed strictly "proven" reserves, or those that can be extracted with a greater than 90 percent probability. This number therefore does not include those reserves that have been located and identified but that are given a slightly lower extraction probability and thus fall into the category of "possible" reserves. Because these are reserves that have already been identified, and ever-improving technologies are allowing for much higher recovery rates, it is likely that Saudi Arabia will be able to substantially increase its recoverable reserve base without even having to tap the large unexplored desert areas of the Kingdom. (West, 2005, pp. 203-204)

Geologists Versus Economists

The debate surrounding the timing of peak oil has been characterised as largely a dispute between geologists and economists. Hirsch, Bezdek and Wendling have summed up the debate in the following terms:

> Some economists expect higher oil prices and improved technologies to continue to provide ever-increasing oil production for the foreseeable future. Most geologists disagree because they do not believe that there are many huge new oil reservoirs left to be found. Accordingly, geologists and other observers believe that supply will eventually fall short of growing world demand – and result in the peaking of world conventional oil production. (Hirsch, Bezdek, & Wendling, 2005, p. 15)

Aleklett and Campbell has characterised the differences between the approaches taken by geologists and economists in the following terms:

> The first is what may be called the *Natural Science Approach*, which observes the factors controlling oil accumulation in Nature and applies immutable physical laws to the process of depletion. The second is what may be called the *Flat-Earth Approach*, in which the resource is deemed to be virtually limitless, with extraction being treated as

> if it were controlled only by economic, political and technological factors. (Aleklett & Campbell, 2003, pp. 5-6)

In order to deal the impending onset of peak oil, Campbell has advocated "nothing less than a radical overhaul of economic principles" (Campbell, 2003, p. 45).

On the other hand, critics of the geologists predicting an imminent peak in world crude oil production believe their arguments are simplistic geological determinism that takes no account of the role of crude oil prices (Witze, 2007, p. 14). Economists would argue that an increasing price for crude oil provides incentives for its conservation as well as for increased exploration and production activities (Haubrich & Meyer, 2007). In addition, a rise in the price of crude oil also provides an incentive through a price signal for the development of substitute products such as alternative energy technologies and/or the development of unconventional crude oil reserves.

Lynch has characterised the arguments of those geologists predicting an imminent peak in world crude oil production in the following terms:

> The arguments made are fairly common: you can't produce oil that doesn't exist, regardless of price; and depletion—which is determined only by geology and chemistry—drives production curves. There is no room for economics in this view, which, given the poor record of oil price forecasting, might seem gratifying. Instead, these models are driven entirely by geophysical factors, and most are based on the work of M. King Hubbert (Lynch, 2002, pp. 376-377)

Lynch contends the Hubbert modellers are wrong because they take the level of URR as a static amount whereas Lynch argues this is a serious error in that it should be a dynamic amount:

> URR refers not to total resources, which is arguably a fixed amount, but to the proportion of the total which is recoverable. It is logical that this should increase over time, as technological advances raise the proportion of a field which can be recovered economically and as other changes (additions of pipelines, for example) lower costs and thus make it economical to produce smaller and/or deeper fields and less productive wells. (Lynch, 2002, p. 378)

Similarly, Sarah Emerson, a US energy economist, has commented:

> The geologists who present the resource scarcity argument tend to ignore changes in the economic context. For example, foreign investment laws can change in countries with large reserves and limited access to capital or technology. This means places we never expected development (or expected slow development) suddenly open up. A list of the countries who have opened up to foreign investment is an impressive who's who of producers: Russia, Azerbaijan, Kazakhstan, Venezuela, now Iraq, and maybe even someday Kuwait and Saudi Arabia. New-found access to capital and technology

> requires a total reappraisal of resource development. (Williams, 2003, p. 20)

Michael Toman and Joel Darmstadter from the Resources for the Future think tank located in Washington DC have commented:

> … optimists who assert that there are many years remaining before oil production peaks are simply and correctly asserting that changes in energy prices and technology can increase the recovery factor in old fields and increase the probability of discovering new, albeit smaller, economically viable fields. (Toman & Darmstadadster, 1998, p. 49)

Charpentier of the USGS has argued that the Hubbert methodology is fundamentally flawed in that it fails to consider factors other than resource depletion in forecasting the production peak:

> Trends in petroleum discovery and production are affected by much more than just resource depletion. They are also shaped by a large variety of economic, technologic, and political factors. (Charpentier, 2002)

4.1.3 Conclusions and Implications

There would appear to be several problems with the method used by those who claim that the peak in world crude oil production is imminent. The method used that was first developed by Hubbert is primarily based upon extrapolation from fitting a curve to a pre-existing pattern of crude oil production. However, production of world crude oil may not necessarily follow the Bell curve shape as originally proposed by Hubbert and it has been clearly demonstrated that past predictions of peak oil made using Hubbert's method have not turned out to be accurate. Furthermore, a critical problem with current exponents using Hubbert's method for forecasting the peak in world crude oil production is that their work is not particularly transparent in that it is not capable of being replicated and as such is beyond critical review and analysis as a consequence.

While there will be a peak in the world production of crude oil, internationally accepted information from sources such as the IEA, EIA and CERA suggest that this peak is still some decades away and will occur beyond 2020.

While information on crude oil reserves, especially by field, is opaque, the most comprehensive study was that undertaken by the USGS in 2000 (USGS World Energy Assessment Team, 2000). The USGS study in 2000 also provides independent confirmation that Saudi Arabian/Saudi Aramco claims regarding the level of their crude oil reserves are credible.

In the event that a peak world oil production should occur sooner than is generally predicted, that is in several decades time, then it will most likely result

in a dramatic increase in crude oil prices as supply is unable to keep pace with increasing demand. A dramatic and ongoing real increase in the price of crude oil will result in adaptation that will likely manifest itself through four main avenues:

- It should trigger an increase in the technical efficiency of processes using and reliant on liquid fuels.
- It should provide an incentive to a shift to alternative energy sources.
- During the transition process involved in the pursuit of increased technical efficiency and the shift towards alternative energy sources, it should lead to a moderation or short-term contraction in the rate of economic growth.
- It should encourage a transition to a less oil intensive economy.

ACIL Tasman concludes that there is no reason to believe that the international oil market is being manipulated in a way that would mask the signals of peak oil. Indeed, the recent increase in oil prices foreshadows what happens when demand outstrips supply – in this case caused by under-investment in supply capacity. Further, from a policy point of view, governments should continue to encourage the transparency of these signals and not attempt to undermine them by controlling the price of liquid fuels, including by altering taxation arrangements to provide what may only be short-term relief.

4.2 Peak production capacity

In dismissing concerns relating to peak oil, the IEA has raised another issue of interest in regard to capital investment for crude oil production:

> The IEA has long maintained that none of this is a cause for concern. Hydrocarbon resources around the world are abundant and will easily fuel the world through its transition to a sustainable energy future. What is badly needed, however, is capital investment in projects to unlock new hydrocarbon resources, be they non-conventional, or in deepwater offshore locations, or in countries where geopolitical factors have restricted investment. (International Energy Agency, 2005, p. 3)

Projections based on the IEA's World Energy Outlook 2007 (International Energy Agency, 2007c) suggest that world demand for oil will increase by about 23 per cent or by around 19.4 million barrels per day (mbpd) between 2006 and 2020 from 84.7 mbpd to 104.1 mbpd. Similarly, the IEA estimates that world demand for oil will increase by about 37.3 per cent, or by around 31.6 mbpd, between 2006 and 2030 from 84.7 mbpd to 116.3 mbpd (International Energy Agency, 2007c, p. 80). The IEA's estimates of world oil demand are provided in Table 6 below.

Table 6 **World Primary Oil Demand Forecasts by the International Energy Agency (million barrels/day)**

Region/Country	2006	2010	2015	2030	2006-2030*
OECD	**47.3**	**49.0**	**50.8**	**52.9**	**0.5%**
North America	24.9	26.2	27.7	30.0	0.8
Europe	14.3	14.5	14.7	14.7	0.1%
Pacific	8.1	8.3	8.3	8.1	0.0%
Transition economies	**4.5**	**4.7**	**5.1**	**5.6**	**0.9%**
Russia	2.6	2.8	3.0	3.3	0.9%
Developing countries	**28.8**	**33.7**	**38.7**	**53.3**	**2.6%**
China	7.1	9.0	11.1	16.5	3.6%
India	2.6	3.1	3.7	6.5	3.9%
Other Asia	5.5	6.2	6.9	8.9	2.0%
Middle East	6.0	7.0	7.9	9.5	1.9%
Africa	2.8	3.1	3.4	4.8	2.2%
Latin America	4.8	5.2	5.6	7.1	1.6%
International marine bunkers and stock changes	4.1	3.7	3.9	4.5	n.a.
World	**84.7**	**91.1**	**98.5**	**116.3**	**1.3%**

Note: *Average annual rate of growth

Data source: International Energy Agency(2007c)

Estimates of world oil demand by OPEC up to 2030 are similar to the most recent estimates made by the IEA (Organisation of Petroleum Exporting Countries, 2007). OPEC estimates that world oil demand will increase from 83.3 mbpd in 2005 to 103.5 mbpd in 2020 (Organisation of Petroleum Exporting Countries, 2007, p. 22). OPEC estimates of world oil demand are provided in Table 7 below.

Table 7 **World oil demand forecast by the Organization for Petroleum Exporting Countries (million barrels/day)**

Region/Country	2005	2010	2015	2020
North America	25.5	26.1	26.9	27.7
Western Europe	15.5	15.6	15.8	15.9
OECD Pacific	8.6	8.6	8.6	8.6
OECD	**49.6**	**50.3**	**51.3**	**52.2**
Latin America	4.6	5.0	5.5	5.9
Middle East & Africa	3.0	3.4	4.0	4.6
South Asia	3.1	3.9	5.0	6.1
South-East Asia	4.4	5.2	6.1	7.1
China	6.5	8.7	10.4	12.3
OPEC	7.4	8.2	9.1	9.9
Developing countries	**29.0**	**34.5**	**40.0**	**45.9**
Former Soviet Union	3.8	4.0	4.2	4.3
Other Europe	0.9	0.9	1.0	1.0
Transition economies	**4.7**	**4.9**	**5.2**	**5.4**
World	**83.3**	**89.7**	**96.5**	**103.5**

Data source: Organisation of Petroleum Exporting Countries (2007)

According to the IEA, world oil resources are sufficient to meet the projected growth in demand to 2030 (International Energy Agency, 2007c, p. 81). The IEA projects that OPEC countries collectively will contribute an increasing share to the world oil market, as they hold the bulk of remaining proven oil reserves and production costs are generally lower than elsewhere (International Energy Agency, 2007, p. 81). As consequence, the IEA is expecting OPEC's share of world oil production to increase from 42 per cent in 2006 to 47 per cent in 2015, and to 52 per cent in 2030. The IEA's forecasts of world oil production are contained in Table 8 below.

Table 8 **International Energy Agency Estimates of World Oil Production (million barrels/day)**

Region/Country	2006	2010	2015	2030	2006-2030*
Non-OPEC	47.0	48.6	50.3	53.2	0.5%
OECD	19.7	18.7	18.3	18.2	-0.3%
Transition economies	12.4	14.0	14.9	17.2	1.4%
Developing countries	14.9	15.8	17.1	17.8	0.7%
OPEC	35.8	40.6	46.0	60.6	2.2%
Middle East	24.1	27.5	31.8	45.0	2.6%
Saudi Arabia	10.5	12.0	13.2	17.5	2.2%
Non-Middle East	11.8	13.1	14.3	15.6	1.2%
OPEC market share	42%	45%	47%	52%	0.9%
Processing gains	1.9	2.0	2.2	2.6	1.3%
World	84.6	91.1	98.5	116.3	1.3%
Conventional oil**	80.9	86.6	92.1	105.2	1.1%
Non-conventional oil***	1.8	2.5	4.2	8.5	6.7%

Note: *Average annual rate of growth. ** Conventional crude oil and condensate. *** Extra heavy oil, natural bitumen, gas-to-liquids and coal-to-liquids. Biofuels not included.

Data source: International Energy Agency(2007c)

While there appears to be sufficient world oil resources to meet the projected growth in world oil demand up to 2020 and beyond, a critical issue is whether there is sufficient production capacity to meet this expected growth in oil demand. The IEA has sounded a note of caution that this outcome depends critically on investment and production policies in key OPEC countries (International Energy Agency, 2007c, p. 81).

While the IEA believes investment and new capacity additions in greenfield projects are expected to increase over the next five years, it has expressed concern as to whether this new production capacity will be sufficient to offset both the decline in existing fields as well as the projected increase in oil demand in the period leading up to 2015 (International Energy Agency, 2007, p. 83). In particular, the IEA expresses concern about the willingness and ability of national oil companies to increase installed capacity once projects now under construction or sanctioned have been brought on stream (International Energy Agency, 2007c, pp. 83-84). In view of these concerns, the IEA warns:

> In view of these uncertainties, a supply-side crunch in the period to 2015, involving an abrupt run-up in prices, cannot be ruled out. (International Energy Agency, 2007c, p. 84)

The IEA observes that OPEC countries have embarked on more than 90 major projects that it estimates will increase gross oil production capacity by 11.4 mbpd on 2006 levels by 2012 (International Energy Agency, 2007c, p. 84). For non-OPEC countries, the IEA estimate that planned gross production capacity additions, including those from non-conventional sources, will be 13.6 mbpd on 2006 levels by 2012 (International Energy Agency, 2007c, p. 84). However, the IEA notes that much of this addition to gross production capacity will be required just to replace the production capacity that will be lost as a result of depletion and associated production decline from existing fields (International Energy Agency, 2007c, p. 84). The IEA notes that additional investment on existing fields could be expected to occur in order to combat the natural decline of output, however, the level of this investment and its impact on mitigating the extent of depletion in existing fields in unknown (International Energy Agency, 2007c, p. 84).

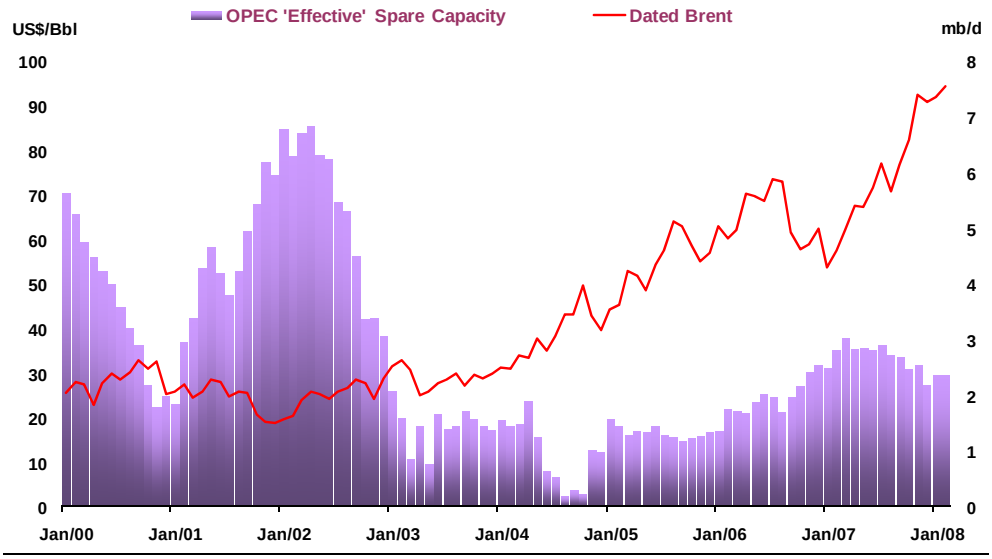
Based on its observed average decline rate of 3.7 per cent per year from fields currently in production, the IEA estimates that there would be a match between global oil supply capacity and demand up to 2012, based on its estimates of new gross production capacity (International Energy Agency, 2007c, p. 84). Based on an average decline rate of 3.7 per cent per year, the IEA estimates that 12.5 mbpd of additional gross production capacity would be required between 2012 and 2015 to meet the increase in expected demand of 4.2 mbpd and the rate of decline in existing fields of 8.4 mbpd (International Energy Agency, 2007c, p. 84). However, the IEA warns that if decline rates were 0.5 percentage points higher than 3.7 per cent per year then there would be a cumulative shortfall in production capacity growth of 2.6 mbpd by 2015, which would be enough to consume most of the world's current spare oil production capacity of 3 mbpd.

4.2.1 Spare Capacity

According to Bob Tippee, the Editor of the *Oil & Gas Journal*, the worldwide oil market requires spare capacity to cushion the market, and thus end-users, against supply disruptions (Tippee, 2007). These cushions in the worldwide oil market take two forms. The first is the level of spare capacity for crude oil production. The second is the level of oil inventories. Tippee observes that when one of those two cushions looks thin then oil traders get nervous (Tippee, 2007). According to Anthony H. Cordeman from the Washington DC based think tank, the Center for Strategic and International Studies, the market's lack of confidence in the ability of oil producers to meet an increase in demand adds a risk premium to any estimates and pushes prices up (Cordesman, 2006).

While the IEA observes that spare production capacity amongst OPEC nations has recovered since the low levels reached in 2004 of less than 1 mbpd to reach nearly 3 mbpd by mid-2007, with further increases likely up to 2009, it projects that spare capacity will begin to decline sharply from 2010 onwards as non-OPEC production growth starts to recede (International Energy Agency, 2007c). The decline in spare production capacity from 2009 could put upward pressure on crude oil prices, which in turn would have negative ramifications on energy security through its impact on the affordability of refined petroleum products for end users. The relationship between spare capacity and the crude oil prices is illustrated in Figure 4 below.

Figure 4 **OPEC spare capacity and oil price**



Data source: Tanaka (2008)

The price of West Texas Intermediate has gone from an average price of US$35.17 a barrel in the March quarter 2004 (Australian Bureau of Agricultural and Resource Economics, 2007b) to trading above US$140 a barrel on the New York Mercantile Exchange during June 2008. One of the contributing factors behind the price rises in crude oil during 2004 was a reduction in worldwide spare capacity due to an unexpected increase in demand for oil and refined petroleum products and a consequent reduction in the amount of spare production capacity. Dr Yergin has characterised this situation in the following terms:

> Asia's growing demand impact became widely apparent only in 2004, when the best global economic performance in a generation translated into a "demand shock" – that is, unexpected worldwide growth in petroleum consumption that represented a rate of growth that was more than double average growth rates of the preceding decade. China's demand in 2004 rose by an extraordinary 16 per cent compared to 2003… US

> consumption also grew strongly in 2004, as did that of other countries. The result was the tightest oil market in three decades (except for the first couple of months after Saddam's invasion of Kuwait in 1990). Hardly any wells were available to produce additional oil. (Yergin, 2006, p. 72)

4.2.2 Conclusions

While supply will continue to expand, a risk for Australian energy security is presented by the prospect that global production expansion may not be sufficient to satisfy global demand growth in the period from 2012 onwards. Ongoing tightness on world oil markets between supply and demand will put upward pressure on prices that would inevitably flow through into Australian prices for refined petroleum products. Such tightness would raise concerns in regard to affordability.

4.3 Reliability of overseas crude oil supplies

Like most other industrial countries, Australia is a net importer of crude oil and other refinery feedstock and is thus dependent on overseas supplies of oil in order satisfy domestic demand. Since the mid-1990s, Australia's proportion of imports from the Middle East have gradually fallen and been partially replaced by crude oil from the South East Asian region (Australian Bureau of Agricultural and Resource Economics, 2008, p. 19). In 2006-07 Vietnam was Australia's largest supplier of imported crude oil accounting for around 26 per cent of imports, followed by Malaysia (15 per cent) and Indonesia (13 per cent) (Australian Bureau of Agricultural and Resource Economics, 2008, p. 23). However, the refined product that Australia sources from South East Asian refineries is dependent on crude oil sources from the Middle East. According to Michael Richardson, a visiting Senior Research Fellow at the Institute of Southeast Asian Studies, South Korea, Singapore and Taiwan each depend on Persian Gulf countries for over 70 per cent of their oil imports (Richardson, 2006).

Australian imports of crude oil and other refinery feedstock is outlined in Table 9 below.

Table 9 **Australian imports of crude oil and other refinery feedstock**

Source	2002-03	2003-04	2004-05	2005-06	2006-07
	ML	ML	ML	ML	ML
Indonesia	5380	4012	3328	3929	3391
Malaysia	2299	4073	4761	3976	3716
New Zealand	990	708	663	638	635
Other Middle East	334	42	158	199	118
Papua New Guinea	1682	1189	1717	2386	2059
Qatar	191	0	77	0	106
Saudi Arabia	719	596	651	829	846
Singapore	719	596	651	829	846
United Arab Emirates	2294	22208	1917	863	2971
Vietnam	6699	5778	6560	6708	6710
Other	3690	3375	3122	3286	3642
Total	27958	23498	26054	24416	25341

Data source: Australian Bureau of Agricultural and Resource Economics (2008)

Given that around 64 per cent of Australia's consumption of crude oil and other refinery feedstock was met by imports in 2006-07 (Australian Bureau of Agricultural and Resource Economics, 2007), the reliability of overseas suppliers is an important consideration in regard to ongoing energy security. Concerns regarding the reliability of oil suppliers have traditionally centred on countries located in the Middle East, particularly those around the Persian Gulf. According to Morse and Myers Jaffe:

> Industrial countries have to worry increasingly about the internal stability of key oil producing countries. New concerns have arisen regarding the threat of international terrorism to important energy targets. (Morse & Myers Jaffe, 2005, p. 66)

In contrast, the South East Asian region that is currently Australia's main source of supply of crude oil has proven to be a relatively stable part of the world. However, consumption of oil in the South East Asian region is likely to continue to increase due to ongoing economic growth. This could result in less crude oil being available for export from the region. The IEA has projected that demand for oil in 'Other Asia' including South East Asia will increase on average by 2 per cent per annum between 2006 and 2030. Similarly, OPEC has projected that demand for oil in South East Asia will increase by around 60 per cent between 2005 and 2020 (Organisation of Petroleum Exporting Countries, 2007, p. 22). Increasing consumption of oil in South East Asia may result in less oil being available for export, with Australia most likely having to find

additional alternative sources of supply. As Professor Michael Wesley from Griffiths University has suggested:

> The Asia-Pacific region's rapid rates of projected economic growth mean that oil exporters in Southeast Asia will increasingly consume more of the oil products they produce. (Wesley, 2007, p. 26)

The most obvious source of alternative supplies of oil to replace any reduction in the availability of supplies from South East Asia is the Middle East OPEC member countries. However, increasing dependence on oil sourced from the Middle East has implications for the level of global energy security as it is perceived be an unstable region of the world. The Middle East has been the scene of numerous wars and terrorist attacks as well as a revolution. As Sadad al-Husseni, a former executive with Saudi Aramco, has observed:

> Global geopolitical factors have always played a role in determining the level of "security" in the oil markets and therefore have an important impact on oil prices.
>
> The regional conflicts in the Middle East, home to over 65 per cent of the world's oil reserves and 30 per cent of global oil production, have had a particularly crucial role in this regard. (al-Husseini, 2004, p. 14)

Dr Daniel Yergin has commented that in the aftermath of the oil embargo of 1973 and the Iranian Revolution of 1979-80, the principal focus of energy security was narrow, focusing on the reliability of the flow of oil, principally from the Middle East, and the response to and management of any disruption (Yergin, 2005, p. 60). Similarly, the World Economic Forum has observed that "[e]nergy security issues have traditionally focused on crude oil supply disruptions in the Middle East." (World Economic Forum & Cambridge Energy Research Associates, 2006, p. 11)

The first world oil crisis began in October 1973, when 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). 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. 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 eventually led to the creation of the IEA in November 1974.

The second world oil crisis occurred in the aftermath of the 1979 Iranian Revolution when oil production and exports from Iran dramatically collapsed from November 1978 to April 1979. During the Iran-Iraq war that broke out in 1980 following Iraq's invasion of Iran, oil production and exports from both Iran and Iraq fell due to many reciprocal attacks on oil fields, oil infrastructure and oil tankers.

In 1990 Iraq invaded Kuwait that precipitated the first Gulf War when a US led Coalition of nations liberated Kuwait from Iraqi occupation in 1991. Following the first Gulf War, the World Economic Forum has observed that the world passed into a decade of lower oil prices and overconfidence about energy security (World Economic Forum & Cambridge Energy Research Associates, 2006, p. 11). However, since the terrorist attacks on the United States on 11 September 2001 and in light of recent events in the Middle East, concerns regarding energy security have re-emerged. According to Dr Daniel Yergin, concerns regarding energy security have now taken on a much broader focus:

> The terrorist attacks of September 11, 2001, widened the focus again, back to the whole system – that is, the security of the infrastructure, the entire supply chain that stretches around the world from production and gathering facilities to distribution to consumers. (Yergin, Energy Security and Markets, 2005, p. 60)

In 2003 the US led Coalition invasion of Iraq led to the second Gulf War. While the second Gulf War ended in a relatively short period with the collapse of the Iraqi regime of Saddam Hussein, reconstruction of the country and the restoration of law and order proved to be more problematic with the continuation of an ongoing insurgency that has resulted in suicide bombings, assignations, and attacks against oil facilities and infrastructure.

According to Yergin, the Middle East faces continuing ongoing challenges to its stability presented by demographic pressures, generational change, the rise of political Islam, the threat to political order and infrastructure posed by terrorist organisations, and potential regional conflicts (Yergin, 2005, p. 53). This in turn raises questions in regard to the internal stability and cohesion of Saudi Arabia, the largest oil producer in the world and the country with the largest oil reserves. A disruption in the supply of oil from Saudi Arabia would flow through to world oil markets, resulting in substantial price increases with detrimental consequences for the world economy. As Morse and Myers Jaffe have predicted:

> There simply is no way for the world to forgo Saudi oil without an enormous increase

> in oil prices and untold damage to the world economy. (Morse & Myers Jaffe, 2005, p. 84)

History suggests that any regime change in Saudi Arabia brought about through armed insurrection would have dire consequences for the supply of oil. Both Libya and Iran suffered from substantial declines in oil production following revolutions. According to Morse and Myers Jaffe, one of the reasons for the decline in oil production following a revolution is the loss of technical expertise:

> Revolutions are propitious times for retaining technical capability and sustaining human resources. When revolutions take place, those working in the petroleum sector have mobility to relocate internationally. Once they emigrate, it is extremely difficult for the new regime to maintain output prior to previous levels. (Morse & Myers Jaffe, 2005, p. 85)

Since May 2003 there have been several major terrorist attacks in Saudi Arabia launched against targets associated with the oil industry. One of the primary motivating factors behinds these attacks is probably a desire to directly threaten the energy security of industrialised nations, as Professor Michael Klare of Hampshire College has commented:

> Oil is seen by many terrorist groups as an attractive target in the struggle between militant Islam and its enemies, in part because of its symbolic importance as the major expression of Western intervention in the Middle East and in part because of its critical role in sustaining the West's energy-intensive economies. (Klare, 2007b, p. 142)

In May 2003, there were suicide bombing attacks carried out against three compounds for foreign oil workers in the city of Riyadh in Saudi Arabia containing a large number of Americans and Westerners. These attacks have been attributed to Al Qaida and were responsible for killing 35 people and wounding over 160 people. In May 2004 terrorists attacked two oil industry installations and a compound for foreign oil workers in the city of Khobar in Saudi Arabia, taking more than 50 hostages and killing 22 of them.

Fears have been expressed that terrorist attacks in Saudi Arabia directed against foreign oil workers might trigger a fall in oil production in the event that foreign oil workers decided to leave. While the families of many foreign oil workers have been relocated to other countries in the Persian Gulf such as Bahrain, there has been no mass exodus of foreign oil workers from Saudi Arabia.

In February 2006 there was an attempted suicide terrorist attack against the world's largest oil processing facility at the Abqaiq plant in Saudi Arabia. The Abqaiq plant handles around two-thirds of Saudi Arabia's oil output. The attack was thwarted by Saudi Arabian security forces protecting the plant.

Sen and Babali have assessed that the impact of terrorist attacks targeting foreign oil workers and oil production infrastructure have so far caused minimal disruptions to supply although it has built in a risk premium in the price of oil:

> … terrorist attacks in Saudi Arabia targeting foreign oil workers and oil fields have not yielded great effects and interruptions to oil supply except fuelling oil prices. (Sen & Babali, 2006, p. 1520)

Another possible source of a supply disruption from the Middle East could be in relation to continuing tensions over Iran's nuclear program. Iran's nuclear program has been the subject of several resolutions by the United Nations Security Council. United Nations Security Council Resolution 1696 was adopted by the United Nations Security Council on 31 July 2006. The resolution, which was proposed by China, France, Germany, the Russian Federation, the United Kingdom and the United States, demanded Iran halt its uranium enrichment program.

United Nations Security Council Resolution 1737 was unanimously passed by the United Nations Security Council on 23 December 2006. The resolution, sponsored by France, Germany and the United Kingdom, imposed sanctions against Iran for failing to stop its uranium enrichment program following resolution 1696. It banned the supply of nuclear-related technology and materials and froze the assets of key individuals and companies related to the enrichment program. United Nations Security Council Resolution 1747 that tightened sanctions imposed on Iran in connection with that nation's nuclear program, was adopted unanimously by the United Nations Security Council on 24 March 2007. More recently the United Nations Security Council Resolution 1803 was adopted on 3 March 2008 which approved a new round of sanctions against Iran as well as requiring Iran to suspend all uranium enrichment, regardless of its location in Iran, as well as research and development associated with centrifuges and uranium enrichment.

Some have speculated that competition between nations in pursuit of overseas oil reserves are becoming a new source of geopolitical tensions that could provide the trigger for possible supply disruptions in the future. In particular, concerns have focused on the practice of Chinese national oil companies of taking equity positions in oil producing capacity overseas. The US-China Economic and Security Review Commission, an agency of the US Government, commented in October 2007 that:

> … China's strategy of acquiring equity oil overseas is an attempt to lock up supplies that, in a time of crisis, could significantly affect the global oil market and subsequently, the United States' ability to acquire oil. (U.S.-China Economic and

Security Review Commission, 2007, p. 178)

- China's pursuit of equity oil acquisitions is contrary to international commercial practices related to energy that support use of the market, and allocation of available petroleum supplies through international cooperation in the event of an emergency.
- In pursuing some of its global energy interests, China aids regimes operating contrary to US foreign policy interests, such as the genocidal government in Sudan and Iran's government that is attempting to develop its own nuclear capability.
- The bilateral relationships China is building around the world – many if not most of them largely motivated by its quest for energy supplies and other resources – have resulted in an increase of its global economic, political, diplomatic, and cultural influence that has the potential to challenge US interests. (U.S.-China Economic and Security Review Commission, 2007, p.185)

On the other hand, Dr Yergin has dismissed concerns regarding increasing geopolitical tensions arising from competition between nations to secure overseas oil reserves:

> Despite all the attention being paid to China's efforts to secure international petroleum reserves, for example, the entire amount that China currently produces per day outside of its own borders is equivalent to just a fraction of the daily production of one of the supermajor oil companies. If there were a serious controversy between the United States and China involving oil or gas, it would likely arise not because of competition for the resources themselves, but rather because they had become part of large foreign policy issues (such as a clash over a specific regime or over how to respond to Iran's nuclear program). Indeed, from the viewpoint of consumers in North America, Europe, and Japan, Chinese and Indian investment in the development of new energy supplies around the world is not a threat but something to be encouraged, because it means there will be more energy available for everyone in the years ahead as India's and China's demand grows. (Yergin, 2007)

Similarly, Flynt Leverett and Pierre Noel have opined that the involvement of Chinese national oil companies in overseas exploration and production activities "should bring more oil, not less, to market" (Leverett & Noel, 2006).

All Australian oil refiners consulted by ACIL Tasman during the course of stakeholder consultations rated the current reliability of overseas oil suppliers as extremely high and that any import supply disruptions experienced were primarily due to shipping delays. The views expressed to ACIL Tasman were consistent with the views expressed by BP to the Australian Senate Rural and Regional Affairs and Transport Committee 2006 inquiry into Australia's future energy supply that:

> BP believes there is no direct issue about availability. Oil – whether crude or product – is a mature internationally traded commodity. BP has imported virtually all of its crude over the past 20 years, and we cannot recall any major issue of availability during this period. (BP Australia Pty Ltd, 2006)

One refiner commented that while overseas suppliers of crude oil were reliable at the macro-level, there were occasional problems encountered at the micro-level with individual oil fields. The oil refiner observed that infrastructure everywhere was stretched with oil selling at over US$100 a barrel as suppliers tried to produce as much as possible and delaying routine maintenance as a consequence.

Australian oil refiners rated the prospects of disruptive events in the Middle East as being the cause behind any future disruption in the supply of oil to Australia as extremely low. While Australian oil refiners acknowledged that disruptive events in the Middle East would inevitably feed into higher world crude oil prices and may be the source of some tightness on world oil markets, they were sceptical about whether the supply of oil from overseas could be cut off altogether. The view of some Australian oil refiners was that it was not in the economic interests of Middle Eastern countries to have any ongoing threats to oil supplies as their economies were dependent on oil revenues. The general view of Australian oil refiners was that as long as Australian consumers were prepared to pay the going price, then oil would definitely be available from overseas.

Some Australian oil refiners accepted that they may have to look further afield in future in order to source oil for their refineries, particularly from the Middle East and Persian Gulf countries. On the other hand, some Australian oil refiners were sceptical regarding the general presumption that Australia would inevitably become increasingly dependent on the supply of oil from the Middle East.

While it was accepted that demand for refined petroleum products would increase in the South East Asia region due to economic growth, some Australian oil refiners did not believe that it necessarily followed that increasing demand for oil for refining purposes within South East Asia would necessarily mean that the supply of oil from South East Asia would diminish for them. The view was expressed that existing refineries as well as new refining capacity coming online in the South East Asian region were capable of refining heavy sour crudes and that national oil companies in the South East Asian region would prefer to process cheaper heavy sour crudes from the Middle East in their own refineries and sell their sweet light crudes on world oil markets at a premium. On this basis there was a belief amongst some Australian oil refiners

that there would still be plenty of sweet light crudes available for purchase from South East Asia. There was also the belief on the part of some Australian oil refiners that they would always be willing to pay more for sweet light crude than refiners in South East Asia because they were able to produce more high value products.

Most Australian oil refiners expect that West Africa will become a major source of oil for refining purposes in Australia in future. Caltex commented that it was already sourcing oil from West Africa. The *Oil & Gas Journal* reported in February this year that offshore West Africa was poised to become an important source of oil for global consumption with 6.5 bb of oil having been discovered in the region over the past 2 years (Izundu, 2008, p. 31). West African oil is typically sweet light crude which is ideal for use in Australian refineries. As Stephanie Hanson from the New York based think tank the Council on Foreign Relations has observed in relation to West Africa:

> The region's oil is light and sweet, making it easier and cheaper to refine than Middle Eastern oil. (Hanson, 2007)

One potential problem with West Africa as an emerging source of supply for oil is that it is also perceived as an unstable region of the world where countries are subject to civil unrest, violence, insecurity and corruption. For example, militant groups operating in Nigeria's southern oil-producing region regularly sabotage oil pipelines and seize local and expatriate oil workers as hostages. However, given that most of the oil is located offshore, this means there is a reduced risk of violence (Hanson, 2007).

Another possible source of oil for Australia in future is Russia's Sakhalin Island located in the North Pacific. The EIA estimate that recoverable oil around Sakhalin Island is almost 7 bb (Energy Information Administration, 2008).

South American could also be another possible source of oil for Australia in the future given recent large discoveries in deep water off the coast of Brazil. In November 2007 the Brazilian Government along with the Brazilian national oil company Petroleo Brasileiro SA announced that the Tupi oil field off Rio de Janeiro state contained 5 to 8 bb of recoverable oil (Izundu, 2007). In April 2008 the head of Brazil's National Petroleum Agency that regulates the Brazilian oil industry, Mr Haroldo Lima, commented that another field close to the Tupi oil field known as the Carioca-Sugar Loaf could contain as much as 33 bb of recoverable oil (Anonymous, 2008).

Concern was raised by one Australian oil refiner regarding possible short-term imbalances in the crude oil tanker market around 2010 and 2011, due to the phasing out of single hulled tankers, albeit that any imbalances would only

likely be temporary. The International Maritime Organisation has set a deadline of 2010 for the phase-out of all single hulled tankers. The IEA has noted that the phasing out of all single hulled tankers is a potential threat to vessel supply (International Energy Agency, 2007b, p. 75). However, there are several factors mitigating any short-term imbalances in the supply of tanker vessels.

According to the IEA there are more tankers on order today than at any point since the shipbuilding boom of the early 1970s, with a current orderbook of around 140 million tonnes carrying capacity as compared with just 73 million at the end of 2003 (International Energy Agency, 2007b, p. 74). The IEA observes that today's orderbook implies that tankers to be delivered by the end of 2010 equate to almost 38 per cent of existing fleet supply in cargo-carrying terms (International Energy Agency, 2007b, p. 74). McQuilling Services, marine transport advisers, have noted that there will be a double digit increase in the supply of tanker vessels in 2009 as measured by carrying capacity (McQuilling Services LLC, 2008). In addition, McQuilling Services notes there is a considerable program underway to convert single hulled tankers into double hulled tankers and that the "2010 effect" on the supply of tanker vessels has been drastically diminished as a consequence (McQuilling Services LLC, 2008).

4.3.1 Conclusions

Even in the event of a major oil supply disruption overseas, it is highly unlikely that overseas oil supply would be cut off for Australia altogether. It is far more likely that the impact of a major oil supply disruption would be felt through higher oil prices as they have in the past. On this basis, the ongoing reliability of overseas suppliers of crude oil in the period leading up to 2020 is rated as extremely high.

4.4 Reliability of overseas refined product supplies

With the closure of the Port Stanvac refinery near Adelaide in 2003, and the reduction in production capacity of the Altona refinery, the south east corner of Australia has gone from being a net exporter to a net importer of refined petroleum products. On the other hand, the Northern Territory and North West Australia have traditionally relied on imported refined product being shipped in directly from overseas.

Singapore is the third largest refining and marketing centre in the world, after Rotterdam and Houston, and has traditionally been the major source of refined petroleum products imported into Australia. For this reason Australia product prices are usually benchmarked against Singapore product prices in regard to

supply contracts.

Adelaide and Darwin, as well as North West Australia, are heavily dependent for their supplies of refined petroleum products on overseas imports. Since June 2003, Australian imports of refined petroleum products have more than tripled. Australia's recent imports of refined petroleum products and the country of source of those products are outlined below in Table 10.

Table 10 **Australian imports of refined petroleum products by source**

Source	2002-03	2003-04	2004-05	2005-06	2006-07
	ML	ML	ML	ML	ML
Indonesia	57	281	162	98	17
Korea	144	280	237	961	818
Malaysia	45	97	93	220	8
Middle East	140	1036	93	220	642
New Zealand	17	3	4	84	96
Singapore	2832	5904	7395	8452	7666
United States	407	434	423	456	378
Other*	1855	3370	2334	4163	8643
Total	5497	11405	11236	15125	18268

Note: * Includes confidential imports of refined products
Data source: Australian Bureau of Agricultural and Resource Economics (2008)

All of the Australian refiners consulted by ACIL Tasman were of the view that overseas suppliers of refined petroleum products were extremely reliable. The view was expressed by one refiner that Australia had become an attractive market for diesel on the part of Asian refiners due to the recent expansion of the mining industry and the consequent increasing demand for diesel. The reliability of overseas suppliers of refined petroleum products was also highly rated by independent wholesalers consulted. The only concern referred to was the tightness in the availability of petrol compliant to Australian fuel specifications. This issue is addressed in section 4.4.1 below.

4.4.1 Availability of fuel to meet Australian standards

In July 2001 the Commonwealth Government announced the first stage of new national fuel standards for petrol and diesel that were progressively introduced between January 2002 and January 2006. In regard to petrol, the standards included limits on the amount of olefins, methyl tertiary-butyl ether (MTBE), sulphur, aromatics and benzene. Probably the most significant change was limiting the amount of MTBE allowed in petrol to one per cent by volume as from 1 January 2004. While MTBE is not used in Australian refineries, it is still commonly used in Asian refineries. In regard to diesel the major change was imposing a limit on the amount of sulphur to 500 parts per million (ppm) from 31 December 2002 rising to 50 ppm from 1 January 2006.

The new national fuel standard for petrol has made it more difficult to source compliant product from within the Asian region. The Australian Competition and Consumer Commission (ACCC) commented last year on the difficulty of

sourcing product to the new Australian fuel standards when they were first introduced:

> The ACCC understands that when the Australian fuel specifications were first introduced, there was an immediate supply constraint on international markets as few overseas refiners refined or were capable of refining fuel to Australian specifications at that time. (Australian Competition and Consumer Commission, 2007a, p. 106)

According to both the Australian Institute of Petroleum (AIP), the peak body representing the domestic oil refiners, and Caltex, the new national fuel standard for petrol increased the relative wholesale petrol price by around 2.5 cents per litre (Australian Institute of Petroleum, 2006) (Caltex Australia Ltd, 2006, p. 8).

In July 2004 the Commonwealth Government announced further changes to national fuel standards for petrol and diesel. In regard to petrol it was announced that sulphur in premium unleaded would fall from 150 ppm to 50 ppm from 1 January 2008. In regard to diesel it was announced that sulphur would be capped at 10 ppm from 1 January 2009 (ultra low sulphur diesel).

The ACCC has recently noted that the lack of alignment of Australian fuel standards with major overseas standards has reduced the supply of Australian grade refined petrol available to independent importers (Australian Competition and Consumer Commission, 2007a, p. 210). However, based on consultations for this study the sourcing of petrol compatible with Australian fuel standards is not just a problem isolated to potential independent importers. All suppliers of petroleum products consulted by ACIL Tasman during this study referred to the difficulty of sourcing petrol compatible to Australian fuel standards within the Asian region, particularly on a spot basis. Even Australian oil refiners with overseas affiliate refiners in the Asian region expressed the view that it could be difficult to procure petrol compatible with Australian fuel standards. The Australian Government has recently opined that Australia's fuel standards are already aligned to international standards when taking into account environmental and other objectives and moves in recent years by Asian countries to adopt more stringent standards (Rudd & Bowen, 2008).

During the course of stakeholder consultations, one party estimated that there was only sufficient refining capacity currently available in the Asian region to double the amount of imported petrol usually coming into Australia compatible with Australian fuel standards.

The impact of tighter Australian fuel specifications on the availability of petrol was correctly foreseen by the former Commonwealth Government when it

commented in its 2004 Energy White Paper that:

> The movement of Australian fuel standards away from those applying more generally in the Asian region can have an impact on the availability of competitively priced imports. A recent example of this was the reduction in the permitted level of olefins in petrol and the effective prohibition of the additive, methyl tertiary butyl ether (MTBE), from petrol in Australia from 1 January 2004. Petrol meeting these standards can be supplied from Asia but it is not as widely available as petrol containing a higher volume of olefins and/or MTBE, and it commands a small price premium (consistent with cleaner fuels costing more to produce). These impacts were anticipated by the Australian Government when it set the standards in 2001. (Commonwealth of Australia, 2004, p. 89)

In its submission to the 2007 ACCC inquiry into the price of petrol, Caltex estimated that there were 11 cargoes of Australian grade petrol currently reliably available for purchase each month within the Asian region (Caltex Australia Ltd, 2007, p. 25). This estimate was based on Caltex's trading experience and other traders' experience who were actively engaged in purchasing petrol to cover Caltex's import requirements. This estimate of 11 cargoes did not include cargoes already supplied by Shell and ExxonMobil refineries in Singapore to their Australian based affiliates. The table from the Caltex submission of the availability of Australian grade petrol from regional refineries is reproduced below as Table 11.

Table 11 **Estimate of availability of Australian grade petrol from regional refineries in 2007**

Country and refinery	Australian grade cargoes available per month
Taiwan	
CPC	1-2
FPC	0
China	
Zhenhai	1
Gaojiao	0
Hainan	0
Qindao	0
Korea	
GS Caltex	1
S Oil	0
SK	0
Japan	1
Thailand	
Thai Oil	0
Star Refinery	0
Singapore	
Shell	1
ExxonMobil	4
Singapore Blenders	1
India	
Reliance	0
Essar	0
Total	11

Data source: Caltex Australia Ltd (2007, pp. 25-26)

Despite current difficulties in securing petrol consistent with Australian fuel specifications, numerous stakeholders consulted commented that the situation had significantly improved in recent years. This is consistent with the views of BP which commented in its submission to the ACCC inquiry last year that:

> We have noticed a significant increase in availability of Australian Specification products from within the region over the past couple of years, particularly from North Asia. This has resulted from refinery upgrades to meet tigher specifications and an increase in surplus export availability from these locations over and above domestic demands. (BP Australia Pty Ltd, 2007, p. 16)

In regard to the importation of petrol into Australia, it is important to note that BP, like the independent wholesalers, has no overseas affiliates in the Asian region from which to call upon in order to source petrol.

It was the expectation of all stakeholders consulted that it would become progressively easier to source petrol compatible with Australian standards as new refining capacity in the Asian region came online and as fuel specifications in the Asian region catch up with tighter standards amongst Western countries. This is consistent with the views of independent importers to the 2007 ACCC inquiry into petrol that it was becoming less difficult to obtain petrol consistent with Australian fuel standards in the Asian region (Australian Competition and Consumer Commission, 2007a, p. 212).

In India, Reliance Petroleum is constructing a new 580,000 bpd export refinery at Jamnagar, adjacent to its existing refinery with a production capacity of 660,000 bpd, that is due to be completed by the end of 2008. It is expected that the new refinery will be able to produce fuels to the European fuel specifications of Euro 4 and Euro 5 and is expected to be able to produce petrol meeting Australian fuel specifications. One party commented during the course of ACIL Tasman's consultations that while Australia was currently heavily dependent on Singapore refineries for sourcing imported supply of refined petroleum products, they expected that this dependency would eventually switch across in the longer term to the new Reliance Petroleum refinery.

In Vietnam, a 140,000 bpd refinery is being constructed at Dung Quat and is expected to begin commercial operations in early 2009. A second refinery at Nghi Son is expected to have a refining capacity of 200,000 bpd and come online in 5 years time but construction has yet to commence. Vietnam is also considering the feasibility of constructing a third refinery in Vung Ro province in southern Vietnam. It is expected that these two refineries will be able to produce to Euro 4 and Euro 5 fuel standards.

Media reports suggest that Kuwait is pressing ahead with construction of a new 650,000 bpd refinery at Al-Zour that will be geared towards exports. In addition, there are also reports that CPC and FPCC in Taiwan are also considering building new refineries or expanding existing refineries (Energy Information Administration, 2006, p. 3). Furthermore, consideration is also being given to building 400,000 bpd refineries at Yanbu and Jubail in Saudi Arabia that will use heavy sour crudes as feedstock with production targeted towards export markets.

According to energy consultants Wood Mackenzie, the Asia Pacific region is moving towards Euro 4 fuel specifications:

> Whilst the majority of Asia pacific countries are planning to lower the sulphur specifications of transportation fuels to meet either Euro IV or sulphur-free specifications, the timings for changes in legislation vary across the region. By 2011

> most of the countries plan to reach 50 ppm sulphur levels for both [petrol] and diesel. (Wood Mackenzie, 2007)

In contrast to petrol, no suppliers raised any concerns regarding the difficulty in the availability of diesel and jet fuel compatible with Australian standards in the Asian region. Standards for diesel and jet fuel in Australia are much more compatible with grades commonly traded in the Asian region.

There does not appear to be any problems regarding the availability of diesel and jet fuel in the Asian region able to comply with Australian fuel standards. The problem regarding the lack of refinery capacity in the Asian region able to comply with Australian fuel standards is gradually being addressed through improvements in fuel standards across the Asian region as well as new refining capacity coming online. Unless Australian fuel standards for petrol are further tightened, the supply situation for sourcing petrol compatible with Australian fuel standards from the Asian region will continue to improve.

4.5 Security of international sea lanes

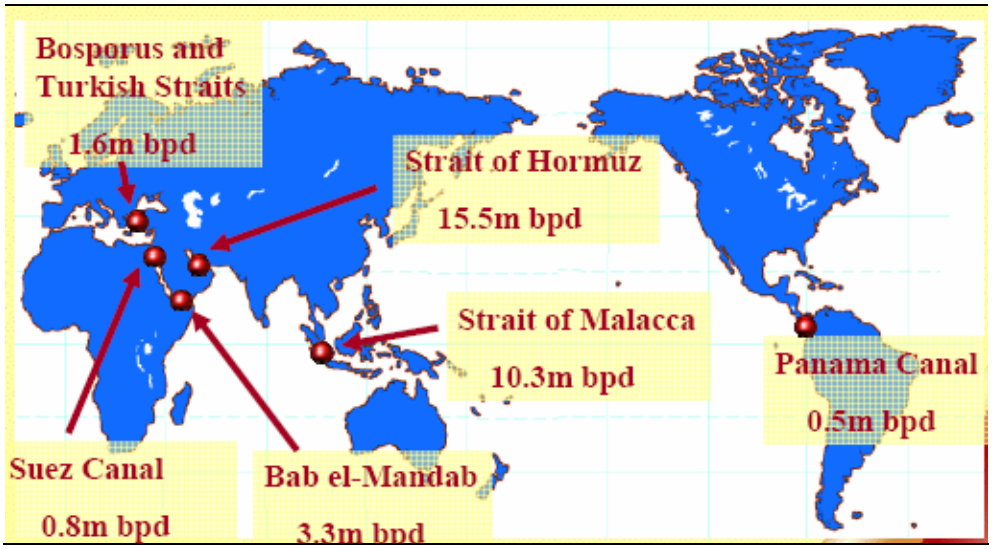
The global movement of oil creates potential threats to supply from piracy, terrorism and warfare along international sea lanes. In October 2002 Al Qaida carried out an attack when a boat packed with explosives rammed a French oil tanker, the *Limberg*, while it sailed off the coast of Yemen. This attack blew a hole in the hull of the ship and resulted in the death of one sailor and the spillage of 100,000 barrels of oil.

In 2007 total world oil production was approximately 85 mbpd and around one-half, or over 43 mbpd was moved by oil tankers on fixed maritime routes (Energy Information Administration, 2007). As a result, risks to maritime flows of oil may threaten the energy security of numerous nations including Australia, as our ongoing energy security in liquid fuels is dependent on the ongoing supply of overseas sourced crude oils and refined petroleum products. The dangers facing oil tankers as they carry their cargoes over long distances has become an increasingly topical issue in government policies around the world.

Chokepoints are narrow channels along widely used global sea routes and are a critical part of global energy security due to the high volume of oil traded through their narrow straights (Energy Information Administration, 2007). The blockage of a chokepoint, even temporarily, can lead to substantial increases in total energy costs (Energy Information Administration, 2007). Chokepoints also leave oil tankers vulnerable to theft from piracy, terrorist attacks, and political unrest in the form of wars or hostilities as well as shipping accidents

(Energy Information Administration, 2007).

Figure 5 **Global Sea Lane Choke Points**



Data source: Masuda (2002)

There are two world oil transit chokepoints that have an important bearing on Australian energy security in liquid fuels; the Strait of Hormuz in the Middle East and the Strait of Malacca in South East Asia.

Over 16 per cent of the crude oil and other refinery feedstock imported to Australia during 2006-07 was sourced from Saudi Arabia and the United Arab Emirates located in the Persian Gulf (Australian Bureau of Agricultural and Resource Economics, 2008, p. 23). As a consequence, the Strait of Hormuz leading out of the Persian Gulf is one of two world oil transit chokepoints of significance to Australia.

The Strait of Hormuz is located between Oman and Iran and connects the Persian Gulf with the Gulf of Oman and the Arabian Sea (Energy Information Administration, 2007). It is the world's most important oil chokepoint due to its daily oil flow of 16.5 to 17 million barrels in 2006, equating to roughly two-fifths of all seaborne traded oil (Energy Information Administration, 2007). At its narrowest point the Strait of Hormuz is 9.8 kilometres wide, and consists of channels for inbound and outbound tanker traffic, as well as a buffer zone.

While the Strait of Hormuz has never been closed to shipping, oil shipping was attacked through the laying of sea mines during the Iran-Iraq war of 1980-1988. During this time, there were 543 attacks on ships with approximately 200 merchant sailors killed (Sen & Babali, 2006, p. 1518). There have been heightened concerns regarding the safety of maritime commerce in the Strait of Hormuz following the terrorist attacks on the United States on 11 September

2001 and growing tensions over Iran's nuclear policy.

Closure of the Strait of Hormuz would require the use of alternative supply routes at increased transportation costs. In response to growing concerns about the risk among Persian Gulf oil exporters, a trans-Gulf pipeline has been proposed (International Energy Agency, 2007, p. 169). The line would start in Kuwait, cross Saudi Arabia and the United Arab Emirates and end in Oman, Yemen or Fujairah outside the straits, picking up oil along the way although it is uncertain whether the project will receive political and financial backing (International Energy Agency, 2007, p. 169).

Dennis Blair, a former Commander in the US Pacific Naval Command, and Professor Kenneth Lieberthal, of the University of Michigan, have argued that that maritime oil tanker traffic is much less vulnerable than has generally been presumed for a number of reasons (Blair & Lieberthal, 2007). They argue that lesser naval powers lack the capability to blockade major shipping routes even when engaged in an all-out war and recent design and performance trends in oil tankers make it increasingly difficult to disrupt shipments. The size and strength of oil tankers has increased markedly over the last two decades while the greater number of oil tankers travelling at higher speeds make them increasingly difficult to identify and intercept.

Blair and Lieberthal believe that there are only a couple of locations where potential risks to international tanker trade are great: the Strait of Hormuz, and the Strait of Malacca and the Strait of Singapore. However, Blair and Lieberthal argue that there is little danger of these waterways being blocked.

While Blair and Lieberthal recognise that Iran has the capacity to attack the Strait of Hormuz from its shore, it runs the risk of interfering with the shipping of many neutral nations. Hence, Blair and Lieberthal contend that a coalition of nations, including the United States, would quickly develop to ensure and safeguard the free flow of oil from the Persian Gulf.

Similar to Blair and Lieberthal, Anthony Cordesman of the CSIS believes that Iran has the military capability to close down shipping in the Persian Gulf for only a limited amount of time:

> Iran could not "close the Gulf" for more than a few days to two weeks even if it was willing to sacrifice [military] assets, suffer massive retaliation, and potentially lose many of its own oil facilities and export revenues… It would almost certainly lose far more than it gained from such a "war"… (Cordesman, 2007, p. 6)

Professor Klare observes that US Navy warships and planes already conduct regular patrols of the Strait of Hormuz to thwart any action on the part of Iran to close the strait:

> To ensure that Iran will not try to close the strait by firing on tankers crossing through it, [US Navy] ships and planes patrol the waterway daily and remain poised for an immediate clash with Iranian forces. (Klare, , 2007, p. 145)

The other world oil transit chokepoint of great importance to Australia is the Strait of Malacca, located between Indonesia, Malaysia, and Singapore, which links the Indian Ocean to the South China Sea and the Pacific Ocean. The Strait of Malacca is the world's second busiest commercial shipping lane and the key chokepoint in Asia with an estimated daily oil flow of 15 million barrels in 2006 (Energy Information Administration, 2007). At its narrowest point the Strait of Malacca is only 0.5 kilometres wide creating a natural bottleneck, as well as potential for collisions, grounding, or oil spills. Piracy, including attempted theft and hijackings, are a constant threat to tankers in the Strait of Malacca (Energy Information Administration, 2007).

In July 2004 Indonesia, Malaysia and Singapore commenced coordinated naval patrols along the Strait of Malacca in an effort to deter piracy and terrorism. The United States offered to assist in this aim by providing US Navy patrols in 2004, however, this offer was rejected by the Indonesian and Malaysian Governments. Similarly, Japan in 2004 also offered to start coordinating patrols in the Strait of Malacca with littoral countries but this offer was also rejected.

If the Strait of Malacca was blocked, nearly half of the world's oil tanker fleet would be required to reroute around the Indonesian archipelago through Lombok Strait, located between the islands of Bali and Lombok, or the Sunda Strait, located between Java and Sumatra (Energy Information Administration, 2007).

Indonesian and Saudi Arabian companies signed a contract in 2007 to build a US$7 billion pipeline across the north of Malaysia and southern border of Thailand to reduce the amount of tanker traffic through the Strait of Malacca by 20 per cent (Energy Information Administration, 2007, p. 299).

In April 2002 the Asia-Pacific Energy Research Centre, which is part of the Asia Pacific Economic Cooperation forum's (APEC) Energy Working Group, hosted a sea-lane security simulation exercise to test the effects of a major disruption to oil tanker traffic passing through the Strait of Malacca involving participants from almost all APEC countries. The outcome of this exercise has been the development of greater links to other relevant international groups, such as the International Maritime Organisation, and the APEC Transportation Working Group, to share information, expertise, and technical

assistance to strengthen sea lane security (Ryan, 2005).

Australian energy security is also dependent on maritime supply routes through the Indonesian archipelago with over 60 per cent of crude oil imports and other 75 per cent of refined petroleum products coming through Indonesia sea channels (Wesley, 2007, p. 27). According to Professor Michael Wesley of Griffiths University, any decision by the Indonesian Government to close certain crucial straits to the navigation of Australian-bound shipping could potentially lead to a serious supply shortfall in petroleum products (Wesley, 2007, p. 27). On the other hand, any protracted closure of Indonesian sea channels could be overcome through rerouting shipping through the Indian Ocean or the Pacific (Wesley, 2007, p. 27).

However, given recent close relations between Australia and Indonesia, including the undertaking of a feasibility study towards a free trade agreement and enhanced security cooperation arrangements, it is extremely difficult to envisage a situation developing that would see Indonesian waters closed to Australian-bound shipping. The Agreement between Australia and the Republic of Indonesia on the Framework for Security Cooperation (Lombok Treaty) was signed by Foreign Ministers in Lombok on 13 November 2006. The Agreement is forward-looking and aims to deepen and expand bilateral cooperation and exchanges on matters affecting our common security in a modern context. It provides a strong legal framework for encouraging intensive dialogue, exchanges and implementation of cooperative activities to combat terrorism and transnational crime, in the areas of defence, law enforcement, counter-terrorism, intelligence, maritime and aviation security, and in relation to the proliferation of weapons of mass destruction, and emergency management and response. On 7 February 2008, Australian Foreign Minister Stephen Smith and Indonesian Foreign Minister Dr Hassan Wirajuda exchanged notes, bringing the treaty into force.

In relation to the Strait of Malacca, Blair and Lieberthal believe that the countries that could most effectively interfere with oil tanker traffic are the surrounding countries of Indonesia, Malaysia and Singapore. Rather than threatening to interfere with shipping, Blair and Lieberthal maintain that these countries currently cooperate in protecting the Strait of Malacca. While recognising that pirate attacks regularly take place at both ends of the Strait of Malacca, Blair and Lieberthal observe that these are generally hit-and-run robberies and that terrorist groups could achieve little more. Even if terrorists managed to scuttle an oil tanker in the Strait of Malacca, Blair and Lieberthal contend that it would still not block the waterway.

In addition, Blair and Lieberthal maintain that only a navy that can dominate a

large area of water over a sustained period of time can seriously disrupt oil tanker traffic. According to the Blair and Lieberthal, only the US Navy has the capacity to impose and sustain such blockades and that China, India, Japan and Russia are at least 20 years away from developing a similar capacity. However, Blair and Lieberthal maintain that the US Navy has a long tradition of playing the world's maritime policeman to the benefit of trade flows:

> The United States has a very long tradition of promoting and protecting the free flow of trade over the world's seas… Nothing in the United States' foreign policy tradition indicates that the country would abuse its maritime power for its own narrow interests. (Blair & Lieberthal, 2007)

Overall, Blair and Lieberthal have arrived at a buoyant assessment of the threat to maritime oil tanker traffic:

> The resilience of today's tanker fleet and the realities of naval power mean that effecting a serious and sustained disruption of international oil shipping is a much more difficult task than is generally imagined. Even the critical chokepoints of maritime commerce could be kept open in the face of attempts by countries or terrorists to wreak havoc on them. (Blair & Lieberthal, 2007)

Professor Wesley has also recognised the crucial role played by the United States, through the US Navy, as the leading guarantor of the maritime energy trade:

> The US sole guarantee of maritime energy security appears to offer many advantages to Asia's energy hungry powers. With Washington determined to play the role of sole provider of maritime security, the world's energy importers are, in effect, being invited to ride free on a public good paid for by the American taxpayer. (Wesley, 2007, p. 39)

Some of the Australian oil refiners spoken to during the course of ACIL Tasman's consultations commented that the security situation in regard to the world's sea lanes had dramatically improved. Several Australian oil refiners commented that the security situation in the Strait of Malacca had improved due to increased levels of coordination between littoral nations patrolling the Strait. One Australian oil refiner said that while piracy was still a problem in parts of South East Asia, it didn't disrupt the transportation nor supply of oil as oil tankers were generally not targeted.

One shipping company consulted commented that international piracy was a challenge for the entire shipping industry, but that the risks were isolated to particular localities and trouble spots could be avoided.

The prevailing view amongst parties consulted was that pirates usually did not target oil tankers.

4.5.1 Overall assessment

While the security of oil tankers in the sea lanes is a risk that must be managed, it is not considered a critical risk for a number of reasons. Firstly, governments have taken action collectively and individually to protect the safety of tankers from piracy and acts of aggression. This has reduced the likelihood of a significant interruption over the 2008 to 2020 period.

Secondly, an interruption to the critical straits of Malacca and Lombok immediately to the north of Australia would not preclude the use of alternative routes for supply of crude oil and product if such an event should occur. There would be a time factor in rerouting cargoes, which could inevitably lead to disruptions to supplies. However the longer shipping times are not likely to lead to a permanent reduction in oil supplies to Australia although they might lead to higher costs for petroleum products until the problem was solved.

ACIL Tasman therefore considers that over the period from 2008 to 2020, interruptions to shipments of crude oil and refined petroleum products to Australia do not represent a significant risk to Australia's liquid fuels supply security. The risk of a catastrophic event is small. Ongoing action by governments and international organisations to maintain shipping security is of course critical to maintaining this risk status.

4.6 Global investment in liquid fuel infrastructure

There has been a dramatic increase in the price of crude oil since 2004, especially in the period from late August 2007 to May 2008 when spot prices for West Texas Intermediate, the most commonly quoted crude oil benchmark in the Western Hemisphere, broke through the US$100 a barrel level for the first time. The price of West Texas Intermediate has gone from an average price of US$35.17 a barrel in the March quarter 2004 (Australian Bureau of Agricultural and Resource Economics, 2007b) to trading above US$110 a barrel on the New York Mercantile Exchange during the first half of 2008.

Given the dramatic recent increases in the price of oil, a question has arisen as to why the supply of oil has not responded to higher prices. This issue has been addressed by the International Monetary Fund (IMF) in its April 2008 edition of the *World Economic Outlook* (International Monetary Fund, 2008).

According to the IMF the sluggish response of supply to higher oil prices has not been due to a lack of investment as it estimates that nominal oil investment during 2004-06 grew by about 70 per cent (International Monetary Fund, 2008, p. 53). However, the IMF has noted that this has not translated into large real investment increases because of increasing costs arising from the global

scarcity of equipment such as rigs and of services such as skilled labour, that in turn has fed into higher average exploration and development costs (International Monetary Fund, 2008, p. 53). In addition, the IMF found there was no evidence that national oil companies were investing less than international oil companies (International Monetary Fund, 2008, p. 54).

The IMF has found the amount of time it takes, on average, for investment to translate into output has increased, which is associated with the increasing complexity of the projects being undertaken (International Monetary Fund, 2008, p. 55). Based on its analysis, the IMF has concluded that although investment eventually does respond to prices, it is now doing so with a greater lag and more slowly than in the past (International Monetary Fund, 2008, p. 55).

In regard to upstream investment the IEA observes that OPEC countries have embarked on more than 90 major projects that it estimates will increase gross oil production capacity by 11.4 mbpd on 2006 levels by 2012 (International Energy Agency, 2007c, p. 84).

OPEC observed in November 2007 that its member countries are undertaking large investments to expand their oil production capacity (Hamel, 2007). In the medium term, it is claimed that OPEC production capacity growth will be underpinned by over 120 projects with a total cumulative capital expenditure to 2012 likely to exceed US$150 billion (Hamel, 2007, p. 28). According to OPEC, these investments are expected to result in an increase in production capacity of over 5 mbpd from current levels (Hamel, 2007, p. 28). Most of this new crude oil is expected to be medium-to-light and thus compatible with the growth in expected demand for transportation fuels (Hamel, 2007, p. 28). OPEC is also expecting significant production capacity expansion in member countries from natural gas liquids (condensate) and gas-to-liquids projects by almost 2.3 mbpd, reaching an output of 6.6 mbpd by 2012.

For non-OPEC countries, the IEA estimate that planned gross production capacity additions, including those from non-conventional sources, will be 13.6 mbpd on 2006 levels by 2012 (International Energy Agency, 2007, p. 84). The IEA is expecting that the bulk of this new capacity will be in Russia, the Caspian region and in deep-water locations such as the Gulf of Mexico and West Africa.

OPEC is expecting oil production amongst non-OPEC countries to increase before going into a gradual decline. According to OPEC, growth in oil production in non-OPEC countries is underpinned by over 300 greenfield and brownfield development projects, most of which are in the construction phase

(Hamel, 2007, p. 14). Offshore projects, both shallow and deepwater, will account for most of the cumulative increase (Hamel, 2007, p. 14). OPEC is expecting Russia's oil production to increase to around 11 mbpd and then plateau with increased production coming from developments in eastern Siberia and northern areas of the country in addition to increased production in the Caspian region. Partially offsetting production declines in North American, OPEC is predicting production growth to come from deep offshore in the US Gulf of Mexico. OPEC is expecting production growth in Latin American to be predominantly driven by offshore projects in Brazil.

OPEC is expecting the most significant growth in oil production amongst non-OPEC countries to come from non-conventional sources, particularly from expansion in production from Canadian tar sands and increases from coal-to-liquids and gas-to-liquids projects in the United States, China, South Africa and Australia.

There is significant investment going on at the present time in the expansion of world refining capacity. The IEA is expecting global crude distillation capacity to increase by 10.6 mbpd during the period from 2007-2012 with 9.1 mbpd coming from new capacity and 1.5 mbpd coming from capacity creep (International Energy Agency, 2007b, p. 9). The IEA notes that the Middle East and Asia will account for 6.7 mbpd of this new refining capacity, which will exceed regional demand, and that India and Saudi Arabia are developing significant new refineries geared towards export markets (International Energy Agency, 2007b, p. 53). According to the IEA this expansion in refining capacity will arise from:

- 4.0 mbpd due to the expansion of existing refineries mainly in the Asia Pacific region and North America
- 5.1 mbpd from newly constructed distillation capacity largely in the Middle East, China and Other Asia (primarily India)
- 1.5 mbpd from capacity creep at existing refineries in OECD North America, Europe and the Pacific.

The IEA also notes that this new investment in refining capacity should increase the flexibility of the refining sector to process the less sought after heavy sour crudes from the Middle East (International Energy Agency, 2007b, p. 9).

Similarly, OPEC also believes that there will be an expansion in worldwide refining capacity although it is not quite as optimistic on the magnitude of the expansion as the IEA. After making a critical assessment of existing projects and announcements of new refining capacity expansion, OPEC is expecting an increase of 8.5 mbpd in global crude distillation capacity by 2012 with 7.4

mbpd coming from new capacity and 1.1 mbpd coming from capacity creep (Organisation of Petroleum Exporting Countries, 2007, pp. 51-53). OPEC is expecting 70 per cent of the increase in new refining capacity to occur in the Middle East and Asia (Organisation of Petroleum Exporting Countries, 2007, pp. 51).

According to OPEC, its member countries are investing heavily in refining and delivery infrastructure such as pipelines, storage facilities and terminals (Hamel, 2007, p. 28). OPEC comments that very large and complex refineries are being planned or under construction both within member countries and abroad and that member countries are expected to add over 3 mbpd of additional refining capacity by 2012, representing an investment of close to US$50 billion (Hamel, 2007, p. 28).

Both the IEA and OPEC have expressed confidence that existing levels of investment in new tanker shipping for the transportation of oil and refined petroleum products should be sufficient to deal with expected increases in demand and trade flows. The IEA has observed that increased demand for long-haul tanker shipping will come from growth in oil exports to China and United States from Saudi Arabia and West Africa countering the effects of decreased demand for long-haul shipping arising from lower oil exports from the Middle East to OECD Europe and OECD Pacific (International Energy Agency, 2007b, p. 74).

The IEA has observed that the tanker trade is well placed to meet the challenges presented by increasing expected demand. According to the IEA there are more tankers on order today than at any point since the shipbuilding boom of the early 1970s with a current orderbook of around 140 million tonnes carrying capacity as compared with just 73 million at the end of 2003 (International Energy Agency, 2007b, p. 74). The IEA observes that today's orderbook implies that tankers to be delivered by the end of 2010 equate to almost 38 per cent of existing fleet supply in cargo-carrying terms (International Energy Agency, 2007b, p. 74). The IEA opines that a brimming orderbook provides the potential to redress the prevailing vessel undersupply, prompted by weak tanker ordering early this decade (International Energy Agency, 2007b, p. 75).

OPEC comments that projections for future tanker capacity requirements confirm and quantify the expectation that tanker trade and tonnage will grow faster than global demand (Organisation of Petroleum Exporting Countries, 2007, p. 113). OPEC also notes that since 2001 there has been a surge in new tanker deliveries, and the order book is running at high levels through to 2009 (Organisation of Petroleum Exporting Countries, 2007, p. 114).

While investment in liquid fuel infrastructure is certainly occurring both at the upstream and downstream levels, the major concern, as previously discussed in section 4.2 above, is whether supply will be sufficient enough to keep up with increasing demand.

4.7 Summary of reliability of global supplies

4.7.1 Developments since 2004

The major development in the world oil market since the beginning of 2004 has been a tripling in crude oil prices. While concerns persist, and have probably intensified regarding the reliability of supply of oil from the Middle East due to geopolitical factors, there have been no major supply disruptions from the Middle East or anywhere else. All Australian oil refiners rated the reliability of overseas oil suppliers as very high. Despite escalating oil prices since 2004, Australian oil refiners were unanimously of the view that as long as Australian consumers were prepared to pay, there were no problems regarding maintaining ongoing supply of petroleum based liquid fuels.

In relation to the availability of fuel in the Asian region able to comply with Australian fuel specifications, all parties consulted by ACIL Tasman referred to the difficulty of sourcing petrol although they were also of the opinion that the refining capacity of the region had improved to the extent that this was becoming far less of a problem than it had previously been. No concerns were expressed in regard to the availability of diesel and jet fuel compliant with Australian fuel specifications.

Based on the views of stakeholders consulted by ACIL Tasman, it would appear that the security of sea lanes in the Asian region, and the Strait of Malacca in particular, has improved since 2004.

4.7.2 Outlook to 2020

While concerns regarding an immediate peak in world oil production persist in some quarters, there appears to be sufficient reserves of oil in the world to satisfy demand beyond 2020. However, a more immediate concern is whether there will be sufficient production capacity for oil in the world in the period beyond 2012 to satisfy demand. Unless there is a significant ramping up of current investment intentions, there is the possibility that global oil supply will not be adequate enough to keep pace with increasing demand from 2012 onwards, thus putting upward pressure on oil and liquid fuel prices. Tightening of oil supply could precipitate further significant increases in the price of oil that would have implications for the affordability of liquid fuels.

On the other hand, developments in the Asian region through further tightening of fuel standards, as well as new refining capacity coming online geared towards export markets, is expected to increase the availability of petrol compliant with Australian fuel specifications.

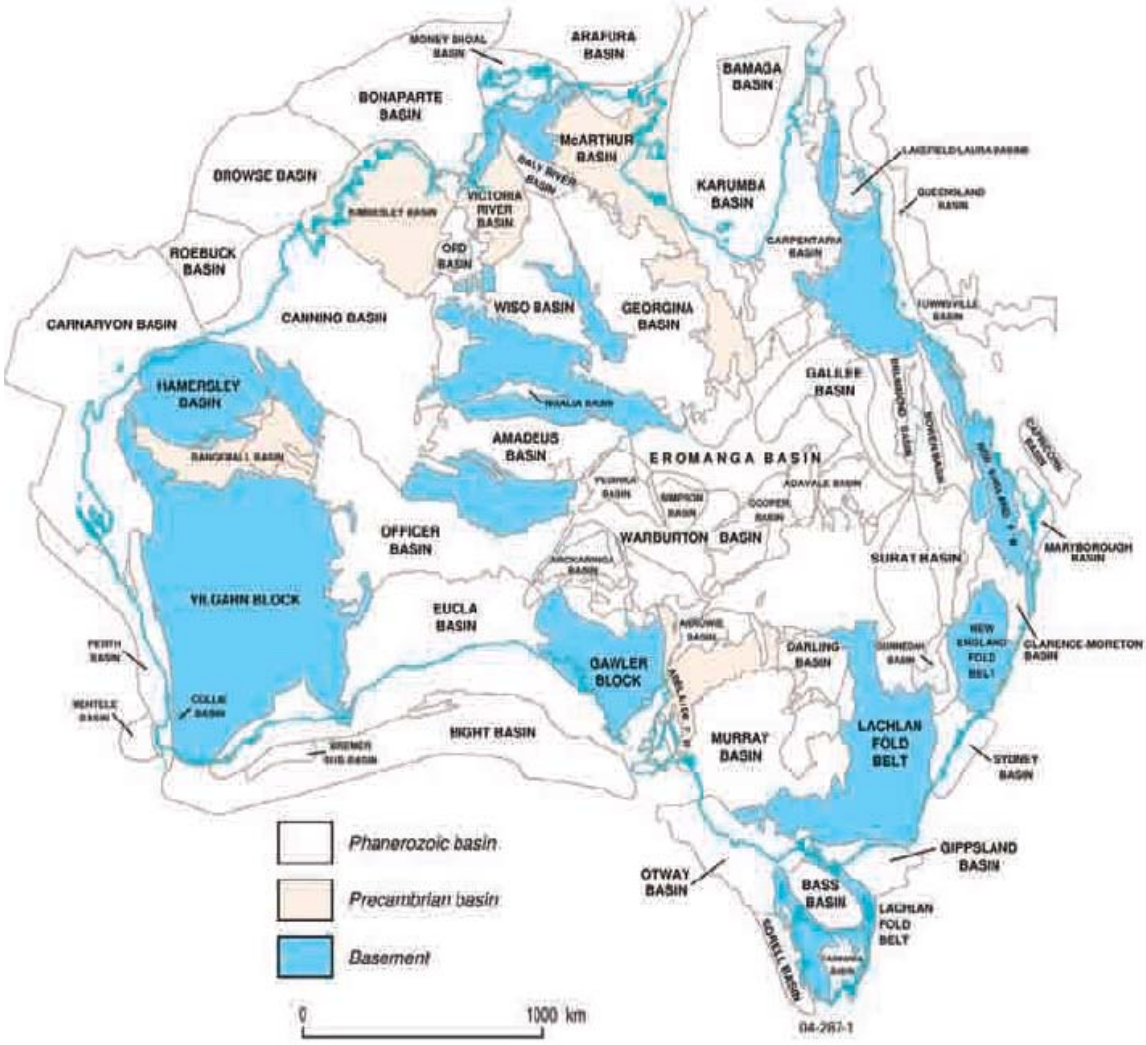
It would appear that concerns regarding possible tightness in the supply of tanker shipping, resulting from the phasing out of single hulled tankers in 2010, have largely been addressed through a significant construction program of tanker shipping as well as through the ongoing conversion of single hulled tankers into double hulled tankers.

5 Australian liquid fuels supply

5.1 Domestic production of crude oil, condensate and liquid petroleum gas

A map of Australia's sedimentary basins is shown below in Figure 6.

Figure 6 **Sedimentary basins of Australia**



Data source: Oil and Gas resources of Australia 2002,*(Geoscience Australia, 2004)*

Crude oil or condensate is currently being produced in Australia from thirteen sedimentary basins shown in Table 12 below.

Table 12 **Australian sedimentary basins and first commercial production of crude oil or condensate**

Basin	Location of Basin	First Commercial Production
Surat	Onshore Queensland and New South Wales	February 1964
Carnarvon	Onshore and offshore Western Australia	January 1967
Gippsland	Offshore and onshore Victoria	March 1969
Bowen	Onshore Queensland	September 1969
Cooper	Onshore Queensland	November 1969
Eromanga	Onshore Queensland, South Australia, New South Wales and Northern Territory	November 1969
Perth	Onshore and offshore Western Australia	October 1971
Amadeus	Onshore Northern Territory and Western Australia	August 1983
Canning	Onshore Western Australia	September 1983
Bonaparte	Offshore Northern Territory and Western Australia	September 1983
Otway	Onshore and offshore Victoria and South Australia	April 1986
Adavale	Onshore Queensland	June 1995
Bass Basin	Offshore Victoria and Tasmania	May 2006

Data source: Geoscience Australia (2006)

According to Geoscience Australia varying levels of oil and/or gas discoveries have been made in the following basins, but are not yet being commercially produced (Geoscience Australia, 2006, p. 11).

Significant discoveries

- Browse Basin (offshore Western Australia and Northern Territory)

Minor Discoveries

- Clarence-Moreton Basin (onshore and offshore Queensland and New South Wales)
- Galilee Basin (onshore Queensland)
- Georgina Basin (onshore Northern Territory and Queensland)
- Ipswich Basin (onshore and offshore Queensland and New South Wales)
- McArthur Basin (onshore Northern Territory)
- Sydney Basin (onshore and offshore New South Wales)

Geoscience Australia notes that it is possible some of these basins will have commercial production in the future, particularly the Browse Basin which contains a number of super-giant gas fields with substantial condensate resources in addition to some small oil fields (Geoscience Australia, 2006, p. 11).

The majority of Australia's indigenous production of crude oil, condensate and LPG comes from the Carnarvon Basin that currently accounts for 63 per cent of total Australian production of naturally occurring petroleum liquids. The mature Gippsland Basin accounts for 19 per cent of total Australian production of naturally occurring petroleum liquids. While production from the Gippsland Basin peaked in the mid-1980s and has declined steadily since, one of the joint operators of the Gippsland Basin predicted in June 2007 that the region still has more than 20 years of oil production left (FitzGerald, 2007).

Details on Australian production of crude oil, condensate and naturally occurring LPG is provided respectively in Tables 13, 14 and 15 below.

Table 13 **Australian production of crude oil by basin**

Crude Oil	2002-03	2003-04	2004-05	2005-06	2006-07
	ML	ML	ML	ML	ML
Adavale	2				
Amadeus	59	136	132	53	53
Bonaparte	4807	3038	1868	1403	1470
Bowen-Surat	27	28	24	23	21
Canning	4	3	3	2	2
Carnarvon Barrow Island	547	502	448	390	390
Carnarvon North West Shelf	8843	8564	7859	4524	5850
Carnarvon Other	4284	3689	3831	5854	7044
Cooper-Eromanga Queensland	450	387	529	432	791
Cooper-Eromanga South Australia	413	445	401	489	1116
Gippsland	6937	6019	4647	3681	3598
Otway					
Perth	119	387	517	395	816
Total	26492	23198	20259	17246	21151

Data source: Australian Bureau of Agricultural and Resource Economic (2008)

Table 14 **Australian production of condensate by basin**

Condensate	2002-03	2003-04	2004-05	2005-06	2006-07
	ML	ML	ML	ML	ML
Adavale	1				
Amadeus					
Bonaparte		46	307	394	394
Bowen-Surat	12	15	23	20	21
Canning					
Carnarvon Barrow Island	350	203	120		8
Carnarvon North West Shelf	6686	5840	5041	5265	5692
Carnarvon Other	101	142	250	202	134
Cooper-Eromanga Queensland	239	242	270	205	167
Cooper-Eromanga South Australia	349	176	221	208	239
Gippsland	769	837	812	770	744
Otway	23	13	7	3	2
Perth	2	1	1	2	3
Total	8532	7515	7052	7069	7404

Data source: Australian Bureau of Agricultural and Resource Economic (2008)

Table 15 **Australian production of liquefied petroleum gas by basin**

Liquid Petroleum Gas	2002-03	2003-04	2004-05	2005-06	2006-07
	ML	ML	ML	ML	ML
Adavale					
Amadeus					
Bonaparte					
Bowen-Surat	18	20	24	23	24
Canning					
Carnarvon Barrow Island					
Carnarvon North West Shelf	1911	1817	1963	2160	2067
Carnarvon Other					
Cooper-Eromanga Queensland					
Cooper-Eromanga South Australia	783	827	664	597	551
Gippsland	1970	1975	1977	1942	1908
Otway					
Perth					
Total	4682	4639	4628	4722	4550

Data source: Australian Bureau of Agricultural and Resource Economic (2008)

In regard to Australia's two main oil producing basins, most of the production from the Carnarvon Basin in North West Australia is exported, while production from the Gippsland Basin in south eastern Australia is used as feedstock in domestic oil refineries (Australian Bureau of Agricultural and Resource Economics, 2008, pp. 15-16).

Australian crudes have traditionally tended to be lighter (lower density) and sweeter (lower in sulphur). However, some of the crudes now being produced in North West Australia are heavy and sour. The most recent discoveries are generally not suitable for Australian refineries that are usually configured to processing sweet light crudes.

Estimates of future domestic production of crude oil and condensate come from two Commonwealth Government agencies, Geoscience Australia and ABARE. The Geoscience Australia and the ABARE estimates differ significantly because they are based on different forecasting methodologies.

Geoscience Australia has estimated Australia's remaining economically

demonstrated naturally occurring petroleum liquids by state as follows in Table 16 below.

Table 16 **Naturally occurring petroleum liquids by state 2006 ***

	Crude oil (GL)	Condensate (GL)	LPG (GL)
Victoria	37	18	27
Queensland	9	1	0
South Australia	1	2	5
Western Australia	115	155	122
Northern Territory**	10	79	58
Tasmania	1	2	2
Total Australia	173	257	214

Note: * Economic demonstrated resources only. ** Includes Timor Lest 90% share of Bonaparte basin reserves.
Data source: Geoscience Australia (2008) *Oil and Gas Resources of Australia 2005*, Canberra.

Geoscience Australia's forecasting method is designed to underpin government advice relating to immediate decision making and production on a 5-10 year time scale (Powell, 2001, p. 277). This approach leads to conservative results, reflecting a shorter-term focus of the assessment and concentrates on the extrapolation of known exploration trends (Powell, 2001, p. 277). Geoscience Australia has acknowledged that this approach will systematically underestimate the resource potential (Powell, 2001, p. 278).

In its 2006 forecasts of domestic production of crude oil and condensate, Geoscience Australia predicted that crude oil production rate will peak in 2007 and then go into decline, while condensate production is expected to increase up until 2014 when it too will go into decline (Geoscience Australia, 2006).

The estimates reproduced below in Table 17 are provided at the 50 per cent probability level that reflects the uncertainty surrounding the development of a discovered accumulation (eg a production estimate at the 50 per cent probability level (P50) means there is a 50 per cent change of production being at least as high as the figure shown).

Table 17 **Crude oil forecast for 2006-2020**

Year	Identified P50	Undiscovered P50	Both P50
	Thousands of barrels per day	Thousands of barrels per day	Thousands of barrels per day
2006	617	1	635
2007	628	2	653
2008	589	3	608
2009	551	5	561
2010	501	11	510
2011	448	20	461
2012	402	30	428
2013	336	40	378
2014	295	50	349
2015	285	59	349
2016	261	71	337
2017	239	79	325
2018	212	85	304
2019	184	93	281
2020	167	98	269

Note: Crude oil from Australia's identified accumulations, and crude oil production from undiscovered accumulations in the Bonaparte, Carnarvon, Eromanga, Cooper Gippsland, Browse, offshore Otway, and offshore Perth Basins

Data source: Geoscience Australia (2006)

Geoscience Australia has also identified several new sources of oil that could increase future domestic production. According to Geoscience Australia, a potential new source of increased oil resources could occur due to reserves growth (previously discussed in section 4.1) (Geoscience Australia, 2006, p. 19). Geoscience Australia has made some preliminary estimates of crude oil reserve growth potential from fields discovered prior to 2003 of 1.064 bb from 2003 to 2050 (Geoscience Australia, 2006, p. 19).

According to Geoscience Australia, another new source oil could come from undiscovered fields in:

- currently producing basins;
- basins where petroleum has been discovered but not yet produced; and
- basins in which petroleum has not yet been discovered. (Geoscience Australia, 2006, p. 19)

Geoscience Australia has noted that Australia is very lightly explored and few of the basins could be considered mature by international exploration standards (Geoscience Australia, 2006, p. 20). Geoscience Australia also notes that while estimating the potential of unexplored basins is difficult, the

potential reserves available from these basins could be substantial (Geoscience Australia, 2006, p. 21). The Commonwealth Government's 2004 Energy White Paper noted that while Australia has some 40 offshore basins that display signs of petroleum potential, half of these remained unexplored (Commonwealth of Australia, 2004, p. 53). Similarly, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) opined in 2006 that:

> It is clear … that Australia is largely unexplored and has significant potential for new discoveries. (Commonwealth Scientific and Industrial Research Organisation, 2006, p. 11)

Furthermore, the United Nations Commission on the Limits of the Continental Shelf confirmed Australia's jurisdiction over an additional 2.5 million square kilometres of seabed in April 2008. This decision gives Australia the rights to any oil resources that exist on and under the seabed.

ABARE has higher forecasts of Australian production for crude oil and condensate than Geoscience Australia. ABARE includes forecasts of Australia's undiscovered oil resources based partly on the estimates developed for Australia by the USGS in 2000 (USGS World Energy Assessment Team, 2000).

ABARE's estimates of Australian oil production are based on P50. According to ABARE, Australian crude oil and condensate production is projected to increase in the medium term before declining below 500,000 barrels a day in 2029-30 (Australian Bureau of Agricultural and Resource Economics, 2008, p. 21). ABARE is forecasting crude oil and condensate production to increase from around 419,000 barrels a day in 2005-06 to around 676,000 barrels a day in 2009-10 and then go into a gradual decline (Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, 2007). ACIL Tasman has converted the ABARE estimates of oil production in petajoules over to equivalent oil production rate in barrels per day using a calorific value of 5883 MJ/barrel (37 MJ/litre) and the results are presented in Table 18 below.

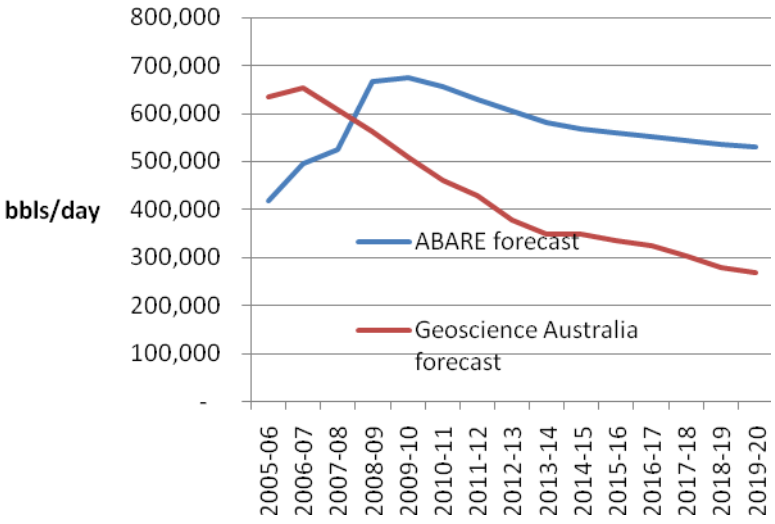
Table 18 **ABARE estimate of Australian production of crude oil and condensate**

Year	Barrels per day
2005-06	419073
2006-07	497217
2007-08	524843
2008-09	668663
2009-10	675929
2010-11	657113
2011-12	629122
2012-13	605602
2013-14	582268
2014-15	569414
2015-16	561636
2016-17	553625
2017-18	546080
2018-19	538070
2019-20	530525

Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke (2007)

A comparison of the Geoscience Australia and ABARE forecasts of Australian crude oil and condensate production is provided below in Figure 7.

Figure 7 **Geoscience Australia and ABARE forecasts of Australian crude oil and condensate production**



Note: Geoscience forecasts are in calendar years while the ABARE forecasts are in financial years.
Data source: Geoscience Australia (2006); Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke (2007)

While the estimates of Geoscience Australia and ABARE may differ, Geoscience Australia has acknowledged that the 2000 assessment by the USGS upon which ABARE has partially based its forecasts does have merit. According to Dr Trevor Powell, former Deputy Director of Geoscience Australia:

> Despite some reservations as to the results, the USGS assessment has been adopted as the best current indicative estimate of the ultimate petroleum potential of Australia's offshore producing basins. (Powell, 2001, p. 285)

While the Geoscience Australia and ABARE forecasts differ, they both forecast a decline in production in the period leading up to 2020. On this basis, Australia will become increasingly reliant upon overseas sources of oil in face of growing demand for petroleum based liquid fuels.

5.2 Domestic production of refined petroleum products

There are currently seven major oil refineries operating within the vicinity of five capital cities run by four refining companies: Caltex Oil Australia Pty Ltd (Caltex), BP Australia Ltd (BP), Mobil Oil Australia Ltd (Mobil), and The Shell Company of Australia Ltd (Shell). With the exception of Caltex, the other three oil refiners are wholly owned subsidiaries of multinational oil companies: the United Kingdom based BP PLC; the US based ExxonMobil Corporation; and the Anglo-Dutch Royal Dutch Shell Group. Caltex is an Australian public company that is listed on the Australian Stock Exchange with a 50 per cent interest ultimately held by US based multinational oil company Chevron Corporation.

Oil refining in Australia has undergone significant rationalisation and has become more heavily concentrated since 1980, which has resulted in the eight refining companies operating ten refineries in 1980 contract down to four refining companies operating seven refineries.[4] In 1982 French refining company Total exited Australia, selling its refining and distribution assets to Ampol. In 1984 Ampol closed down the former Total refinery located at Matraville in Sydney. In 1984 BP acquired the Bulwer Island refinery in Brisbane from US refining company Amoco along with its distribution and retailing assets. In 1985 BP closed its Westernport refinery near Melbourne. In 1990 Mobil acquired the downstream assets of Esso (a subsidiary company of US refining company Exxon), and took ownership of the remaining 35 per

[4] It could be argued that Australia had a ninth refiner in H. C. Sleigh who marketed themselves under the Golden Fleece banner. While H C Sleigh did not refine petrol as such, it did own a 25 per cent stake in the Kurnell lubricating oil refinery in 1980 that was majority owned by Caltex. In 1981 H. C. Sleigh sold its petroleum interests to Caltex.

cent interest in the Port Stanvac and Altona refineries that it did not already own. In 1995 Ampol and Caltex reached an agreement to merge the two companies. In April 2003 Mobil announced that it would be ceasing operations at its Port Stanvac refinery and would mothball the refinery. Mobil attributed the closure to the fact that the refinery was incurring financial losses on its operations and that it couldn't compete against larger refineries in the Asia Pacific region (Mobil Oil Australia Pty Ltd, 2003). Refining operations at Port Stanvac ceased in early June 2003.

Rather than close the Port Stanvac refinery down permanently and demolish the facility, Mobil has instead decided to maintain the refinery in a condition that it could enable it to be restarted (so called "mothballing"), subject to necessary investment to meet Australian fuel standards and in the event economic conditions improved (Mobil Oil Australia Pty Ltd , 2007, p. 3). Given recent buoyant refining margins it could be argued that given Mobil has not decided to restart the Port Stanvac refinery given recent favourable conditions, it is unlikely to restart the refinery in the near future. The South Australian Government has sought a decision from Mobil by 2009 concerning the future of the Port Stanvac refinery (Australian Competition and Consumer Commission, 2007a, p. 50).

In recent times, capacity at some of Australia's remaining refineries has been reduced as a result of the need to reconfigure in order to comply with Australian fuel standards that have been progressively introduced since 2002 (Australian Competition and Consumer Commission, 2007a, pp. 51-52). In particular, Mobil has restructured its Altona refinery, resulting in shutting down parts of the refinery and putting some of the equipment into new service. This has reduced capacity by 50,000 bpd (Mobil Oil Australia Pty Ltd , 2007, p. 3).

Each refinery is configured to process particular types of crude oil. Australian refineries are primarily configured towards processing sweet light crude with the exception of Bulwer Island and its hydrocracker that enables it to process some of the heavier crudes from the Middle East. According to AIP, Australian crudes do not match the proportions of products required by Australian consumers for LPG, jet fuel and diesel and are not suitable for producing heavier products such as bitumen, lubricating oils and greases (Australian Institute of Petroleum, 2008, p. 5). Hence, AIP comments that, in order to produce the required product slates in Australia, Australian refineries use a mixture of crudes from variety of sources (Australian Institute of Petroleum, 2008, p. 5). Around 70 per cent of crude oil used in Australian refineries is imported.

In order to remove impurities from refined petroleum products, such as

sulphur, further chemical processing must be undertaken that adds to a refinery's capital costs. It has been estimated that the new Australian fuel standards that are being progressively introduced between 2002 and 2009 has required a capital upgrade of more than $2 billion on the part of Australian refineries in the decade leading up to 2010 (Australian Institute of Petroleum, 2006a, p. 51).

The nameplate production capacity of refineries in Australia is outlined below in Table 19.

Table 19 **Nameplate capacity for major Australian oil refineries**

Company	Location	Capacity(bpd)
BP	Bulwer Island, Brisbane	84,000
BP	Kwinana, near Perth	131,000.0
Caltex	Lytton, Brisbane	108,600
Caltex	Kurnell, Sydney	130,700
Mobil	Altona, Melbourne	80,000
Shell	Clyde, Sydney	90,000
Shell	Geelong, near Melbourne	110,000
Total		734,300

Data source: Australian Competition and Consumer Commission (2007a, p. 51)

There is also a mini-refinery located at Eromanga in western Queensland that is operated by Inland Oil Refiners Pty Ltd that has a refinery capacity of 1,500 bpd and produces diesel and jet fuel but no petrol.

Oil refining is subject to large economies of scale (as well as scope), as capital costs rise less than proportionately to capacity. Scherer has estimated that refineries need a production capacity of 200,000 bpd in order to reach the minimum efficient scale (Scherer, 1996, p. 114).

Australian refineries are considered to be relatively small by world standards, with Australia's largest refinery, Kwinana, having a capacity of 131,000 bpd and Australia's combined seven refineries having a total production capacity of 734,300 bpd. By way of comparison in Singapore, which is the major refining centre closest to Australia, there are three major oil refineries that have a total production capacity of 1.3 million bpd: ExxonMobil's 605,000 bpd refinery; Royal Dutch Shell's 458,000 bpd refinery; and the Singapore Refining Corporation's 273,000 bpd refinery. In addition, capacity for the new Indian Reliance refinery will be 580,000 bpd once it comes online.

The Australian refinery industry was built around supplying virtually all domestic demand through a nationwide network of fuel distribution and retailing, with the exception of the Northern Territory, which usually has

product imported in from Singapore. Details on recent Australian production of refined petroleum products are provided in Table 20 below.

Table 20 **Australian production of refined petroleum products**

Product	2002-03	2003-04	2004-05	2005-06	2006-07
	ML	ML	ML	ML	ML
Petrol	17984	17375	17913	16528	17732
Automotive diesel oil	13335	12544	12822	10154	11055
Jet fuel	5149	4964	5325	5216	5332
Fuel oil	1441	1105	1092	1048	942
Liquefied petroleum gas	1657	1062	995	1125	1387
Industrial and marine diesel fuel	117	84	22	31	21
Bitumen	751	678	1091	831	1356
Lubricants	521	259	202	163	146
Aviation gasoline	134	114	144	119	119
Heating oil	195	118	106	102	86
Other	5439	5183	4843	5362	5476
Total Products	46723	43486	44555	40679	43652

Data source: *(Australian Bureau of Agricultural and Resource Economics, 2008)*

There are a range of views on the future of the Australian refining sector and its productive capacity. Consistent with ABARE's assumptions regarding Australian refining capacity up to 2030 (Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, 2007, p. 46) and based on ACIL Tasman's consultations with stakeholders, there is universal agreement that it is extremely unlikely there will be any new major additions to Australia's refining capacity. BP has recently opined that it is highly unlikely that a new refinery would be built in Australia for a number of reasons including capital costs in the order of $3 billion and the difficulty of obtaining a sufficient return on that level of investment (BP Australia Pty Ltd, 2007, p. 18). Previously, the Chairman of Shell Companies in Australia, Mr Russell Caplan, has commented:

> I doubt very much that we will see another refinery built in Australia. Investors are much more likely to build new capacity in Asia or the Middle East. (Caplan, 2006)

According to one stakeholder, the only circumstance where they could envisage a new refinery being built in Australia was in the event of the discovery and subsequent development of a substantial new oil producing basin.

ABARE has assumed that Australia's domestic refining capacity will still increase through ongoing investment in efficiency improvements leading to an increase in gross refining output from 1,476 petajoules in 2005-06 to 1,758 petajoules in 2019-20 (Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, 2007, p. 46). ABARE is projecting that the proportion of petroleum products consumption sourced from domestic refineries is projected to fall from 73 per cent to 69 per cent between 2005-06 and 2019-20 (Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, 2007). Details on ABARE's projections of Australian domestic refining output and its percentage of total domestic production of refined petroleum products is presented below in Table 21.

Table 21 **Projections of domestic refining output as a percentage of domestic demand**

Year	Domestic Refining Output as a Percentage of Domestic Demand
2005-06	73%
2010-11	72%
2014-15	71%
2019-20	69%

Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke (2007)

The views of stakeholders consulted by ACIL Tasman on future expansions to Australian refining capacity were mixed. Some stakeholders expressed the view that there would be some modest increases in domestic refining capacity due to some capacity creep generated through process improvements.

On the other hand, some stakeholders expressed the view that Australian refineries could come under increasing competitive pressure from lower refining margins and larger scale overseas refineries. Australian refiners consulted by ACIL Tasman were unanimous in the view that refining margins would come under downward pressure with the expansion of refining capacity in the Asian region.

Some stakeholders referred ACIL Tasman to comments by a senior executive from Shell (Russell Caplan referred to above) and comments by the Managing Director of Caltex.

According to comments by the Managing Director of Caltex, Mr Des King:

- At least two of Australia's remaining seven oil refineries are likely to close within the next decade because they will not be able to compete with surplus Asian refined petroleum products.
- By 2030 Australia was likely to be importing between 50 to 70 per cent of its petrol, jet fuel and diesel. (Wilson, 2008)

Some stakeholders expressed the view that the previously observed trend of redundancy in Australian refining capacity would continue as more Australian oil refinery refineries were closed because they were uncompetitive with larger scale refineries overseas. Shell has previously considered closing the Clyde refinery in 2001 but decided against it (The Shell Company of Australia, 2000). Shell has commented that it was making additional investment in the Clyde refinery to ensure it is able to reliably produce ultra low sulphur diesel required by Australian fuel specifications that come in effect in January 2009 (The Shell Company of Australia Ltd, 2007).

The issue of refinery joint ventures between the domestic refiners was raised by ACIL Tasman during the course of consultations. While refinery joint ventures have previously been contemplated in late 1998, these were subsequently abandoned and there has been no refinery joint venture proposal since that time. Any proposal for a refinery joint venture could also run into a regulatory barrier through the operation of section 50 of the Trade Practices Act. Section 50 of the Trade Practices Act prohibits mergers or acquisitions that have the effect or likely effect of substantially lessening competition in a substantial market for goods or services within Australia. Responsibility for the administration and enforcement of section 50 of the Trade Practices Act resides with the ACCC. Given recent reservations expressed by the ACCC on the state of competition within the downstream petroleum industry (Australian Competition and Consumer Commission, 2007a), any refinery joint venture could prove problematic. In any event, refinery joint ventures may not necessarily be advantageous from the perspective of improving energy security as they create interdependencies between refineries which may result in a problem with one refinery having flow on consequences for another refinery.

Recently, concerns have been expressed regarding the reliability of Australian refineries, with perceptions that the incidence of unexpected refinery shutdowns are becoming more commonplace. Unexpected refinery shutdowns result in tightness and sometimes shortages for various products. During the first part of 2008 there were widespread shortages of premium unleaded petrol across Sydney and New South Wales associated with problems at the Clyde refinery. In January 2008 there was an unplanned shutdown of the catalytic cracking unit at the Clyde refinery (The Shell Company of Australia Ltd, 2008b). In addition, diesel supply was tight in South-East Queensland in April 2008 as the result of urgent unplanned maintenance repairs on a major diesel processing plant at the Caltex Lytton refinery in Brisbane (Caltex Australia Petroleum Pty Ltd, 2008).

In a recent background paper produced by the AIP, it has been acknowledged that there have been recent supply disruptions due to major refinery outages,

sometimes lasting for months at a time (Australian Institute of Petroleum, 2008, p. 12). Despite recent refinery outages, however, AIP maintains that "Australian refineries have had an extended period of good performance reliability" (Australian Institute of Petroleum, 2008, p. 14).

In its submission to the 2007 petrol inquiry by the ACCC, Caltex commented that:

> In recent years Caltex has significantly increased the amount of funding allocated and spent on preventative maintenance in order to maintain safe operations and minimise lost production due to unplanned shutdown or sub-optimal operations. Increased reliability of the refineries directly contributed towards higher finished product production. (Caltex Australia Ltd, 2007, p. 12)

Caltex further commented that a standard oil refinery reliability benchmarking measure called "Solomon utilisation" measures the degree to which the combined refinery process units are being utilised. In a chart produced using this measure, Caltex was able to show that the utilisation rates both of its refineries had been trending upwards in recent years, with the utilisation rate for the Kurnell refinery approaching 90 per cent in 2007 and the utilisation rate for the Lytton refinery exceeding 90 per cent (Caltex Australia Ltd, 2007, p. 12).

Concerns regarding a possible increase in the incidence of unexpected refinery shutdowns were put to the Australian refiners by ACIL Tasman during the course of consultations. The responses received by ACIL Tasman were all similar. All Australian refiners were unanimously of the view that reliability of their refinery operations was no worse than it had been in the past and that there had been no increase in the incidence of unexpected refinery shutdowns.

However, the Australian refiners observed that the impact of the incidence of unexpected refinery shutdowns was now more severe than it had been in the past resulting in product tightness and sometimes shortages. This was attributed to a number of reasons. In the first place, the implementation of tighter Australian fuel specifications had made the domestic oil refineries more susceptible to supply disruptions. It was explained to ACIL Tasman by all Australian refiners that tighter fuel specifications had increased the level of interdependency between refinery processing units and that a problem with one processing unit was now more likely to disrupt production and possibly shut down production from the refinery altogether than was previously the case as the fuel produced may no longer be compliant with Australian fuel specifications. This is consistent with testimony provided by Shell during public hearings for the ACCC's 2007 petrol price inquiry (Australian Competition and Consumer Commission, 2008b, pp. 28-30). In the second

place, with the Australian eastern seaboard moving from a net exporter to a net importer of refined petroleum products, there is little to no spare refining capacity left in the system to cover the loss of production capacity. For example, in the event of an unexpected supply disruption in the past, Australian oil refiners commented that they previously often had the option of redirecting product bound for export markets, an option that is less feasible as domestic demand has grown and domestic refining capacity has contracted.

One Australian refiner explained that in the event of an unexpected supply disruption they went through a series of escalating steps in order to secure adequate product supplies:

- Negotiate a supply agreement with the other local oil refiner.
- Negotiate a supply agreement with other oil refiners.
- Order a cargo of product from overseas.
- Inform customers that their product allocations will be reduced.

Similarly, AIP has outlined the range of options available to refiners in the event of a supply disruption:

- In-refinery options including repair of production unit or truncate maintenance program
- Sourcing supplies from other refiners
- Sourcing supplies internationally
- Carefully allocating bulk fuel supplies to customers. (Australian Institute of Petroleum, 2008, p. 14).

The Australian refiners all acknowledged that there is now less communication between them than had previously been the case in the event of a major supply disruption of refined petroleum products. Communications between the refiners in the event of a major supply disruption have become far more restricted since the termination of refinery exchange agreements across Australia in July 2002 and their replacement through buy-sell arrangements. Refinery exchange agreements were reciprocal trading agreements whereby an oil refiner agreed to supply refined petroleum products in areas of close proximity to their oil refineries to other oil refiners in exchange for the receipt of those same refined petroleum products in locations far removed from their refineries from those same oil refiners. The refinery exchange system was replaced with transactions occurring on purely commercial terms, known as buy-sell arrangements, which are negotiated every six months by the domestic refiners on a bilateral basis.

Two reasons were advanced as to why there is now less communications

between the Australian refiners in the event of a supply disruption. First, knowledge of supply disruptions is commercially sensitive information that may provide opportunities for some market participants. Second, the refiners wish to avoid any compliance or perception issues in regard to section 45 of the Trade Practices Act, which prohibits agreements, that have the purpose, effect or likely effect of substantially lessening competition.

Several representatives of State Governments consulted complemented the domestic refiners on how they managed and were able to procure supplies of refined petroleum products in the event of unexpected refinery shutdowns to avoid product shortages. Most State Government representatives said that they relied on the companies to manage supplies in such circumstances. This is consistent with comments made by AIP that the domestic refiners have been able to obtain alternative supplies of refined petroleum products on every occasion when there has been an unexpected refinery shutdown without any markets suffering too adversely from any major product shortages:

> …every instance the industry has managed to arrange supply through imports and established inter-company processes without any significant shortfalls in the market. (Australian Institute of Petroleum, 2008, p. 12)

In addition, several representatives of State Governments consulted also complemented the domestic refiners on their level of consultation and how they were kept fully informed of potential supply disruptions. This is also consistent with recent comments made by AIP:

> AIP members maintain close contact with relevant Federal and State/Territory government authorities and keep them appraised of the supply situation on an ongoing basis.
>
> AIP members inform the appropriate government(s) and departments when it is probable that customers will experience a major impact from a supply disruption. (Australian Institute of Petroleum, 2008, p. 15)

On the other hand, concerns were raised by wholesale market customers for road transportation fuels of the domestic refiners that there were significant information asymmetries in the event of a major supply disruption. Several wholesale market customers expressed concern in the event of a major supply disruption they were given little advanced warning. These wholesale market customers complained they were not informed of major supply disruptions in a timely manner, thus making the task of securing alternative product supplies more difficult, and increasing the prospect that they would run out of product(s) altogether. A major concern noted by customers was the major stock outs of premium unleaded petrol due to refinery disruptions in late 2007 and early 2008.

In the course of consultations, the Australian refiners were asked if they would be interested in participating in a consultative forum to discuss supply management issues in the event of a major supply disruption. Discussions with the supply managers indicated that the refiners considered they were able to communicate on major supply disruption issues while being conscious of potential trade practice implications. The refiners, through their peak lobby group, have indicated that there is a strong case for coordinating their efforts in the period between the identification of an existing or emerging Liquid Fuel Emergency (LFE) and prior to the declaration of an LFE by the Federal Energy Minister (the so-called 'pre-planning' or 'alert' phase of the LFE Management Plan). Such early coordination would facilitate the development and implementation of a national industry response, thereby more efficiently managing the disruption and mitigating the prospect of stock-outs in a timely way. The peak lobby group, AIP, has recently commented that:

> … AIP believes consideration must be given to how industry and government can more effectively co-operate on essential preparations prior to an emergency being declared. (Australian Institute of Petroleum, 2008, p. 19)

The matter of establishing a consultative forum to discuss supply management issues in the event of a major supply disruption (not an LFE) was put to numerous stakeholders during the course of consultations. However, the view of most stakeholders was that the industry was best placed to manage and resolve difficulties in the event of a supply disruption. The issue of a consultative forum is further taken up in section 9.10 of the report below.

An upcoming challenge facing the domestic refining industry is the introduction of an emissions trading system for greenhouse gases. The Commonwealth Government is establishing an emissions trading scheme in order to address climate change and has committed to developing a national emissions trading scheme starting no later than 2010 with the detailed design finalised by the end of 2008.

A commercial risk is posed to domestic refiners from imported fuel if overseas refineries do not share the same cost burden from the introduction of an emissions trading system as domestic refiners in the production process for refined petroleum products. Refiners in countries such as India, Singapore, Taiwan, Vietnam and South Korea are unlikely to have an emission trading system imposed upon them for some time, potentially putting Australian refiners and Australian refined petroleum products at a competitive disadvantage with imported product. A Caltex spokesperson commented in February 2008 that:

> Caltex … argues that government policy should maintain the competitiveness of

> Australian export and import competing industries and, in particular, protect energy-intensive, trade-exposed industries from the impact of any emission trading scheme while competing nations are not subject to commensurate emissions reduction policies. (Topham, 2008)

While ongoing incremental expansion of existing domestic refineries will probably occur, it is extremely unlikely that any new refineries will be constructed in Australia. Australia is not unique amongst developed countries in this regard as new oil refineries have not been constructed in the United States since the 1970s while very few refineries have been constructed in Western Europe since the 1970s. Given the importance of economies of scale in oil refining and the relatively small scale of the domestic refineries, there may be some further retrenchment of refining capacity coupled with the expected increasing reliance on overseas production of refined petroleum products.

While there have been recent production problems with domestic refineries that has resulted in tightness in some product markets, the closure of domestic refineries will not improve Australia's energy security in liquid fuels. This is because the closure of domestic refineries will reduce the diversity of supply options available for Australia, thus detracting from Australian energy security. The existence of domestic refineries provides a much greater degree of flexibility in the product supply chain in the event of an unexpected mishap. Domestic refineries have the capacity to undertake further processing of imported refined petroleum products that are non-compliant with Australian fuel specifications. Domestic refineries also have some limited capacity to expand production of certain products in the event of a major supply disruption. Furthermore, the closure of domestic refineries will make Australia more dependent on overseas refiners who may be less responsive to the needs of their Australian customers than would be the case with a domestic refiner, which could result in a diminution in the level of service afforded.

5.3 Self Sufficiency

Australia's level of self-sufficiency in terms of the production of crude oil and other refinery feedstock as well as in the production of refined petroleum products has declined. As outlined below in Table 22, Australia's level of self-sufficiency in crude oil and other refinery feedstock (expressed in volume) has declined from 84 per cent in 1999-2000 to 72 per cent in 2006-07.

Table 22 **Australia's level of self-sufficiency in crude oil and other refinery feedstock**

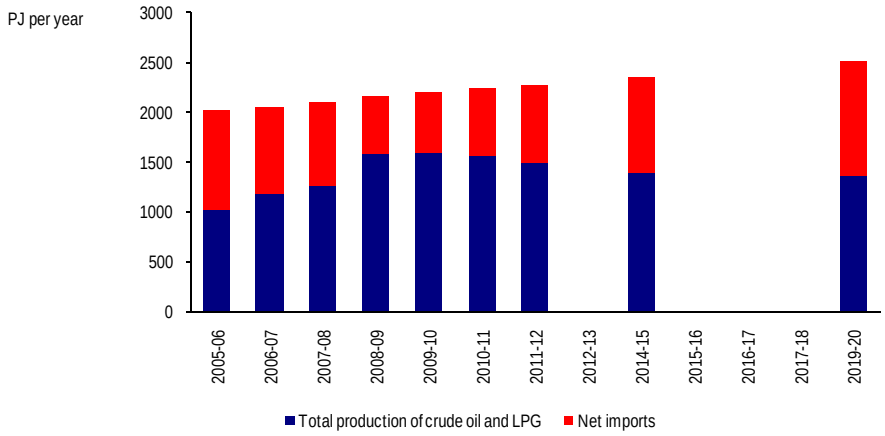
Year	Domestic production of crude oil and other refinery feedstock	Domestic consumption of crude oil and other refinery feedstock	Percentage of domestic consumption satisfied by domestic production
	ML	ML	
1999-00	37447	44500	84%
2000-01	39839	44708	89%
2001-02	37820	42911	88%
2002-03	35023	44548	79%
2003-04	30713	39949	77%
2004-05	27311	40334	68%
2005-06	24315	36895	66%
2006-07	28555	39453	72%

Data source: Australian Bureau of Agricultural and Resource Economics (2007b)

However, these figures on the level of self-sufficiency in crude oil and other refinery feedstock underestimate the extent to which Australia is dependent on overseas sources of crude oil and other refinery feedstock. This is because Australia is also a net importer of refined petroleum products which are generally produced from crude oil and other refinery feedstock sourced from non-Australian sources.

In energy terms, domestic production of crude oil, condensate and LPG represented around 59 percent of Australia's available refinery feedstock and petroleum products in 2006-07. While ABARE's energy projections indicate that the ratio of domestic production to total consumption of petroleum fuels (an broadly equivalent measure in energy terms) increases to 73 per cent by 2009-10, the ratio declines to 54 percent by 2019-20 (Figure 8) (Australian Bureau of Agricultural and Resource Economics, 2008).

Figure 8 **Australian oil and LPG production and net imports**



Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, (2007)

These projections of overall self sufficiency levels are not necessarily an indication of Australia's overall liquid fuels vulnerability. They also include exports of crude oil, condensate, notably from North West Australia where some crudes are not suitable for Australian refineries. Domestic supplies of crude oil and condensate accounted for only 28 per cent of the domestic refinery input in 2006-07 in volume terms (Department of Resources Energy and Tourism, 2008). Self sufficiency in specific product areas is of more interest than an overall measure.

Australia's level of self-sufficiency in its three main petroleum products of petrol, diesel and jet fuel is outlined below in Table 23.

Table 23 **Self-sufficiency in automotive petrol, automotive diesel oil and jet fuel**

Year	Petrol	Automotive diesel oil	Jet Fuel
2002-03	95%	96%	121%
2003-04	87%	87%	115%
2004-05	90%	84%	113%
2005-06	87%	64%	97%
2006-07	92%	65%	91%

Data source: Australian Bureau of Agricultural and Resource Economics (2008)

In terms of refining capacity, Australia maintained over 90 per cent self-sufficiency in petrol and jet fuel in 2006-07. However, in regard to jet fuel there are likely to be regional disparities in the level of self-sufficiency around the

country as jet fuel demand at Sydney Airport is likely to represent a high proportion of overall Australian demand and is therefore more likely to be reliant on imported sources of jet fuel than other cities with processing refineries. In 2007 jet fuel demand for New South Wales which includes Sydney Airport represented almost 45 per cent of Australian demand for jet fuel.

The most significant recent decline in the level of self-sufficiency has been in regard to diesel, which has fallen from 96 per cent in 2002-03 to 65 per cent in 2006-07. While some of the decline in the level of self-sufficiency is due to the reduction in Australian refining capacity, most of it is due to increasing demand for diesel, particularly from the expansion in the mining industry.

Overall, there are regional disparities in regard to the extent of self-sufficiency of refined petroleum products depending on the proximity of an operating refinery. The Northern Territory, North West Australia, north east Australia and South Australia are dependent on overseas imports of refined petroleum products to a significant extent. On the other hand, other parts of Australia are much closer to being in balance and not as dependent on imports of refined petroleum products.

5.3.1 Implications of declining self sufficiency on energy security

Affordability

The implications for affordability of developments since 2004 depend on exactly how it is defined. A more traditional definition of affordability of the ability to purchase a product given existing budget/financial constraints would suggest that affordability for the individual and for households has deteriorated since 2004.

Based on the 2003-04 household expenditure survey by the Australian Bureau of Statistics, the average Australian household spent $29.72 per week on petrol (Australian Bureau of Statistics, 2006). This translates to around 32.7 litres on average a week for capital city motorists in 2003-04. Based on the national metropolitan average price for petrol in the week ended 13 April 2008, purchasing 32.7 litres of petrol would have cost $46.14, representing a 55 per cent increase over average 2003-04 prices. Based on increases in average weekly earnings, it would appear that increases in household incomes have not kept pace with increases in petrol prices over the intervening period suggesting that households that try to maintain their consumption of petrol will be relatively worse off. For example, full time male ordinary time average weekly earnings has gone from a year average of $995.30 in 2003-04 to $1,175.40 in

November 2007, an increase of only 18 per cent (Australian Bureau of Statistics, 2008a).

On the other hand, if affordability is defined in terms of maintaining the competitiveness of the economy then affordability is unlikely to have been significantly affected. This is because crude oil as well as refined petroleum products are internationally traded commodities and prices paid in Australia for petroleum based liquid fuels closely follow movements on world markets. For example, the 2007 inquiry into petrol pricing by the ACCC found that Australia's domestic oil refiners set the price of petrol with reference to an import parity price, the landed price of obtaining refined product from an overseas refiner (Australian Competition and Consumer Commission , 2007a). On this basis, increases in the price of crude oil which is the major input into refined petrol products, as well as any increases in refining margins, which is the difference between the price of crude oil and refined petroleum products, would have translated into higher prices for petroleum based liquid fuels for everyone including overseas competitors. As long as oil and refined petroleum products remain commodity products traded on international markets and affordability is defined in terms of maintaining international competitiveness, then affordability is unlikely to change significantly.

Adequacy

The expected decline in the production of indigenous crude oil means that Australia will inevitably become more dependent on overseas suppliers of crude oil in order to sustain domestic production of refined petroleum products. Given the diversity of overseas supply options available both now and into the future, maintaining adequacy of oil supply is unlikely to present a major challenge in the period leading up to 2020.

In terms of refined petroleum products, while there appears to be greater tightness in domestic markets for diesel, it is usually the case that there are sufficient quantities of refined petroleum products in order to satisfy domestic demand sourced through either domestic production or through overseas imports. However, as the gap between domestic production and demand for petroleum based liquid fuels is likely to widen in the period leading up to 2020, the critical factors in maintaining Australian energy security will be access to adequate supplies of overseas refined product and the adequacy of domestic infrastructure to cope with increasing importation of petroleum based liquid fuels. Based on previous analysis in section 4, it appears that Australia should be able to source adequate supplies of petroleum based liquid fuels from overseas refiners in the foreseeable future. On this basis, it appears that the adequacy of domestic infrastructure to service the importation of petroleum

based liquid fuels will be the major issue for maintaining energy security.

Reliability

Arguably the most significant change has been in regard to reliability of supply for petroleum based liquid fuels. This has been the result of two factors. Tighter fuel specifications for Australia has meant there is now a higher degree of interdependency between the operating units of a refinery. An unexpected shutdown of a refinery unit could potentially result in the inability of a refinery to produce fuels compliant with Australian fuel specifications. Previously, the unexpected shut down of a refinery unit may not have resulted in the entire shut down of the refinery as some fuel compliant with Australian specifications may have still been able to be produced (with the exception of a problem with the crude distillation unit). In addition, Australian refining capacity has reduced and the south east corner of Australia has changed from being a net exporter of refined petroleum product to a net importer. This has resulted in a reduction in the safety margin in the system to deal with unexpected refinery shutdowns.

While there may be occasional tightness in product markets and at locations that are import dependent (from either domestic or international sources), these appear to be only temporary and related to the late arrival of shipments. No serious problems in terms of reliability have occurred in those parts of Australia that highly dependent on imports such as the Northern Territory, South Australia or Tasmania. Another potential problem with import dependence is the possibility of the arrival of shipments of refined petroleum products that are non-compliant with Australian fuel specifications.

There has been a spate of production problems with domestic refineries during the first half of 2008 that resulted in tightness and even shortages in some product markets across the country. Based on recent experience, it would appear that reliance on domestic refining capacity has posed a larger risk in terms of reliability than overseas refining capacity coupled with shipping transportation although these problems have been only short-term in their duration. While the incidence of refinery production disruptions has not changed, their impact can now be more severe. This is due to increased interdependency between refinery production units with the move to cleaner fuels. Ongoing refinery production disruptions are expected to be an ongoing source of occasional product tightness in those regions supplied by domestic refineries, possibly even sometimes leading to product shortages.

This does not imply that the Australian refineries are not important to managing risks associated with interruptions to supply. On the contrary,

Australian refineries provide an important diversification of supply of petroleum products which is important to reducing Australia's liquid fuels vulnerability.

5.4 Regional differences

The Northern Territory is entirely dependent on overseas supplies of refined petroleum products. Refined petroleum products are shipped into the terminal in the Port of Darwin owned by Vopak. This terminal has a storage capacity of 160 ML and is co-mingled facility in which fuels imported by different operators are stored in the same tanks (Australian Competition and Consumer Commission, 2007a, p. 61). Parts of the Northern Territory around Alice Springs are supplied from Adelaide by road tanker.

During the course of consultations by ACIL Tasman, the only concerns expressed in regard to supply problems in the Northern Territory have been in relation to unexpected demand surges for refined petroleum products related to the conduct of military exercises by the Australian Defence Force (ADF) where local suppliers have not been given any advanced warning. It is understood that liaison and communications between the ADF and suppliers has improved and this problem has been addressed.

Tasmania is entirely dependent on mostly domestically produced supplies of refined petroleum products sourced from the Kwinana refinery and the Geelong refinery that are shipped into various terminals around the island. Tasmania is serviced by four import terminals: BP runs import terminals at Hobart and at Burnie; Shell operates an import terminal at Devonport; and Marstel operates an import terminal at Bell Bay. No major concerns were raised during the course of consultations regarding the reliability of supply in Tasmania, with any product shortages occurring being only temporary due to the late arrival of a shipment.

Most of South Australia is dependent on imported product shipped into the Port of Adelaide through a common user berth and distributed through terminals located at Birkenhead that are owned and operated by the oil majors. The major suppliers of refined petroleum products through Adelaide are Mobil who source product from Singapore, BP who source product from their Kwinana refinery, and Shell who source product from their Geelong refinery. Two to three shipments of refined petroleum products are received a week on average into Port Adelaide. Refined petroleum products can also be imported into South Australian through terminals at Port Lincoln (Caltex, Shell/Mobil).

No major concerns were raised during the course of consultations regarding

the reliability of supply in South Australia. Concerns were expressed that the late arrival of a shipment could result in some tightness in product markets, as well as the lack of coordination in regard to the arrival of shipments which could also create some tightness in product marketsin addition to problems in regard to demurrage. Concerns were also expressed in regard to diesel shortages during the harvest season in South Australia. Mobil commented to ACIL Tasman during the course of consultations that demand for diesel skyrockets in South Australia during the harvest and it was extremely difficult to forecast the timing of the harvest as it was determined by climatic events.

Victoria sources refined petroleum products through a variety of sources including local refineries as well as overseas refineries mainly in Singapore. There are local refineries at Geelong operated by Shell and at Altona operated by Mobil. In the vicinity of Melbourne, refined petroleum products can be imported through the Shell refinery at Geelong, through the Yarraville terminal adjacent to the Port of Melbourne that is operated by Mobil, through two terminals located at Newport also adjacent to the Port of Melbourne that are operated by Caltex and Shell respectively, a terminal at Altona operated by Martel Terminals and through the Hastings terminal located in Western Port Bay that has changed ownership several times and is now operated by United Petroleum.[5] No concerns have been expressed in regard to the overall reliability of supply of refined petroleum product in Victoria at an aggregate level, however, concerns have been expressed regarding the availability of product for emergency services in country Victoria on occasions although these problems are localised in nature. One concern raised was that demand for jet fuel from Melbourne Airport had reached the level of the production capacity of both refineries in the vicinity of Melbourne. There has been a dramatic increase in demand for jet fuel from Melbourne Airport due to a number of factors including the emergence of new domestic airline Jet Star and more international flights.

New South Wales sources refined petroleum products through a variety of sources including local refineries as well as overseas refineries. There are two local refineries operating in the Sydney region, the Shell Clyde refinery and the Caltex Kurnell refinery. Refined petroleum products can be imported into Botany Bay through several channels. There are berths located for the importation of refined petroleum products at the Caltex Kurnell refinery. There is also a common user bulk liquids berth maintained by Sydney Ports through which product can be imported into a terminal operated by Vopak at Port Botany. While refined petroleum products can be imported into the Clyde

[5] The Hastings terminal was acquired from Trafigura in December 2007 (United Petroleum, 2007).

refinery from a single pipeline running from Gore Bay located on Sydney Harbour, Shell has previously noted that it is logistically difficult to import refined petroleum products through this pipeline and prefers to use it to carry crude oil to the refinery (Australian Competition and Consumer Commission, 2007b, p. 38).

There is also a fuel import terminal at Port Kembla in Wollongong that is operated by Manildra Park Pty Ltd. Manildra Park Pty Ltd currently imports marine fuels into Port Kembla and resells those fuels to the Australian bunkers fuel market and also uses the terminal to distribute fuel to land based bulk users in New South Wales.

Several parties consulted raised concerns regarding the adequacy of infrastructure available to service Sydney and New South Wales with refined petroleum products. One party commented that the level of infrastructure was probably lagging around five years behind the level of demand.

- Concerns were raised that the Sydney Metropolitan Pipeline, which transports road transport fuels from the Kurnell refinery to the Silverwater and Parramatta terminals, the main distribution hub for road transport fuels in Sydney, was operating at its capacity constraints.
- Concerns were raised that the pipeline carrying jet fuel to Sydney Airport and the storage tanks facilities located at Sydney Airport, the Joint User Hydrant Installation (JUHI), had either reached or were approaching the level of their capacity constraints.
- Concerns were raised that with an increasing level of jet fuel being imported into Sydney from overseas refineries increased the risk that jet fuel may not be able to meet Australian fuel specifications, particularly in relation to electrical conductivity. This problem could be exacerbated through the absence of blending facilities at the JUHI at Sydney Airport needed to correct the problem.
- Concerns were raised that the bulk liquid berth at Port Botany was congested, operating beyond the level of its capacity constraints with demurrage becoming a problem.
- Concerns were expressed regarding the reliability of the local Sydney refineries in light of production problems during the first half of 2008.
- Concerns were expressed that swells in Port Botany could temporarily prevent the passage of tankers into the port, potentially disrupting shipments to the Kurnell refinery.
- Concerns were raised that there was little to no additional land available around Sydney for the construction of a new import terminal facility and that further expansion of existing import terminal facilities would eventually be constrained due to a lack of available land.

While the lack of available land around Sydney may constrain the future expansion of import terminal facilities in the Sydney region, this could create opportunities for the development of new import terminal facilities around Newcastle and Wollongong that could be used in future to supply the Sydney region.

Queensland sources refined petroleum products from a number of different sources. There are two local refineries operating in the Brisbane region, the BP Bulwer Island refinery and the Caltex Lytton refinery face each other on opposite sides of the Brisbane River and it is possible for these two refineries to receive imported product through the Port of Brisbane. In Brisbane refined petroleum products can be imported into the Neumann Petroleum terminal at Eagle Farm located on the Brisbane River, although this facility has always been capacity constrained as to the size of shipments that can be transported in. Shell can also import refined petroleum products into Brisbane through its terminal at Pinkenba. There are terminals along the Queensland coast able to receive imported product either from domestic or overseas sources at Gladstone (BP/Shell, Caltex/Mobil), Mackay (BP, Caltex, Shell), Townsville (BP, Caltex/Shell), Cairns (BP, Caltex, Shell).

- Concerns were raised regarding recent product shortages in relation to diesel due to unexpected refinery maintenance at one of the two Brisbane refineries.
- Concerns were raised that pipeline infrastructure used for transporting refined petroleum products in the Brisbane region was reaching the level of its capacity constraints.

Western Australia sources refined petroleum products from a number of different sources. There is one local refinery operating at Kwinana outside Perth run by BP. Imports of refined petroleum products can be received in the Perth region through Kwinana by the Kwinana refinery which has access to three dedicated berths, Coogee Chemicals (used by Mobil) and Terminals West (used by Gull Petroleum) who rely on berth 4 of the Bulk Cargo Jetty at Kwinana. There are terminals along the Western Australian coast able to receive imported product either from domestic or overseas sources at Broome (BP/Shell), Port Hedland (BP, Caltex), Geraldton (BP, Shell), Albany (Caltex) and Esperence (BP, Shell).

- Concerns have been expressed that the task of sourcing petrol in the event of a supply disruption at the Kwinana refinery has been made extremely difficult through Western Australia's restrictive fuel specification which restricts the volume of MTBE allowed to 0.1 per cent.
- Concerns were raised as to whether there was an adequate level of storage of refined petroleum products in Western Australia, especially in light of

the expansion of the mining industry in the north of the state.

- Concerns were raised regarding the usage of berth 4 of the Bulk Cargo Jetty at Kwinana with cargoes of fertiliser having priority over shipments of refined petroleum products.

These matters will be considered further in section 7.2 below.

5.5 Planned/ proposed investment on liquid fuels infrastructure

There are various upstream projects in the pipeline for crude oil and condensate production. A list of investment projects where investment funds have been committed or are currently under construction is provided below in Table 24.

Table 24 **Major new Australian crude oil/condensate production projects with committed capital expenditure or under construction**

Project	Project Type	Operator	Target capacity bpd	Capital Expenditure ($ million)	Start-up
Angel gas and condensate field	condensate	Woodside Energy	50,000	$1400	Late 2008
Vincent oil field	oil	Woodside Energy	100,000	$1000	2008
Woolybutt Oil Field South Lobe	oil	Eni Australia	6-8,000	$180	Early 2008
Montara	oil	Coogee Resources	na*	$595	2008
Puffin SW	oil	AED Oil	20-25,000	$100	22008
Pyrenees	oil	BHP Billiton	96,000	2020	2010

*Note:** Note available.

Data source: Australian Bureau of Agricultural and Resource Economics (2007c)

In addition there are several liquid petroleum production projects currently under consideration, a list of which is provided in Table 25 below.

Table 25 **Major new Australian crude oil/condensate production projects under consideration**

Project	Project Type	Operator	Target capacity bpd	Capital Expenditure ($ million)	Start-up
Basker, Manta and Gummy development	Oil	Anzon Australia/ Beach Petroleum	na*	$300	2008
Crux liquids project	condensate	Nexus Energy	32,000	$643	2010
Ichthys gas field	condensate	Inpex Holdings/ Total SA	100,000	$8000	2013-15
Talbot oil field	oil	AED Oil	10-20,000	na*	2009
Van Gogh	Oil	Apache Energy/Inpex Alpha	63,000	$1000	2009

*Note:** Note available.

Data source: Australian Bureau of Agricultural and Resource Economics (2007c)

There are also five projects currently under consideration to increase Australia's production of refined petroleum products that are outlined below in table 26.

Table 26 **Major new Australian production facilities for refined petroleum products under consideration**

Project Type	Operator	Target capacity	Capital Expenditure ($ million)	Start-up
Condensate processing facility	Darwin Clean Fuels	60,000 bpd of petrol, diesel, LPG and jet fuel	$450	2010
Gas to liquids project	Arrow Energy/ Alcan	14,000 bpd diesel 5,000 bpd naptha 1,000 bpd LPG	$1000	na*
Gas to liquids project	Sasol Chevron	30-45,000 bpd of diesel, naptha and LPG	$1000	2015+
Coal to liquids project	Monash Energy (Anglo American/ Shell)	60–70,000 bpd liquid fuels	na*	2017
Diesel refinery for Port Bonython	Stuart Petroleum/Scott Group	750 bpd	$25	na*

Note: * Note available

Data sources: Australian Bureau of Agricultural and Resource Economics (2007a), Stuart Petroleum Limited (2008)

Construction on the proposed diesel refinery at Port Bonython by Stuart

Petroleum and the Scott Group is currently scheduled to begin in 2009. In addition, Stuart Petroleum and the Scott Group have announced plans to commence construction of diesel import and storage terminal in mid-2008 following the completion of a detailed engineering design stage (Stuart Petroleum Limited and Scott Group of Companies, 2007). Construction of the diesel refinery is expected to commence following the completion of the terminal.

Caltex outlined a significant program of investment in its submission to the ACCC petrol inquiry in 2007 (Caltex Australia Ltd, 2007). According to Caltex large investments are planned to meet growing demand, improve environmental performance and reduce costs with its annual capital expenditure expected to average $350 million from 2007 to 2009 comprising:

- Around $290 million will be required to complete the Caltex Refinery Performance Improvement Plan by early 2009.
- $60 million has been earmarked to strengthen the Caltex terminal infrastructure around the country.
- The balance (around $200 million annually) will be for maintenance and compliance capital expenditure through the Caltex marketing, supply and distribution, and refining groups.

Some of the major projects Caltex is undertaking include:

- New Lytton refinery diesel hydrotreater unit (DHTU). At an estimated capital cost of about $250 million the Lytton refinery is in the process of constructing a second DHTU with an expected capacity of 3,000 tonnes per day. This new DHTU will allow the Lytton refinery to produce another 22,200 bpd of 10 ppm sulphur diesel. It is anticipated the new DHTU with be online in the first quarter of 2009.
- New Lytton refinery sulphur recovery unit (SRU). In association with the new DHTU, a new sulphur recovery unit is also under construction at a cost of over $55 million. This unit will enable the Lytton refinery to significantly reduce sulphur dioxide emissions.
- New Kurnell refinery sulphur dioxide mitigation measures. The Kurnell refinery is developing plans to meet more stringent sulphur dioxide emission standards as required under new post-Clean Fuels Project licence conditions.
- New Kurnell refinery crude oil tank. At an estimated capital cost of $32 million the Kurnell refinery is constructing a new 88 ML crude oil storage tank. With completion due mid 2008, the primary purpose is to increase crude oil stockholdings to allow high levels of production to continue during periods of rough weather which has historically delayed crude vessels from discharging their cargoes in Botany Bay.

- New Kurnell refinery diesel tank. At an estimated cost of $13 million, the Kurnell Refinery is constructing a new 18 ML diesel storage tank which has recently been completed. This additional tank will allow the refinery to store any off-specification diesel produced during major maintenance activity on some diesel processing units. This will allow the Kurnell refinery to continue producing near normal levels of petrol and jet fuel during these scheduled major maintenance activities.
- Lytton refinery isomerisation catalyst upgrade. At a cost of $4 million, a new catalyst is being utilised in the Lytton refinery isomerisation unit to increase the octane-making capability of the refinery. This catalyst produces an addition 2 to 3 octane numbers and helps produce high octane petrol to meet growing market demands for higher octane fuels.

BP told the ACCC petrol inquiry last year that it had opened a new 25 ML diesel storage tank in Mackay in Queensland in late 2006 to cater for the large growth in demand by the mining industry (BP Australia Pty Ltd, 2007, p. 19). BP told ACIL Tasman during the course of consultations that it had invested in new tank storage capacity for crude oil at its Kwinana and Bulwer Island refineries, and that it had invested in new tankage storage capacity primarily for diesel in Adelaide, Queensland and northern Australia. BP has also announced plans to construct two 23-million tonne storage tanks and associated pipelines to import fuel through Newcastle Port (Newcastle Port Corporation, 2006, p. 2).

Shell told ACIL Tasman during the course of consultations that it had recently invested in new tank storage facilities in Brisbane.

Marstel Terminals is currently investing in more tankage storage capacity through the recommissioning of tank storage at its terminal at Bell Bay in Tasmania in order to bring the facility back to its full capacity of 45 ML (Australian Competition and Consumer Commission, 2007c, p. 59). Marstel Terminals has recently been granted approval by the New South Wales Government to establish a new bulk liquids storage facility at Newcastle Port consisting of six tanks to store 59 ML of fuel. This new terminal will also incorporate a fuels and biofuels blending facility. Construction of this new facility is scheduled to commence in April-May 2008 in order to be operational by the middle of 2009. Manildra Park Pty Ltd has also been given approval to establish a ship refuelling and biodiesel production facility at Newcastle Port that involves the refurbishment of two existing 15,000 tonne storage tanks and the construction of three additional storage tanks as well as a distribution network of pipelines.

Vopak is currently in the process of constructing an additional 75,000 cubic

metres of storage capacity at its Port Botany facility that is due for completion in October 2008 (Australian Competition and Consumer Commission, 2007d, p. 17). Depending on the uptake of this additional storage capacity, Vopak is considering construction of a further 85,000 cubic metres of storage capacity with construction possibly commencing in the middle of 2008 in order to be available some time in 2009 (Australian Competition and Consumer Commission, 2007d, 17).

Neumann Petroleum is also planning to increase its current terminal storage capacity through construction and relocation to a larger facility with a berth that has a deeper draught allowing it to import cargoes from larger tankers (Australian Competition and Consumer Commission, 2007e, p. 8).

In the course of consultations, ACIL Tasman has become aware that tank storage capacity for the joint user hydrant installations for Melbourne and Brisbane airports has recently been increased. On the other hand, uncertainty surrounding the extension of the lease for land currently made available for the JUHI at Sydney Airport may be impeding further investment in the upgrading of this facility.

Sydney Ports Corporation is currently examining the feasibility of constructing a second bulk liquids berth at Port Botany. In November 2007 the New South Wales Minister for Ports and Waterways announced that the New South Wales Government was moving forward with plans to construct the new berth at a cost of $69 million (Tripodi, 2007). Earlier this year, environmental approvals were granted for the project to proceed.

In terms of future investment in the downstream petroleum industry, the peak lobby group for the oil refiners, the AIP has recently commented:

> Industry infrastructure investment will continue to be focused on maximising the efficiency of the supply chain.
>
> As part of industry's ongoing efforts to maintain supply reliability, industry will be considering further investment in port unloading, terminalling and storage capacity.
>
> In this context, it is important that a positive investment environment is maintained and any barriers to efficient investment in additional supply chain improvements are improved. (Australian Institute of Petroleum, 2008, p. 16)

Some of the refiners spoken to by ACIL Tasman commented that they would invest in new infrastructure when it made economic sense for them to do so.

During the course of ACIL Tasman's consultations, it became aware of the intention on the part of numerous parties to establish new import terminals through the installation of new tank storage capacity at various locations

around the country including some mining companies. Some of these proposals are only in the preliminary stages of development and none of these proposals are as yet in the public domain. In addition, ACIL Tasman found throughout the course of its consultations that numerous other parties were also interested in establishing new import terminals around the country.

However, despite the heightened level of interest shown in the establishment of new import terminals and the construction of new tank storage capacity, concerns were also raised by several parties regarding impediments to investing in new facilities including:

- Concerns were raised in regard to lengthy and cumbersome planning and environmental approval processes to get permission to handle hazardous materials.
- Concerns were raised regarding the lack of suitable land for the construction of new import terminal facilities at port locations around the country.
- Concerns were raised that encroachment of urban land development on terminal facilities was impeding many terminal operators who wanted to increase storage capacity.
- Concerns were raised that the administration of Australia's competition laws were impeding the signing of long-term storage contracts necessary to underwrite investment in new storage tank facilities.

Some of these impediments increase the transaction costs associated with the construction of new infrastructure facilities, which could even deter investment from occurring altogether in some instances. Prominent US economist Oliver Williamson has identified three critical dimensions for categorising transactions:

1. Uncertainty
2. Frequency with which transactions recur
3. The degree to which durable transaction-specific investments are incurred. (Williamson, 1979, p. 239)

Several parties consulted expressed frustration that it had taken them many years and much expense to go through various planning and environmental approval processes for new infrastructure projects associated with the importation of refined petroleum products such as bulk liquid berths and new terminal storage facilities. Some of these parties opined that it must be possible to streamline and expedite these various regulatory approval processes. A multitude of regulatory approval processes increases the amount of time associated with the development of new infrastructure projects which in turn may add to the development costs as well as to the uncertainty as to whether the project will actually proceed.

Several parties consulted expressed the view that domestic refiners had generally taken the most advantageous positions for import terminal facilities at various port locations around the country, leaving little suitable land available for the construction of new import terminal facilities. In particular, several parties commented that they believed there was little to no additional land available around Sydney for the construction of a new import terminal facility and that further expansion of existing import terminal facilities would eventually be constrained due to a lack of available land.

A related concern expressed by some parties was that lax zoning laws had allowed urban land development to encroach on the industrial areas of ports, thus limiting the opportunity for the further expansion of existing import terminal facilities in some locations. One participant consulted accused various port authorities of being more interested in real estate development rather than focusing on the management of port operations.

Participants in the downstream petroleum industry perceive that there is hostility from the ACCC towards any long-term contracts for the leasing of storage between import terminal operators and domestic refiners which could in turn be impeding investment in the construction of new terminal storage facilities. These perceptions are consistent with concerns expressed in 2007 by the ACCC that domestic refiners could artificially restrict import terminal capacity available to independent importers (non-vertically integrated wholesalers of refined petroleum products) by leasing capacity in excess of their needs despite ACCC admissions that it had no evidence of this practice actually occurring (Australian Competition and Consumer Commission, 2007a, p. 213). The ACCC's concerns in this regard would appear to be based on fears that domestic refiners could "hoard" independent terminal storage capacity as a means of engaging in strategic entry deterrence into Australian wholesale markets for refined petroleum products.

Consistent with the views of downstream petroleum industry participants collected during the course of consultations, the ACCC found that import terminal operators were reluctant to invest in large-scale terminal facilities without a long-term contract from an importer (Australian Competition and Consumer Commission, 2007a, p. 214). On the other hand, the ACCC found that independent importers were generally unable or unwilling to enter into long-term arrangements without some certainty that they had markets for their product imports (Australian Competition and Consumer Commission, 2007a, p. 214).

The development of a terminal storage facility is an investment in specialised physical capital of a transaction-specific nature. The value of the use of this facility, by its very nature, is much smaller for any activity other than the distribution of refined petroleum products. Thus owners/operators of terminal storage facilities are "locked in" to the distribution of refined petroleum products. In order to minimise on the uncertainty associated with such an

investment, owners/operators seek to enter into long-term contracts with customers. ACCC hostility towards long-term contracts between terminal storage facility owners and customers could present a challenge to further ongoing investment. ACIL Tasman is concerned that the ACCC could be using its authority in the administration of the competitive conduct provisions of the Trade Practices Act to engage in 'economic engineering' of the downstream petroleum industry in favour of independent importers. Such activity raises concerns regarding the investment environment for new import terminal storage capacity.

It would appear that participants in the downstream petroleum industry are responding to the market incentives being presented to them by either investing in new infrastructure or investigating the feasibility of new infrastructure investment, particularly in regard to new import terminal facilities. In this regard, the market would appear to be working towards ensuring Australia's ongoing energy security in refined petroleum products. However, infrastructure investment could be impeded through various regulatory requirements which in turn may present a challenge to ongoing energy security as Australia becomes increasingly dependent on imported refined petroleum products. Extending the scope of the Government's upcoming audit of petrol import terminal capacity announced in April 2008 will present an opportunity to assess whether planned investment in import terminal facilities will be sufficient to keep up with Australia's increasing reliance on imported refined petroleum products.

5.6 Summary of reliability of Australian supplies

5.6.1 Developments since 2004

The major change since 2004 is that the impact of the incidence of unexpected refinery maintenance and shutdowns is now more severe than previously due to the increased level of interdependence between refinery operating units associated with tighter Australian fuel specifications. A problem with one refinery processing unit is now more likely to disrupt production and possibly shut down the refinery altogether than was previously the case as the fuel produced may no longer be compliant with Australian fuel specifications. Furthermore, there is a limit to the potential to utilise spare refining capacity to cover temporary losses in production capacity in particular refineries. In addition, it appears that infrastructure supporting the downstream petroleum industry in particular locations, such as in Sydney, has reached the level of its operating capacity.

5.6.2 Outlook to 2020

With increasing demand for petroleum based liquid fuels outstripping any possible expansion in domestic refining capacity, Australia's reliance on imported refined petroleum products will continue to increase. This will put greater reliance on the adequacy of infrastructure available to support the importation of refined petroleum products.

Ongoing refinery production disruptions are expected to be an ongoing source of occasional product tightness in those regions supplied by domestic refineries, possibly even sometimes leading to product shortages.

It does appear that participants in the downstream petroleum industry are responding to the incentives presented to them through market signals and are investing in maintaining and upgrading existing infrastructure as well as constructing new infrastructure. This should help ease pressure in the supply chain from infrastructure bottlenecks that are beginning to emerge.

6 Sources of supply disruption

During the course of consultations stakeholders were asked to identify what they believed to be the most likely major potential sources of supply disruption to transport liquid fuels. Stakeholder identified major potential sources of supply disruption that are outlined in the subsections below which include:

- supply routes
- refinery incidents
- critical infrastructure
- distribution channels for road transportation
- industrial action.

6.1 Supply routes

Nearly all stakeholders consulted nominated a supply disruption of imported crude oil suitable for processing in Australian refineries as one of the two most likely sources of a supply disruption to refined petroleum products. Such a disruption could be due to problems in relation to crude oil production or international sea lanes. Instability in the Middle East was believed to the most likely source of such a supply disruption.

In addition, supply of refined petroleum products would also be disrupted due to the loss of access to imported refined petroleum products. This could be due to the simultaneous loss of overseas refining capacity capable of meeting Australian fuel specifications. It could also be due to problems in regard to international sea lanes. Supply routes as the source for a major supply disruption will be assessed in section 7 below.

6.2 Refinery incidents

Nearly all stakeholders nominated coincidental unexpected refinery shutdowns as the other most likely source of a supply disruption to refined petroleum products. The occurrence of multiple unexpected refinery shutdowns has happened before. Retail petrol prices spiked over the Christmas 2000 and the New Year period following a series of unexpected refinery shutdowns on the Australian eastern seaboard. The impact of a series of unexpected refinery shutdowns is now likely to be far more severe than previously given there is no longer any spare domestic refining capacity and therefore less scope to redirect domestically refined petroleum products bound for export markets.

Another event nominated by several stakeholders that could trigger a series of

unexpected refinery shutdowns, which in turn could jeopardize the supply of refined petroleum products, is power blackouts. Oil refineries need power to continue to operate and a failure of the power system could close down a refinery unexpectedly. Refineries in Australia have been subject to unexpected shutdowns due to electricity blackouts. Refinery incidents as a source for a major supply disruption will be assessed in section 7 below.

6.3 Critical infrastructure

Some parties nominated the failure of critical infrastructure as a potential source for a supply disruption for refined petroleum products such as terminal facilities, pipelines and berthing facilities at ports. This could be due to an equipment breakdown or through a deliberate act of sabotage. However, the effects of a failure in critical infrastructure are likely to be isolated to particular geographical area.

Several parties nominated the blockages of critical shipping channels on the approach to ports as a possible source of a supply disruption. Another event identified that could disrupt the supply of refined petroleum products is power blackouts. Oil terminals and pipelines need power in order to continue operation. Oil terminals cannot continue to distribute refined petroleum products without a power source. Similarly, pipelines carrying either oil or refined petroleum products need power in order to continue pumping to transport the product.

Critical infrastructure as a source for a major supply disruption will be assessed in section 7 below.

6.4 Distribution channels for road transport

The supply of refined petroleum products could also be disrupted due to problems associated with the distribution channels for road transport, which includes road tanker delivery of refined petroleum products to distribution points for final end consumers such as retail service station sites.

There were no concerns raised at all during the course of consultations arising from a supply disruption related to road tanker delivery. However, the Service Station Association (SSA) expressed concern the distribution system for refined petroleum products was under threat arising from the closure of retail service station outlets in regional Australia. While acknowledging that service station numbers have been in decline in recent years as a result of increasing efficiency within the downstream petroleum industry, the SSA observed that the rate of service station closure had accelerated due to the entry of

supermarket chains Coles and Woolworths into petroleum product retailing. SSA contended the supermarket chains were able to negotiate very large volume price discounts from suppliers and that other service station operators were unable to secure refined petroleum products on terms that would enable them to effectively compete against the supermarket chains.

The SSA believes that as service stations close due to competitive pressures from the larger supermarket chains, distribution channels to small and medium communities in regional Australia have been impaired.

Distribution channels for road transport as a source for a major supply disruption will be assessed in section 7 below.

6.5 Industrial action

Some parties nominated industrial action as a potential source for a supply disruption for refined petroleum products. Industrial action could occur at various points along the chain of supply from crude oil production, points of distribution of crude oil to the refinery, refinery production, and points of distribution to final end users.

The gas and crude oil production facilities of Bass Strait were subject to several industrial disputes during the 1990s. Similarly, there have been numerous industrial disputes at Australian oil refineries, some of which that have adversely affected the supply of refined petroleum products. There has also been a long history of industrial disputes involving tanker drivers engaged in the transportation of refined petroleum products.

However, the level of industrial disputation in Australia has dramatically declined since the mid-1980s, with the number of working days lost per 1,000 employees at historically low levels (Australian Bureau of Statistics, 2008c). In addition, the scope to engage in legally protected industrial action in Australia is extremely limited and can be rescinded. This position will remain despite foreshadowed changes to Australia's industrial relations system by the Commonwealth Government.

Under these circumstances, the prospect of industrial action as the cause of a major supply disruption for refined petroleum products is rated extremely low. On this basis, industrial action as a source for a major supply disruption will not be considered further.

7 Vulnerability assessment

7.1 Fuel types

It should be noted each domestic refinery holds significant stocks of crude oil, intermediate products and finished products. Depending on the nature of any supply disruption in liquid fuels, refinery stockholdings create a buffer which enables alternative supply arrangements to be made, generally without any significant impact on consumers of refined petroleum products.

Petrol

In regard to petrol, most of Australia is still heavily dependent on domestic production capacity. The greatest risk posed to the supply of petrol comes from a domestic supply disruption, as it may be difficult to source product compatible with Australian fuel specifications from overseas refineries to make up for any shortfall in a timely period. During the course of consultations, many stakeholders commented that it was impossible to order petrol from overseas meeting Australian fuel specifications on the spot market, and that orders usually had to be negotiated directly with overseas refiners. It was estimated that it could take a period of anywhere between three to six weeks from placing an order to receive a cargo of petrol from an overseas refinery - six weeks was noted as being a more realistic time frame. In addition, most stakeholders recognised the scarcity of refining capacity in the Asian region capable of producing petrol to the Australian fuel specifications.

However, the difficulty of sourcing petrol compatible with Australian fuel specification will improve with new refining capacity coming online in the Asian region and as fuel standards are tightened across Asia. Provided Australian fuel specifications are not tightened further, it should become progressively easier to source petrol compatible with Australian fuel specifications. Overall, it is assessed that a major disruption to the supply of petrol and product shortfall should only be short-term in nature and would be overcome through a combination of overseas imports and restoration of the situation leading to the domestic supply disruption.

Diesel

Unlike the situation with petrol, Australia has become increasingly dependent on imported supply of diesel with imports representing over one third of domestic demand. The greatest risk posed to the supply of diesel comes from both domestic and overseas supply disruptions. However, based on

stakeholder consultations it is understood that diesel compatible with Australian fuel specifications is commonly traded in the Asian region and relatively easy to procure. Similarly to the case with petrol, it is assessed that a major disruption to the supply of diesel and product shortfall should only be short-term in nature and would be overcome through a combination of overseas imports and restoration of the situation leading to either an overseas or domestic supply disruption.

Jet Fuel

In regard to jet fuel, while Australia has a high level of self-sufficiency there are regional variations, particularly in Sydney where domestic demand is concentrated and which is partially import dependent as a result. The greatest risk posed to the supply of jet fuel comes from both domestic and overseas supply disruptions. This could arise due to problems with domestic and/or overseas refineries, as well as problems with domestic supply infrastructure such as pipelines and storage facilities.

A problem with jet fuel supplies occurred in Sydney from mid-September 2003 until mid-October 2003. On 19 September 2003 jet fuel customers were rationed to 90 per cent of normal uplifts from the Sydney JUHI. On 25 September 2003 jet fuel customers were rationed to 35 per cent of normal uplifts for a period of 36 hours after which time rationing was progressively eased. Rationing was finally lifted on 13 October 2003. A contributing factor to this event was a number of coincidental production problems at a number of refineries (Kurnell, Clyde and Geelong).

Based on stakeholder consultations it is understood that jet fuel compatible with Australian fuel specifications is commonly traded in the Asian region and relatively easy to procure. On the other hand, concerns have been raised regarding the ability of overseas sourced jet fuel to meet Australian fuel specifications, particularly in regard to electrical conductivity. Leaving aside the issue of electrical conductivity that is beyond the expertise of ACIL Tasman to assess, it is considered that a major disruption to the supply of jet fuel and product shortfall would only be short-term in nature and would be overcome through a combination of overseas imports and restoration of the situation leading to either an overseas or domestic supply disruption. However, even a short-term disruption to airline traffic arising from a jet fuel supply disruption could do immense and lasting economic damage. This issue will be further considered in section 7.7 below.

7.2 Regional vulnerabilities

One of the main supply risks to the ongoing supply of refined petroleum products to various parts of Australia comes from product shipments either from domestic or overseas sources. North and North West Australia including the Northern Territory, and most of South Australia are highly dependent on shipments on refined petroleum products from overseas refineries. The main risk of supply disruptions to these regions come from problems with overseas refineries, problems with shipments and sea lanes, and problems with berthing and terminal storage facilities. For example, concerns were raised that Port Adelaide had only one berth available to receive cargoes of refined petroleum products which presented a risk to liquid fuel supplies across South Australia if a ship was unable to berth for any particular reason. Aside from problems due to the late arrival of shipments and some logistical problems associated with the simultaneous arrival of multiple shipments creating competition for limited berthing facilities, few concerns were expressed regarding the reliability of supply from overseas sources. On the basis of consultations, it is assessed that the prospect of a major supply disruption to regions of Australia largely dependent on overseas supplies of refined petroleum products is extremely low.

Tasmania is dependent on refined petroleum products sourced from domestic refineries located at Geelong and Kwinana. The main risk of a supply disruption comes from problems with the Geelong and Kwinana refineries, problems with product shipments, and problems with berthing and terminal storage facilities. While there have been some rare late arrival of product shipments that have resulted in some product tightness, the view was expressed that Tasmania has a very good regional dispersion of portside terminalling facilities that ensures Tasmania would always be able to receive product shipments in several localities even if there was a problem with one or more terminals. On the basis of consultations, it is assessed that the prospect of a major supply disruption to Tasmania of refined petroleum products is extremely low.

The rest of Australia is supplied through a combination of domestic and overseas sources of refined petroleum products. The main risks of a supply disruption come from problems with the supply of domestic and imported sources of crude oil for the operation of domestic refineries, problems with domestic and overseas refineries, problems with sea lanes and shipments for overseas sourced crude oil and refined petroleum products, and problems arising from breakdowns with domestic critical infrastructure such as berthing facilities, terminals and pipelines.

Concerns have been expressed regarding congestion at common user berths for the discharge of refined petroleum products at Port Botany in Sydney and at Kwinana near Perth. Concerns regarding swells preventing the discharge of crude oil for the Kurnell refinery on Port Botany are being addressed through Caltex building more storage capacity for crude oil at the Kurnell refinery.

Concern was expressed regarding the reliability of domestic refineries and critical infrastructure in some parts of Australia, particularly in Sydney, which is operating at or close to capacity. Concerns have been expressed regarding pipeline infrastructure in Sydney and Brisbane, which may be operating at or close to its capacity raising the prospect of a malfunction.

Concerns have also been expressed regarding the adequacy of supply of jet fuel to Sydney Airport in relation to the storage capacity of the JUHI and the capacity of the pipelines delivering jet fuel to the airport. However, despite recent problems with major refinery outages, there have no major product shortages where consumers have not been able to resort to close substitute products. For example, given product shortages of premium unleaded petrol in Sydney during the first part of 2008, consumers still had the option of purchasing regular unleaded petrol as a substitute product. Overall, on the basis of consultations it is assessed that the prospect of a major supply disruption to the rest of Australia of refined petroleum products is extremely low.

However, due to the tighter fuel specifications operating in Western Australia compared to the rest of the country, there may be a heightened level of risk in regard to the supply of petrol in that state in the event of a refinery outage at the Kwinana refinery due to the increased difficulty of sourcing petrol from overseas refineries able to comply with the Western Australian fuel specifications. While the ExxonMobil refinery in Singapore can produce petrol that meets the Western Australian fuel standards and supplies petrol to Western Australia on a regular basis, concern has been expressed that this is probably the only refinery in the Asian region that can meet the Western Australian fuel specifications. A Shell company representative commented back in October 2001 on the Western Australian fuel specifications that:

> Shell has attempted to produce fuel in Singapore which meets this standard. Our experience was that we were only able to produce small quantities of such fuel and the cost premium was around 5 cents a litre. (Callaghan, 2001)

An unexpected shutdown of the Kwinana refinery raises concerns as to whether there is sufficient refining capacity is available in the Asian region to cover supply shortfalls of petrol in Western Australia.

7.3 Supply chain vulnerabilities

Potential vulnerabilities exist all along the supply chain for refined petroleum products. There are potential vulnerabilities in the production of crude oil whether from overseas or domestic sources. For example, crude oil supply from Bass Strait was cut off in the aftermath of the Esso Longford gas plant explosion on 25 September 1998 with Victorian refineries loosing the source of around 50 per cent of their crude oil supplies. In response to the Longford gas explosion, both Mobil and Shell were forced to place orders for crude oil imports and to divert shipments of crude oil from interstate and from New Zealand to keep their Victorian refineries operating. Despite the Longford gas explosion, there were no product supply shortages (Australian Institute of Petroleum, 2003).

One refiner commented to ACIL Tasman during the course of consultations that while there were occasional problems encountered within individual oil fields overseas, overseas suppliers of crude oil were generally very reliable. All domestic refiners rated the reliability of overseas crude oil suppliers as extremely high. Based on consultations with stakeholders, it would appear that the prospects of a supply disruption due to problems with crude oil production either in Australia or overseas is extremely low. Furthermore, no concerns were expressed by any of the domestic refiners in regard to the lack of availability of crude oil overseas as long as one was prepared to pay the going price. There would appear to be a sufficiently diverse range of supply options available to mitigate against any serious and sustained supply disruption from one particular source and that there are adequate supplies of crude oil in the immediate future provided Australia is prepared to pay the asking price. This is consistent with the views of AIP, which has commented:

> Reliable access to crude oil supplies suitable for Australian needs has not been a problem, even during periods of rapidly rising oil prices. Australia will continue to be able to access crude oil and products to meet its fuel requirements as long as we pay the international market price. There is no reason to believe this situation will change. (Australian Institute of Petroleum, 2008, p. 5)

Potential vulnerabilities exist in the supply chain in regard to the shipment of both crude oil and refined petroleum products to Australia. However, no major concerns were expressed regarding sea lane security during the course of consultations which supports the views of various security analysts that the world's sea lanes are relatively safe for oil tankers. In addition, the amount of shipping capacity appears to be adequate for the shipment of both crude oil and refined petroleum products in the foreseeable future given the amount of new tankers on order and the conversion program to turn existing tankers into

double hulled tankers. The available evidence suggests that the prospect of a major supply disruption arising from problems with shipments of crude oil and refined petroleum products appears to be very low.

Potential vulnerabilities exist in regard to the channel approaches to ports and through the malfunction of port unloading transfer facilities. Port authorities consulted expressed the view that the sinking of vessels in channels may cause some temporary disruptions, but could be cleared in a matter of weeks or months and would not cause permanent disruptions to port traffic. Port authorities consulted by ACIL Tasman commented that they took every possible precaution to prevent such incidents from occurring including through the use of harbour pilots. No concerns were expressed during the course of consultations regarding the malfunction of port unloading transfer facilities with the view expressed that such problems can usually be addressed and rectified in a relatively short period of time. The available evidence suggests the prospect of a major supply disruption arising from problems in regard to channel approaches to ports and port unloading transfer facilities are extremely low.

Potential vulnerabilities exist in regard to the supply of refined petroleum products from domestic and overseas refineries supplying Australian product markets. In particular, there were a spate of problems with domestic refineries during the first half of 2008. Despite recent problems with domestic refineries, there have been no major product shortages in any market for which close substitute products were not available. As previously discussed in section 5.2, domestic refiners has been able to cover recent supply disruptions arising from unexpected shutdowns of refineries through imports and other processes. During the course of consultations, all parties with experience of importing refined petroleum products into Australia rated the reliability of overseas suppliers as extremely high. The available evidence suggests that the prospect of a major supply disruption arising from refinery problems in Australia and overseas is extremely low with sufficient diversity of supply sources generally available to eventually cover any temporary shortages relating to refinery production problems.

Potential vulnerabilities also exist in regard to the supply of refined petroleum products from terminal facilities. Concerns were raised by several parties consulted that the terminal facilities operated by the domestic refiners were old and in need of upgrading. In addition, concerns were raised that terminal facilities are now being run harder and closer to their full operating capacity, which is increasing the prospect of breakdowns occurring. Terminal problems could arise through the malfunction of the gantry unloading transfer facility. Despite some recent issues in Melbourne in regard to terminal facilities, no

major product shortages have actually occurred where at least close substitute product were not available. An emerging issue, however, is probably the lack of adequate terminal capacity to meet increasing demand, particularly for diesel in northern and North West Australia. While there appears to be enormous interest in the construction of new terminal capacity with many projects under construction or in the development phases, there are a range of impediments to further investment that were outlined in section 5.5. The available evidence suggests that the prospect of a major supply disruption arising from problems with terminals appears to be very low at the present time, however, impediments to investment may begin to impinge on the adequacy of terminal storage capacity in the future to keep up with demand in refined petroleum products.

Potential vulnerabilities also exist in regard to the possible malfunction of pipeline transfer facilities. There was a major incident with the Santos pipeline that carried crude oil from Moonie to Brisbane in July 2007 when the pipeline ruptured resulting in a spill of crude oil in a Brisbane suburb. The pipeline was subsequently shutdown and Santos announced that the pipeline will be permanently closed. Another pipeline problem arose in Melbourne with the detection of corrosion and a small breach in the pipeline wall in a Mobil pipeline at Newport in December 2006 that was subsequently repaired. It took only nine days from the detection of the pipeline problem on 12 December 2006 to repair the pipeline and return it to operation on 21 December 2006 (LanePiper, 2007). Concerns have also been expressed that pipeline infrastructure in Sydney and Brisbane may be operating at the level of its capacity constraints raising the prospect of a malfunction. In the event of a major pipeline disruption, it is possible to transport refined petroleum products by road tankers. For example, Santos has been transporting crude oil from Jackson to Brisbane by road tanker since the closure of the Santos pipeline. The available evidence suggests the prospect of a major supply disruption arising from problems in regard to the malfunction of a pipeline is extremely low and that alternative supply systems are available although this could put pressure on the road tanker fleet. It also appears that minor pipeline breaches can be repaired in a relatively short period of time. The available evidence suggests that the prospect of a major supply disruption arising from a pipeline malfunction is extremely low.

Potential vulnerabilities may also exist in regard to the availability of road tankers and retail service station sites for the distribution of road transport fuels to final end users. Views were mixed on the adequacy of supply of road tankers during the course of consultations. Some parties expressed the view there were some shortages of road tankers. Reasons attributed for the

shortages of road tankers included Santos transporting crude oil from the Moonie field to Brisbane by road tanker, and the transportation of ethanol into New South Wales. On the other hand, other parties expressed the view that there were no major problems in regard to the adequacy of supply of road tankers. Overall, no party consulted expressed the view that the availability of road tankers represented a major vulnerability to the supply chain as there are a plentiful number of road tankers that are widely dispersed and that no single incident could severely restrict their operation. Concerns were raised by the SSA that the accelerated rate of closure of retail service station sites in non-metropolitan areas could leave motorists in rural and regional Australia without sufficient distribution channels for transport fuels. On the other hand, there are still some 6,000 retail service station outlets across Australia (Australian Institute of Petroleum, 2008). In 1994 when there were some 9,800 retail service stations, the Motor Trades Association of Australia (MTAA) was of the opinion that there was over-capacity in retailing and estimated that between 3,000 and 3,600 sites would have to close to ensure that the sector was earning a normal economic rate of return (Industry Commission, 1994, pp. 22-23). The current number of retail service stations of around 6,000 is close to the appropriate number of retail service stations suggested by the MTAA in 1994. The available evidence suggests that the prospect of a major supply disruption arising from problems with road tankers and retail service stations is extremely low to being practically non-existent.

7.4 Industry response capabilities

During the course of ACIL Tasman's consultations, one Australian refiner explained that in the event of an unexpected supply disruption they went through a series of escalating steps in order to secure adequate product supplies which has previously been outlined in section 5.2 above.

Similarly, AIP has outlined the main response options to meet a demand-supply shortfall:

- In-refinery options:
  - Repair production unit or handling facility.
  - Draw down refiners' stocks.
  - Truncate maintenance program.
  - Increase production throughput of facility.
  - Technical refinery options (depending on duration of the supply disruption):
    - … alter the cut points for different products (which could result in less jet fuel);

  - … change catalysts to produce more/less diesel/petrol for a lengthy disruption (very expensive and 3 month implementation time); or
  - … change crude types together with relaxation of fuel standards for a lengthy disruption (3 month implementation time).
- Sourcing alternative supplies from other refiners:
  - availability depends on location and time to relocate stocks.
- Source alternative supplies internationally:
  - spot and stranded loads, or
  - redirection of international cargoes.
- Allocate bulk fuel supplies to customers:
  - constrain supply to customers in order to encourage draw-down of customer stocks.
- Other options:
  - utilise other transport means to move product, or
  - modify/improve supply planning strategies and customer consultation. (Australian Institute of Petroleum, 2008, p. 15)

Several representatives of State Governments consulted complemented the domestic refiners on how they managed and were able to procure supplies of refined petroleum products in the event of unexpected refinery shutdowns to avoid product shortages. This is consistent with comments made by AIP that the domestic refiners have been able to obtain alternative supplies of refined petroleum products on every occasion when there has been an unexpected refinery shutdown without any markets suffering too adversely from any major product shortages:

> …every instance the industry has managed to arrange supply through imports and established inter-company processes without any significant shortfalls in the market. (Australian Institute of Petroleum, 2008, p. 12)

Given recent refinery problems around Australia, particularly in regard to Sydney, it appears that domestic refiners are extremely adept at managing supplies of refined petroleum products in order to avoid major product shortages.

7.5 Supply disruption and IEA obligations

The most likely effect of any supply disruption occurring in Australia arising from Australia's IEA obligations to release emergency stocks under the IEP Agreement would be through higher prices for refined petroleum products. The event triggering the release of emergency stocks by IEA member countries

under the IEP Agreement could be expected to put considerable upward pressure on world crude oil prices and prices for refined petroleum products. Price rises due to worldwide factors could in turn be exacerbated due to domestic and local factors arising from shortages for refined petroleum products.

In the event of a supply disruption which requires Australia to meet its international obligations to the IEA under the IEP Agreement, the current policy of the Commonwealth Government is to allow market mechanisms to operate to constrain demand. This would occur by allowing higher prices for refined petroleum products to flow through to consumers. The Commonwealth Government would monitor the effects of the price rises on the pattern of demand without intervening in the market.

An event triggering the release of emergency stocks under the IEP Agreement could trigger across-the-board panic buying by final end users of refined petroleum products resulting in no significant reduction in demand. If price rises did not lead to a sufficient decline in demand, the Commonwealth Government would, in the first instance consider an industry-based bulk rationing strategy. This would involve seeking the co-operation of industry to place its consumers on allocation systems, e.g. fuel purchasers would be able to purchase a set percentage of their normal fuel allocations. At the same time, the Commonwealth Government would encourage the general public to voluntarily reduce oil consumption by promoting public transportation, car-pooling, multiple taxi-hire arrangements and other strategies designed to reduce overall fuel demand.

If further intervention was required in order to constrain demand in the form of a regulated fuel-rationing system, the Commonwealth Government has powers to require bulk and/or retail rationing, procedures for which have been developed as part of its LFE Response Plan. Implementation of this Plan would require the LFE Act to be invoked.

Following the declaration of a national emergency, the Commonwealth Government in partnership with State and Territory Governments and industry (depending on which measures were implemented) would be responsible for implementing the required measures for achieving the desired level of reduction in oil demand.

The national response plan anticipates a multi-phase approach to demand restraint that encompasses voluntary restraint and a system of rationing. Rationing could occur at either the bulk or retail customer level on a sliding scale of severity, according to the level of restraint required. The plan

incorporates an overriding objective of ensuring that those users that are deemed to be essential to the health, safety and welfare of the community (e.g. fire, police, ambulance services, etc.) always have access to fuel and that the remaining fuel supplies are distributed equitably to fuel consumers.

7.6 Risk of a national liquid fuel emergency

All stakeholders consulted rated the likelihood of an event leading to a declaration of a NLFE under the LFE Act as extremely small. Based on the fact that a NLFE has never been declared under the LFE Act to respond to a fuel supply disruption or to meet a commitment to the IEA in the period over 20 years in which the LFE Act has been operation, the assessment of stakeholders is not unreasonable. In terms of domestic factors, while there may be short-term supply disruptions for refined petroleum products occurring on a regional basis associated with refinery production and infrastructure problems, the probability of a coincidental number of problems occurring across the nation to warrant the declaration of a NLFE is rated as extremely low. While international events may trigger tightness in markets for crude oil and refined petroleum products ratcheting up prices, it is difficult to envisage an event that would cut off the supply of crude oil and refined petroleum products to Australia altogether that would warrant the declaration of a NLFE.

Based on past experience as well as domestic and international factors, the assessment of ACIL Tasman is that the risk of a NLFE being declared is extremely low in the period leading up to 2020.

7.7 Likely impact of a LFE

Given the critical role that refined petroleum products play in supporting social and economic activity in Australia, the impact of a supply disruption of sufficient magnitude to trigger a NLFE would have a potentially devastating effect on social order and upon economic welfare.

A sudden and abrupt disruption in the supply of refined petroleum products could trigger a massive upheaval in the lives of most Australians. Refined petroleum products provide a critical source of energy for transportation purposes as well as for electricity generation purposes in remote areas of the country, which could potentially be under threat. Many Australians rely on refined petroleum products to support personal motor vehicle transportation as well as for the provision of transport services such as buses, trains and airplanes. Australians are heavily reliant upon refined petroleum products to support travel to domestic and international locations.

Disruptions to the supply of jet fuel could have far reaching economic ramifications. Jet fuel is an essential input into the provision of aviation transportation services which in turn is a major input into the Australian tourism industry. In 2006-07 the Australian tourism industry was worth $38.9 billion to the Australian economy with international tourism contributing $9.9 billion (Australian Bureau of Statistics, 2008d). International airline services was the means through which over 5.2 million overseas visitors aged 15 and over arrived in Australia in the year ended 31 March 2008 (Tourism Research Australia, 2008). Even a short-term disruption to jet fuel supplies could be damaging to Australia's reputation as an international tourist destination with long-term implications.

Distribution of goods throughout Australia is supported by road, rail and air transportation services dependent on refined petroleum products. Many aspects of ordinary Australian life that we all take for granted could be under serious threat from an event triggering a NLFE.

A blockade of oil refineries and terminals that began on 7 September 2000 in the United Kingdom created severe social and economic disruption. According to Nick Robinson:

> The immediate impact of the fuel protests was dramatic. At one level, they resulted in serious economic and social disruption: panic buying of petrol was widespread, with 90% of petrol stations running out of fuel by 13 September as the road-transport dependent supply chain broke down; commuting became progressively more difficult; rationing of fuel use to 'essential users' was introduced; supermarkets reported panic buying of staple groceries; the army was put on standby to ensure the delivery of fuel to the emergency services, schools were closed and the [National Health Service] was placed on 'red alert'.(Robinson, 2003, pp. 424-425)

After provision has been made for emergency services, the Commonwealth Government is committed to the use of the price mechanism to ration any remaining refined petroleum products that may be available to the public. It is an objective of the LFE Act that the price mechanism would provide an effective means through which to allocate refined petroleum products in an orderly manner.

However, a rise in prices for refined petroleum products may not provide sufficient incentives for consumers to cut back on their demand for refined petroleum products in the short run. This is because refined petroleum products are generally considered to be inelastic with regard to price in that the quantity demanded responds less than proportionately to changes in price. A previous study has estimated that the short run price elasticity of demand for petrol in Australia to be between -0.10 and -0.12 (Donnelly, 1982), while a

more recent study has estimated it at -0.12 (Davey, 2007).

In addition, the declaration of a NLFE could trigger across-the-board panic buying by motorists. This could result in long queues at retail service station sites. Long queues at retail service stations sites could pose challenges to maintaining law and order and public safety. In 2003 fights broke out in queues for fuel at retail service stations in Baghdad in Iraq and fights broke out in queues for fuel in California in 1979.

In all likelihood the declaration of a NLFE will be precipitated by an event expected to bring about a significant increase in the prices of crude oil and refined petroleum product. At the very least, increased prices for crude oil and refined petroleum products could be expected to increase inflation and detract from domestic economic growth. According to energy consultants Dr Robert Hirsch, Roger Bezdek and Robert Wendling, increased oil prices reduce national income because when spending on oil rises there is less income available to spend on other goods and services (Hirsch, Bezdek, & Wendling, 2005, p. 28). Hirsch, Bezdak and Wendling also observe other adverse effects from higher oil prices including:

> Higher oil prices result in increased costs for the production of goods and services, as well as inflation, unemployment, reduced demand for products other than oil, and lower capital investment. Tax revenues decline and budget deficits increase, driving up interest rates. These effects will be greater the more abrupt and severe the oil price increase and will be exacerbated by the impact on consumer and business confidence. (Hirsch, Bezdek, & Wendling, 2005, p. 28)

Based on model simulations, ABARE has found that an increase in crude oil prices has a negative effect on Australian gross national product (GNP) (McDonald, Chester, Gunasekera, Buetre, Penm, & Fairhead, 2005). This ABARE study found that in the event world crude oil prices were to remain at significantly higher levels over the period from 2005 to 2010 than assumed in a reference or business as usual case then Australia's economy would be adversely affected. This study found that if all other things (including other energy commodity prices) were held equal over the period and oil prices were assumed to be 30 per cent higher, then Australia's GNP would on average be an estimated 0.8 per cent lower than in the reference case in 2010. When oil prices were assumed to be 60 per cent higher than in the reference case, Australia's GNP was estimated to be on average 1.2 per cent lower than in the reference case in 2010.

Depending on the extent of any shortages of refined petroleum products associated with the declaration of a NLFE, economic activity could be severely disrupted. The Australian economy is heavily dependent on energy provided by

refined petroleum products and a serious shortage of product could precipitate a contraction in economic activity. ABARE has modelled the impact of a three month disruption to the supply of oil from the Middle East that reduces world production by 8 per cent and associated increases in world energy prices (Hogan, Fairhead, Gurney, & Pritchard, 2005). This ABARE study found that such a supply disruption would lead to a contraction in Australian GNP of 0.3 per cent in both 2005 and 2020 relative to the reference case year of the disruption.

7.8 Likely scenarios

Almost all stakeholders consulted by ACIL Tasman nominated two events likely to trigger a NLFE. Those events are:

- the removal of supply of crude oil from overseas
- coincidental production problems with domestic refineries.

The exact nature of the event leading to the removal of all overseas crude oil supplies was not specified by stakeholders. While domestic refiners commented that domestic refineries could manage on an exclusive diet of Australian sweet light crudes, there would be significant penalties in terms of production yields for particular types of products.

It is extremely difficult to envisage an event that would cause the supply of overseas crude oil to Australia to be removed altogether. While there are events, most likely in the Middle East, that could cause tightness on world markets for crude oil, it is extremely unlikely that such an event would remove all supplies of imported crude oil from Australia providing the scope for Australian refiners to switch over to other overseas sourced crude oils for refinery feedstock. Events disrupting the supply of overseas crude oil to Australia would be expected to be associated with significant price rises for crude oil that would have implications for affordability. However, as long as Australia was prepared to pay the asking price for crude oil then it is extremely improbable that the supply of crude oil from overseas would be cut off altogether.

Coincidental production problems at refineries along Australia's eastern seaboard could severely curtail the production of refined petroleum products, possibly preventing production at some refineries altogether. Such problems have occurred on a number of occasions in past, most recently during the first part of 2008. So far, such events have occurred without triggering any major product shortages where there was not at least close substitute products available.

One possible source of supply disruption to Australia of refined petroleum products is coincidental refinery production problems. Such problems have been known to occur in the past although they have not resulted in economically critical shortages due to the ability of domestic refiners to find alternative sources of supply. In the event that such problems did occur, it is likely that any resulting shortages would only be temporary in nature and rectified through a combination of imports of refined petroleum products and the repair of refinery production problems.

A number of other events were also identified by individual stakeholders including the following:

- A loss of overseas refining capacity
- An influenza pandemic
- The breakdown of critical infrastructure such as terminals and pipelines
- Sinking of a vessel in a channel approach to a port disrupting shipments of crude oil and refined petroleum products.

As the major source of imported refined petroleum products to Australia, some stakeholders commented that the loss of refining capacity in Singapore could be the sources of significant product shortages in Australia. With additional refining capacity in the Asian region coming online, there would appear to be sufficient diversity of supply available to guard against any threat to the supply of refined petroleum products from overseas sources in the event of a problem with refineries in Singapore. In regard to an influenza pandemic, it may be possible to find means of disposing of surplus jet fuel in some manner.

In the event of an influenza pandemic, there would be a significant decline in demand for international airline travel which in turn would reduce demand for jet fuel. If refineries were unable to reduce jet fuel production, then eventually petrol and diesel production could be 'choked off' because of a lack of tankage and other avenues for disposing of jet fuel. However, in some instances refineries have the capacity to close off jet fuel production without impacting the other streams.

Critical infrastructure such as terminals and pipelines is being run harder and at the level of their capacity constraints, thus increasing the prospect of breakdowns occurring. However, the impact of such events would be isolated and felt more on a local and regional basis. The impact of such events should be only temporary as critical infrastructure is eventually repaired.

The impact of the sinking of a vessel in a channel approach to port would also be isolated and felt more on a local and regional basis. The impact of such an

event should only be temporary as the channel is either cleared or a new channel is dredged.

7.9 Impact of response plan

It is difficult to predict what the impact of the response plan will be in the event of a declaration of a NLFE. There is no precedent for the occurrence of such an event in Australia in order to provide any guidance. The impact of the response plan will depend on factors such as how much refined petroleum products will be made available to the general public, how much reliance is put on price signals in order to constrain demand in the face of diminishing supply, and whether there is any across-the-board panic buying.

If sufficient stocks of refined petroleum products are to be made available to the general public and prices are allowed to move freely to reflect changes in supply conditions as well as demand, then price signals would normally be expected to provide sufficient incentives to consumers to constrain demand in the face of diminishing supply. However, interference with price signals through the imposition of price regulation could thwart attempts to constrain demand in event of diminishing supply through market based incentives.

On the other hand, if fear sets in amongst the general public that the supply refined petroleum products will shortly cease altogether in the event of a major supply disruption triggering a declaration of NLFE then across-the-board panic buying could set in. The problem with across-the-board panic buying is that it could exacerbate the prospect of supply shortages and the cessation of supply altogether. US economist Robert Martin concluded back in 1983 that:

> … we find that events that adversely affect the expected value of petrol supplied result in increases in the amount ordered by consumers. For example, public statements concerning the low level of crude oil stocks or a production interruption such as the Iranian crisis will result in higher orders for petrol. This, of course, does not imply that the authorities should mislead or fail to inform the public. However, it is important to realise that highly pessimistic statements are largely self-fulfilling prophecies in this case. (Martin, 1983, p. 22)

State and Territory Governments impose non-market based rationing systems in the event of major supply disruptions generally based on odds-and-evens motor vehicle number plates or caps on the amount of fuel purchased. However, the effectiveness and efficacy of such non-market rationing systems has been queried in the past. According to US academics Michael Metzger and Robert Goldfarb the full effects of an odds-and-evens rationing system on the length of queues are extremely complex and may involves increases in petrol queues (Metzger & Goldfarb, 1983). The equity of a cap on the amount of fuel

purchased has long been queried, with some arguing that such measures favour those who own more motor vehicles. It is uncertain as to whether the introduction of non-market based rationing systems would prove to be any more effective in countering the effects of across-the-board panic buying than a market based system relying on price signals.

7.10 2020 outlook

It is difficult to envisage an event that would cut off the supply of crude oil to Australian refineries altogether. Provided Australia was prepared to pay the prevailing international price of crude oil, supply should continue indefinitely.

Based on stakeholder consultations, the most likely ongoing source of a supply disruption to refined petroleum products is coincidental refinery production problems. For reasons previously outlined in section 5.2 relating to greater interdependence between refinery operating units and little to no spare production capacity available, the impact of coincidental refinery problems will now be felt even more acutely.

There would appear to be sufficient diversity of overseas refinery capacity to guard against problems with refining in one particular location. However, on a regional basis a significant supply vulnerability exists in Western Australia in relation to petrol. In the event of coincidental production problems at the BP Kwinana refinery near Perth and the ExxonMobil refinery in Singapore, it would be extremely difficult to source petrol compliant with Western Australia's fuel specifications.

New refinery capacity in India and South East Asia may reduce this vulnerability in the short to medium term with the proviso that the time to replace lost supplies may be longer. The longer shipping lines and the time needed to source alternative supplies will extend the time for sourcing replacement supplies. However, it is understood that Reliance Petroleum is looking to establish significant product storage facilities in Singapore associated with its new refinery in India that could result in shorter shipping lines and time needed to source replacement supplies.

An upcoming challenge is presented in terms of the adequacy of infrastructure in being able to meet growing demand for refined petroleum products, particularly in relation to terminal storage capacity. While plenty of interest has been expressed in relation to investment in new terminal storage capacity, stakeholders consulted have expressed frustration at various impediments that exist in relation to further investment.

The ongoing reliability of domestic refineries will continue to be a matter of

great importance in ensuring ongoing supply of refined petroleum products in the period leading up to 2020. This could be a source of some short-term occasional product tightness and possibly even shortages occurring on a regional basis. With the gap between domestic production and domestic demand for refined petroleum products likely to grow in the period leading up to 2020 placing an increasing reliance on imports, the adequacy of infrastructure to support imports could also present an ongoing challenge.

7.11 Conclusions

Australia's liquids fuels vulnerability has changed since the 2004 white paper. In terms of the three criteria through which energy security is generally assessed, ACIL Tasman makes the following findings:

- Despite a growing dependence on imported sources of oil and refined petroleum products, adequacy in terms of suppliers being able to keep up with demand has generally been maintained with any supply disruptions only occurring on a short-term basis. With an increasing reliance on imported refined petroleum products, the adequacy of infrastructure to support imports could pose an ongoing challenge in the period leading up to 2020.
- The biggest change since 2004 has been in regard to the reliability of the system. There have been some offsetting impacts on reliability of supply since the last assessment. The incidence of refinery production disruptions has not changed, but their impact can now be more severe. This is due to increased interdependency between refinery production units with the move to cleaner fuels. There is also little to no spare refining capacity left in the system to cover the loss of production capacity. The extent to which a production disruption becomes a supply disruption to end users depends on a refiner's stockholdings and ability to source alternative supply. Recent experience suggests refiners have become adept at managing production disruptions, with no major supply shortages in any market for which close substitutes were not available. This outcome also reflects the improved reliability of the international supply chain for crude oil and products imported to Australia. There remains, however, some pressure in the supply chain from bottlenecks in importing and distribution infrastructure. While the industry is responding to this pressure with plans for investment in new and upgraded infrastructure, the nature of this problem requires a more detailed investigation, as planned by the Government, given our growing reliance on imports. Overall, while refineries will likely incur unplanned shutdowns in the period to 2020, the prospect of a major supply disruption to end-users arising from refinery problems in Australia or overseas is extremely low.
- Affordability on an individual and household level has certainly

deteriorated. However, if affordability is defined in terms of maintaining international competitiveness then given that oil and refined petroleum products are commodity products traded on international markets then it is unlikely to have been significantly affected by rising prices since 2004. As previously commented on in section 5.3.1 above, as long as oil and refined petroleum products remain commodity products traded on international markets and affordability is defined in terms of maintaining international competitiveness then affordability is unlikely to change significantly in the period leading up to 2020.

Based on historical, domestic and international factors, ACIL Tasman rates the probability of an event occurring that is likely to warrant the declaration of a NLFE as extremely low.

8 Minimising risks

8.1 Increasing use of imports

With the exception of a brief period during the 1980s, Australia has always been dependent to some extent on imported sources of crude oil. With most crude oil produced in North West Australia being exported to overseas markets and the level of production in the oil fields in Bass Strait in the Gippsland Basin declining, Australia will become increasingly dependent on imported sources of crude oil for domestic refining purposes.

However, dependence on international sources of crude oil markets does not necessarily increase the risk of supply disruptions but can instead assist in minimising the risk of a supply disruption. This is because crude oil is available from a diverse range of sources around the world thus minimising the prospect of a supply disruption arising from an undue reliance on any one particular source. While the disruption in the supply of crude oil from any one particular source may result in tightness in the market and thus may trigger further price increases, diversity in the range of potential suppliers ensures there are plenty of alternative sources of supply available in the event of a major supply disruption.

Views are mixed as to whether the increased use of imported refined petroleum products has increased or decreased the risk of a major supply disruption occurring in Australia. AIP has characterised the view of those who believe that increasing reliance on imported products as increasing the level of risk as follows:

> Some argue that the greater length of supply lines and the time required for imported cargoes to reach Australia, place the market at greater risk of supply disruptions and constrain response options to disruptions. (Australian Institute of Petroleum, 2008, p. 9)

On the other hand, AIP has argued that the increased frequency and volume of shipping to Australia means greater supply reliability because there is greater flexibility in the supply chain (Australian Institute of Petroleum, 2008, p. 9). According to AIP:

> … this outcome is providing wider sources of supply and is helping to increase the options available to acquire (in the market) and bring cargoes of fuel to Australia in response to an emergency. The increasing frequency of ships bringing fuel to Australia has also increased industry flexibility in responding to unplanned supply disruptions at particular locations. (Australian Institute of Petroleum, 2008, p. 9)

During the course of consultations, the consensus of opinion regarding the reliability of overseas suppliers of refined petroleum products was that they were extremely reliable.

The increasing reliance upon imported sources of refined petroleum products has arguably increased the diversity of supply options for Australia and thus improved energy security. Given recent problems with domestic refineries, diversity of supply provided through access to the production of overseas refineries has certainly assisted in mitigating the prospect of any major product supply disruptions occurring in Australia.

8.2 Flexibility of supply chains

Some flexibility exists in supply chains for the production of refined petroleum products.

In the event of a NLFE, there is little prospect that Australian production of crude oil could be significantly expanded. As the IEA has recently commented:

> Australia's capacity to rapidly increase production during a supply disruption is considered insignificant. (International Energy Agency, 2007a, p. 62)

On the other hand, it is possible that some domestic production of crude oil from North West Australia that is currently exported could be redirected towards domestic refiners in the event of a NLFE. Domestic refiners consulted commented that it is possible for them to process domestically produced sweet light crudes from North West Australia that are usually sent for export, although they warn that there would be significant penalties in terms of production yields for particular types of products.

The current high rate of utilisation for domestic refineries implies there is very little flexibility to significantly expand the domestic production of refined petroleum products in the event of a major supply disruption. While there may be scope to increase production of certain types of products within a refinery through various strategies such as changing the refinery feedstock, changing the catalyst used in a catalytic cracker or hydrocracker unit, and altering the cut points for different products (ie 'stealing' the denser components from jet fuel for diesel), these come at the cost of reducing refinery output of other products. However, flexibility in the supply chain comes from the ability to source refined petroleum products from overseas refineries. Increasing levels of refining capacity in the Asian region should afford a higher level of supply chain flexibility for Australia in future. Shell publicly commented that it would be importing fuel from refineries in the Asia-Pacific region to cover part of its production shortfall arising from problems at its Clyde refinery in January 2008

(The Shell Company of Australia Ltd, 2008). Similarly, Caltex commented that it would be importing diesel to cover part of the product shortfall for diesel due to problems at its Lytton refinery (Caltex Australia Petroleum Pty Ltd, 2008).

In the event of production problems with local refineries, domestic refiners have the flexibility to extend supply lines from other locations to cover product shortfalls. It has been observed in relation to recent refinery production problems in Sydney that supply lines from the Victorian and Brisbane based refineries have been further extended into New South Wales. Similarly, Caltex commented in April 2008 that road tankers would be taking diesel from Newcastle to supply retail service stations in South-East Queensland and that some diesel would be trucked from Gladstone to retail service stations north of Brisbane to cover diesel production problems at the Lytton refinery (Caltex Australia Petroleum Pty Ltd, 2008).

The regular shipments to Australia of refined petroleum products sourced from overseas refineries provide an additional source of supply chain flexibility. In the event of a major supply disruption occurring in one part of the country, it is possible for imported shipments of product to be redirected towards locations where major product shortages could be impending. Domestic refiners consulted commented that they did engage in the redirection of imported shipments to cover looming product shortages in locations.

However, one obstacle to greater supply chain flexibility through either domestic refiners extending supply lines or through the redirection of imported product shipments is the existence of different state-based fuel specifications. The most serious of these is in regard to MTBE in petrol in Western Australia which has previously been discussed in sections 5.4 and 7.2.

Another obstacle to greater supply chain flexibility from overseas refineries and domestic refineries suffering from unit production problems is the Australian fuel specifications. Suppliers of refined petroleum products referred to the difficulty of procuring petrol compatible with Australian fuel specifications in a timely manner during the course of stakeholder consultations as outlined in section 4.4.1.

Consultants Economic Associates were commissioned by the predecessor to the Commonwealth Department of Resources, Energy and Tourism to undertake a study into the issues associated with lowering fuel quality, relative to fuel standards as set under the *Fuel Quality Standards Act 2000*, during a LFE (Economic Associates Pty Ltd, 2007). The study specifically examined the impact of temporarily lowering Australian fuel standards for petrol and diesel

in the event of a LFE. The study found that there would be greater scope to increase the supply of petrol and diesel from both domestic and overseas refineries if packages of relaxations in fuel quality standards were adopted. On the other hand, the Australian Trucking Association has expressed concern about the possible detrimental impact on the engines of the heavy duty vehicle fleet in the event that diesel with higher sulphur content was available for sale in Australia. However, this concern was taken into account in the Economic Associates report with the recommendation that arrangements should be considered to safeguard vehicle operability as the uptake of new technology within the motor vehicle fleet increases. In particular, the Economic Associates report noted that the supply of fuel may have to be partitioned so that lower quality fuel was diverted to users with less demanding engine operability tolerances. In order to minimise and mitigate the potentially disruptive social and economic effects of an LFE, consideration should be given to the relaxation of Australian fuel standards in the event of an LFE.

Another source of flexibility in the supply chain is the ability of suppliers of refined petroleum products to reduce the allocation of bulk fuel supplies to customers. Some of the refiners consulted by ACIL Tasman commented that this would be there very last resort in the event of a major supply disruption.

8.3 Infrastructure

Increasing the level of terminal storage capacity could minimise the impact and risk of a major supply disruption. Amongst many of the parties consulted by ACIL Tasman there were perceptions that there was insufficient terminal storage capacity around Australia. However, as previously documented in section 5.5 there is construction and plans for the expansion of terminal storage capacity around Australia, in addition to the intention on the part of numerous parties to establish new import terminals through the installation of new tank storage capacity at various locations around the country.

8.4 Stocks

Stocks of crude oil, refined petroleum product and LPG provide a short-term buffer against the impact of interruptions to liquid fuel supplies. The seven refineries all hold stocks of crude oil. Stocks of refined petroleum products and LPG are also held at refineries, terminals and in some cases at customer sites. Indicative levels of stocks of crude oil and refined petroleum products held at Australian refineries and terminals are shown in Table 27. Stocks of imported crude oil provide typically around 5 to 15 days cover of refinery consumption and refineries and terminals hold typically between 5 and 10 days of

consumption cover.

Table 27 **Indicative stocks of crude oil and refined petroleum products**

Stocks	Level of cover in days
Crude oil at refineries for imported crude oil	5 to 15 days refinery consumption with minimum planning inventory of 5 days
Crude oil at refineries supplied from Australian fields by pipeline	1 to 2 days
Refinery terminals stocks of product	10 days
Marketing terminals stocks of product	5 days to 7 days

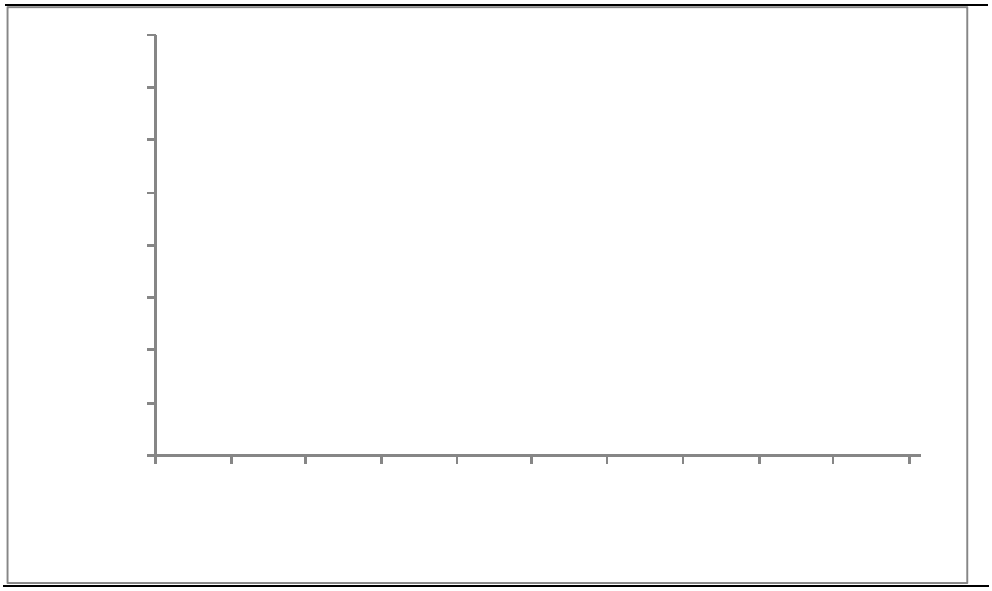
Note: Crude oil typically takes up to 10 days to be processed through the refinery
Data source: Australian Institute of Petroleum (2008)

Australian governments do not hold or require industry participants to hold stocks of crude oil or refined petroleum products. In Australia stocks are held to accommodate short-term fluctuations in demand and are based on commercial considerations. Refineries and marketers of refined petroleum products determine the level of stockholding in order to maintain commercial operations and continuity of supply to their customers.

With increasing dependence on imported crude oil and the ongoing prospect of unplanned interruptions in domestic refineries, it is possible that these levels of cover may not be sufficient to ensure adequacy of supply in domestic markets in the event of a major supply disruption. For example, it was reported to take up to at least three weeks to locate and import a shipment of product in an emergency. This however is not sufficient evidence to conclude that these levels of cover will not be adequate in future. Importing is only one of a number of strategies available to manage risks associated with interruptions to supply.

Stocks of crude oil and refined product (expressed in energy equivalent terms) held in Australia from 2003 are shown in Figure 9.

Figure 9 **Australian stocks of crude oil and product 2003 to 2008**



Note: Based on conversion of monthly data provided in tonnes of oil equivalent converted to petajoules.

Data source: ABARE (2008) , Standing Committee on Emergency Questions *(International Energy Agency, Monthly releases)*

Total stocks expressed in energy terms have declined from a high of 220 PJ in 2003 to around 170 PJ in January 2008.

The decline in 2003 would have been influenced by the closure of the Port Stanvac refinery in South Australia in June 2003. Improved supply chain efficiencies and rationalisation of terminals has also reduced the stocks held at depots and remote locations. In addition, growth in demand combined with falling domestic production of crude oil has led to an increase in net imports, which reduces the days cover which is expressed in terms of net imports.

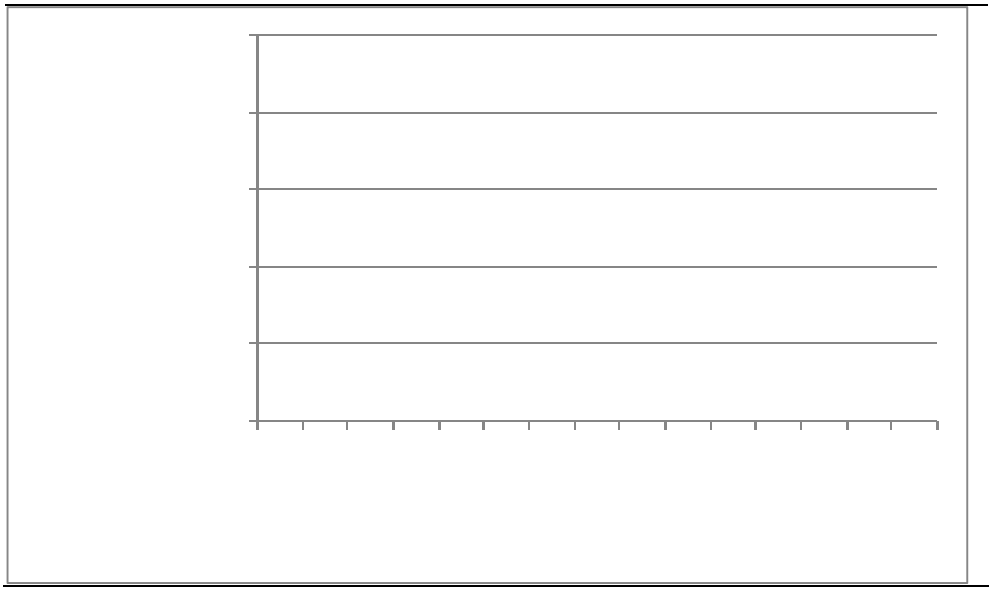
The recent fall in cover is understood to be a result of the planned and unplanned shutdowns in refineries and the associated normal drawdown in stocks that would accompany such shutdowns, discussed earlier in this report, and the impact of the cyclones on production in North West Australia.

As a member of the IEA, Australia has a commitment to maintain emergency stocks of liquid petroleum fuels equivalent to at least 90 days of net imports. Stocks can include crude oil, refined petroleum products and LPG.

Australia's stocks of petroleum declined from the relatively high level of 209 days of net imports in 2000 to around 110 days in 2006. Stocks fell below the 90 day level on a calendar year basis in 2006 and again in 2007.

More recently stocks have fallen below the 90 day level on a monthly basis since December 2007. These trends are shown in Figure 10.

Figure 10 **Recent stocks cover (days of net imports)**



Note: Stocks include crude oil, refined petroleum products and LPG

Data source: IEA Standing Committee on Emergency Questions *(International Energy Agency, Monthly releases)*

While Australia's IEA commitments are not directly of concern in terms of liquid fuels vulnerability, they represent international obligations for Australia that relate to global risk management by IEA member countries. Australia is required to meeting its obligations for as long as it is a member of the IEA.

In consultation with stakeholders, ACIL Tasman found that in most cases terminal operators were planning further investment in additional storage capacity as part of normal commercial operations. ACIL Tasman was not able to form a judgement on whether this new investment would be sufficient to meet IEA obligations in future. The adequacy of Australian stock levels and Australia's IEA obligations are discussed in more detail in Section 9.3 below.

8.5 Longer term prospects for alternative fuels

Alternative fuels are often regarded as an important means of improving Australia's energy security in liquid fuels. There are a number of alternatives to conventional refined petroleum products, some of which are commercial now or close to commercial and others that are still in the research and development stage.

The fuels that are relevant in the period to 2020 include biofuels, LPG, liquid fuels produced from coal (CTL) and liquid fuels produced from natural gas (GTL), compressed natural gas (CNG) and liquefied natural gas (LNG).

Other energy sources such as fuel cells based on hydrogen, hybrid and electric

vehicles are unlikely to be significant as alternative fuels in period to 2020. Hybrid and electric vehicles may become more significant in terms of reducing dependence on liquid transport fuels. However, full conversion to electric vehicles is unlikely to be realised by 2020.

Australian governments have been actively supporting the development of alternative fuels. The most notable programs include the excise concession available to alternative fuels. The CSIRO also has a research and development focus on alternative fuels under its Energy Transformed Flagship. The primary means through which the Commonwealth Government supports the development of alternative fuels is through the provision of excise exemptions although these will be partially phased down from 2012.

8.5.1 Biofuels

Biofuels include fuels produced from soft commodities such as grains, corn and molasses and flour, vegetable oils and tallow. The two relevant biofuels are fuel ethanol and biodiesel.

Fuel Ethanol

Fuel ethanol can be produced from a range of sources including waste starch, molasses and cereal grains. Around 150 ML of fuel ethanol is produced annually at the Manildra plant (Nowra, NSW), the CSR plant (Sarina, QLD), the Schumer (Rocky Point Sugar Mill, QLD) and by Tarac (Nurioopta, SA). This is likely to increase to 230 ML with the commencement of the Dalby Bio-Refinery in late 2008.

Additional capacity of around 145 ML is planned by 2010 (from new production at Rocky Point and expansion of CSR and Manildra). In total this would represent around 2 per cent consumption of current petrol Australia wide.

ABARE, CSIRO and the Bureau of Transport and Regional Economics undertook a study of the economics of fuel ethanol in 2003. The report estimated that the break even cost of ethanol produced from new plant would be 32 cents per litre from cereal grain and 33 cents per litre from molasses. While the price of petrol has risen significantly since that time the Biofuels Association of Australia reported that the cost of feedstock has also risen in parallel with the price of crude oil. As a result the economics of ethanol production remain finely balanced at current oil prices.

Governments have introduced policies to encourage fuel ethanol. The Federal Government introduced an effective exemption from excise for fuel ethanol

through capital grants for biofuels producers until 1 July 2011. In addition, the Federal Government has supported the installation of infrastructure at retail sites to encourage E10 sales.

Under fuel taxation reforms, announced in the 2004 Energy White Paper, effective excise will be applied to fuel ethanol from 1 July 2011 commencing at a rate of 2.5 cents per litre and then increased to a final rate of 12.5 cents per litre in 2015.

The New South Wales Government has foreshadowed increasing its mandated level of ethanol in petrol from 2 per cent to 4 per cent and the Queensland Government has indicated that it will bring forward its mandate for ethanol in petrol of 5 per cent to 2010. No other State or Territory Government has introduced mandated ethanol targets.

Fuel ethanol is a useful extender for petrol. It is not dependent on supplies of crude oil and stocks of feedstock are available to ensure continuity of supply according to the Biofuels Association of Australia (personal communication). However, it is not feasible to increase production to meet short-term interruption to supplies of liquid fuels. Even if production of ethanol were to reach 375 ML per year it would still only extend supplies by around 2 per cent of national consumption of petrol. Ethanol could therefore usefully extend the supply of petrol in the event of an interruption to supply. While new technology offers the possibility for a significant improvement in the economics of ethanol production, it is still not likely to significantly reduce Australia's vulnerability to interruptions in liquid fuels supply in the period to 2020.

Biodiesel

Biodiesel is produced from tallow, waste cooking oil and from palm oil. Current operational biodiesel capacity is around 310 ML per annum comprising mainly Smorgon Fuels, Eco Tech, Future Fuels, Biodiesel Industries Australia, and Biodiesel Producers.

There is potential for up to 560 ML per year to be produced and research into the use of algae in biodiesel processes may significantly improve the economics. However, the cost of these feedstocks has risen in recent years while concern over protection of rainforests in Queensland has restricted the future use of palm oil. The future potential of biodiesel to significantly extend diesel production is therefore still uncertain.

Biodiesel must be blended with conventional diesel. The maximum blend level is around 20 per cent as biodiesel is of higher density than conventional diesel

and can have filter blocking problems above this level. A biodiesel blend of 5 per cent is considered the most likely to be successful, although even that is not supported by all vehicle manufacturers because of potential fuel system blockages.

Consultations with independent marketers involved in biodiesel (Gull and Neumann) suggested to ACIL Tasman that biodiesel is considered a useful extender but not a substitute for diesel fuel in the event of a liquid fuel interruption. In addition, concerns regarding the quality of biodiesel were raised by several parties during the course of consultations which may limit its commercial viability.

Biodiesel is currently subject to the same rate of excise as ordinary diesel at the present time imposed at the rate of $0.38143 per litre. However, biodiesel that meets the biodiesel fuel standard is eligible to receive a production grant of $0.38143 per litre, bringing the effective rate of excise down to zero. The effective rate of excise on biodiesel will be increased to 3.8 cents per litre from 1 July 2011 rising to 19.1 cents per litre by 1 July 2015 – still a significant discount to the excise paid on ordinary diesel.

Biofuels and liquid fuels vulnerability

Biofuels represent a useful extender to conventional transport fuels. However, they cannot be produced in significant greater volumes during an interruption to liquid fuel supplies. Their production also depends on transport of feedstock which in itself is dependent on liquid fuels.

Increased use of biofuels in transport fuels is not likely to significantly reduce Australia's liquid fuels vulnerability in the period to 2020.

8.5.2 LPG

LPG consumed in Australia comes from various sources: naturally produced; Australian refineries; and imports. Around 75 per cent of Australia's LPG comes from underground reservoirs and is mainly associated with the production of natural gas. With excise free status and subsidies for conversion, LPG has been a popular alternative to petrol particularly in taxis and in some dual fuelled vehicles.

The Australian LPG Association of Australia (ALGPA) estimated there were 600,000 LPG vehicles, two thirds of them private vehicles. The ALGPA estimate that 98 per cent of taxis run on LPG. There are around 3,240 service station sites that retail LPG in Australia, representing around 50 per cent coverage of all service stations. There is a significant body of infrastructure

already in place for the distribution and retailing of LPG.

With an abundance of LPG produced from naturally occurring sources and refining crude oil, LPG has been regarded in the past as an alternative fuel which provides security against interruptions to imported crude and refined petroleum products. However, according to the ALGPA, LPG is a complement not a replacement for petrol.

The full excise exemption that currently applies will phase out under current legislation. The excise on LPG will gradually increase from 2.5 cents per litre on 1 July 2011 to 12.5 cents per litre by 1 July 2015. This still represents a considerable discount on the excise applied to petrol although it should be borne in mind that LPG contains only 77 per cent of the energy content of petrol. Production of LPG produced from Australian oil fields could provide an important replacement for transport fuels in the event of an emergency (Trebeck, Landels, & Hughes, 2002, p. 105). However the availability of vehicles with the capability to run on LPG would limit its broader application.

8.5.3 LNG

LNG in road transport use has been considered as a commercial alternative to diesel fuelled vehicles in Australia. The economics of LNG is more favourable to longer haul and larger trucking tasks where refill facilities can be conveniently located.

As part of its proposed Bell Bay Pulp Mill development, Gunns Limited is investigating the possibility of converting the log transport trucks that will service the mill from diesel to LNG. Gunns Limited could manufacture LNG from the natural gas that will be available at the mill, using power from the excess of electricity that the mill will generate. Wesfarmers Limited has invested $138 million to construct a 175 tonne-per-day liquefied natural gas (LNG) plant at Kwinana near Perth. The plant is due to be completed in the first half of 2008.

LNG, while only economic at this stage in these larger applications, diversifies Australia's transport fuel sources and as it is based on abundant domestic supplies of natural gas, can improve Australia's energy security.

LNG requires liquefaction facilities and specially equipped trucks. It is therefore limited to specific applications where trucking routes can be coordinated with liquefaction facilities. It application can be expected to provide a small but important alternative to diesel supplies.

While there is no excise currently applied to LNG, it will be applied at the rate

of 2.5 cents per litre from 1 July 2011, gradually increasing to 12.5 cents per litre by 1 July 2015.

8.5.4 CNG

Compressed natural gas (CNG) has been used in public transport applications in Australia for buses in Canberra. It can also be used in conventional motor vehicles, however, the economics of CNG in smaller applications are not sufficiently competitive with conventional motor fuels and the infrastructure required to support a wider network of filling stations is not insignificant.

CNG can be expected to increase in applications such as public transport where infrastructure can be provided and where air quality concerns justify the additional cost of CNG.

As with LNG, this technology diversifies supplies of transport fuels away from conventional petroleum fuels. Its contribution can be expected to increase in certain applications.

While there is no excise currently applied to CNG, it will be applied at the rate of 3.8 cents per litre from 1 July 2011, gradually increasing to 19.1 cents per litre by 1 July 2015.will still provide a lower fuel tax per energy unit than equivalent petrol.

8.5.5 Gas to liquids

Gas to liquids (GTL) technologies have been in development for some time and have been proven to be technically feasible. Based on the Fischer-Tropsch synthesis process, commercial feasibility is dependent on the price of natural gas which has been rising as global demand for gas has increased and the LNG market has matured. Increasing construction costs and uncertainties over the impact of emissions trading schemes are also issues that proponents need to consider in the course of commercialisation.

There are a number of companies actively researching and developing GTL including:

- Sasol
  - Sasol developed its Sasol Slurry Phase Distillate process which can produce a synthetic diesel from natural gas or goal.
  - Is developing a GTL project in Qatar and Nigeria.
  - Sasol Chevron are exploring development of a GTL plant in Australia.
- Shell
  - Shell has been working on a proprietary middle distillate synthesis

process developing a demonstration plant in 1983.
  - In 1986 Shell established a plant at Bintulu in Malaysia in a joint venture with Mitsubishi, Petronas and the Sarawak state government.
  - Shell has committed to a 140,000 bpd GTL plant at Ras Raffan in Qatar. The first phase is to commence in 2009.
- Syntroleum
  - Developed Syntroleum process first in 1985 and since then has been exploring opportunities for GTL projects including in PNG.
- Rentech
  - Has been developing GTL prospects in Dubai, Bolivia and PNG.
- BP developed a demonstration GTL plant in Alaska which has been operating since 2002.
- Exxon Mobil
  - Developed and tested an AGC-21 flued bed sygas generation process.
  - ExxonMobil/Qatar GTL announced a Heads of Agreement for a GTL projects at Ras Raffan and Malaysia.

Sasol and Chevron have formed an alliance to develop a 36,000 bpd GTL demonstration plant in Australia. This would represent around 4 per cent of Australia's projected demand for distillate in 2019-2020. GTL synthetic distillate is low in sulphur and virtually free of aromatics and would be blended with conventional distillate to produce diesel fuel meeting Australian standards.

While commercially proven under some circumstances, GTL is not necessarily commercial at current prices for natural gas and conventional distillate. At the present time industry sources maintain that natural gas has more value in LNG markets than in GTL in Australia.

The GTL process also emits greenhouse gas emissions. The impact on its economics under an emissions trading scheme will depend on the form and structure of the scheme which is currently under consideration by the Commonwealth Government.

With Australia's substantial resources of natural gas, GTL offers a prospective alternative liquid fuel that would increase supply security. However, its contribution in the 2008 to 2020 period is likely to be limited.

8.5.6 Coal to liquids

The Fischer Tropsch process has also been applied to coal gasification leading to production of liquid fuels. Monash Energy are exploring the potential for CTL production based on the extensive resources of brown coal (lignite) in the

La Trobe Valley in Victoria.

The technology has been proven and is operating in South Africa and Qatar. The diesel produced has a lower cetane number than conventional diesel in Australia and would need to be blended with conventional diesel to meet Australian fuel specifications.

Monash Energy identified a number of challenges that needed to be addressed before commercial feasibility could be determined. These included:

- Management of emissions from the coal to liquids process.
  - Emissions are significant and carbon capture and storage would need to be addressed.
- The impact of an emissions trading scheme.
- Transport of the product to a suitable port.

Monash Energy would not be in a position to assess commercial viability until 2012. Plant construction would take 5 years.

Subject to the technical and commercial issues being addressed, Monash Energy envisage that a demonstration plant of around 75,000 bpd could be considered. This would represent around 8 per cent of Australia's distillate demand in 2019-20.

As with GTL, this technology has a number of commercial hurdles to overcome before it is likely to be considered as a viable prospect for Australia. With the additional process of coal gasification, emissions are likely to be higher than a GTL plant and hence it is likely to be more seriously affected by the impact of an emissions trading scheme than GTL.

CTL will not affect Australia's liquid fuels vulnerability before 2017 at the earliest. With the uncertainties associated with CTL it is unlikely to be a major factor in the period up to 2020.

8.5.7 Conclusions on Alternative Fuels

Alternative fuels can be expected to play a small but important role in reducing Australia's liquid fuel vulnerability in the period leading up to 2020. Current generation biofuels are potentially a useful extender to conventional petroleum fuels but are not likely to provide a significant increase in security because of constraints on ability to surge supply and the relatively small contribution that they will make to overall liquid fuels supplies. Of the two, biodiesel is likely to be the more significant given the growth in demand for distillate particularly in Western Australia and Queensland.

LPG, LNG and CNG are likely to provide important alternative supplies for some cars and taxis, public transport and longer distance heavy transport vehicles. However, the need for specialist retailing infrastructure is a constraint on broader applications, as is the economics of these fuels in the Australian transport context.

GTL provides an important alternative to conventional diesel. However it is only likely to be available after 2015 and not likely to be able to provide more than 4 per cent of total diesel demand before 2020. It is also subject to cost uncertainties in respect of the alternative value of natural gas as an LNG export. Similarly, the outlook for the future application of CTL in Australia is uncertain.

8.6 Demand restraint

In the event of a major supply disruption there are various devices through which demand restraint could be exercised. In the first instance, demand restraint could be achieved through a market based mechanism as provided for through price signals. The price of refined petroleum products would be expected to increase in the event of a major supply disruption through the normal market processes and the interaction of the forces of supply and demand.

Demand restraint as practiced through normal market processes and price signals is further enhanced through the imposition of additional tax on the sale of refined petroleum products. Petrol and diesel are subject to excise (and customs) duty and LPG will become subject to excise (and customs) duty as from 1 July 2011. The sale of petrol, diesel and LPG are also subject to the goods and services tax (GST).

Following on from the discussion in section 7.7, it is widely accepted that demand for refined petroleum products is price inelastic in the short run. However, demand for refined petroleum product is believed to be much more price elastic in the long run as consumers are able to respond to price incentives presented to them over a sustained period through possibly improvements in technology related to motor vehicles and/or changes in behaviour. It has been found that the long run price elasticity of demand for petrol is generally about three higher than the short run price elasticity of demand (Dahl & Sterner, 1991). While increases in taxation would be expected to make only a minimal contribution to demand restraint in the short-term, it may be far more effective at constraining demand over the longer term.

The AIP has commented that it strongly supports market mechanisms in the

event of major supply disruptions:

> Overall, AIP member companies support a strong market based approach to responding to any fuel supply emergency, and that maximum use is made of existing business practices (eg. bulk allocation procedures) along the fuel supply chain. (Australian Institute of Petroleum, 2008, p. 17)

As previously discussed in section 7.9, if fear sets in amongst the general public regarding the future availability of refined petroleum products then across-the-board panic buying could result which may exacerbate the prospect of supply shortages and the cessation of supply altogether to the general public. Across-the-board panic buying may precipitate the introduction of non-market based mechanisms to ration remaining supplies of refined petroleum products. State and Territory Governments impose non-market based rationing systems in the event of major supply disruptions generally based on odds-and-evens motor vehicle number plates or caps on the amount of fuel purchased. As was previously discussed in section 7.9 the effectiveness and efficacy of such non-market rationing systems has been queried.

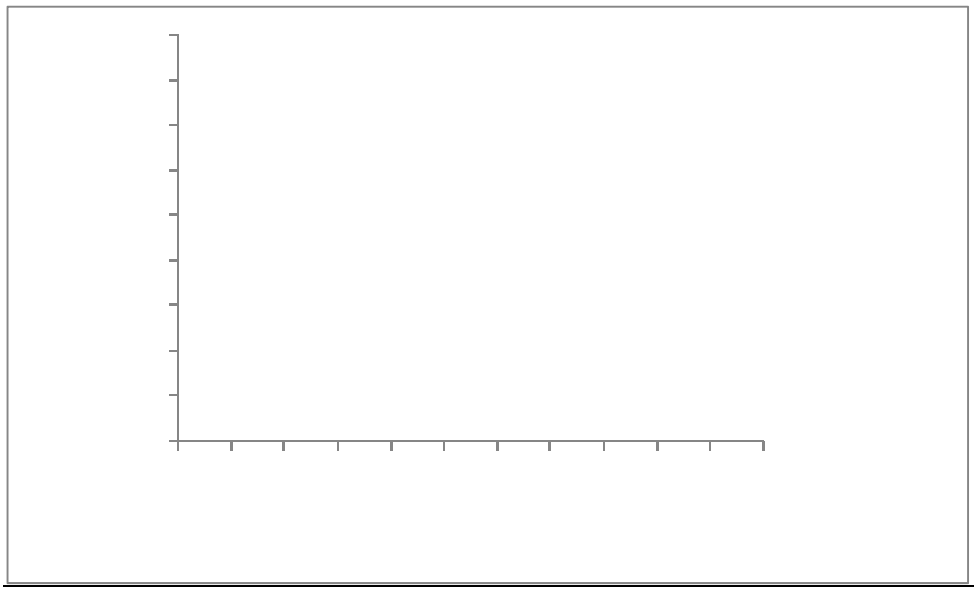
Another means of achieving demand restraint is through improving the level of fuel efficiency of motor vehicles. In this regard, it is noted that the new Commonwealth Government has committed itself to a Green Car Innovation Fund worth up to $500 million over the five years from 2011 to provide incentives for R&D and innovation, to support the use of new engineering solutions and advanced materials to improve fuel efficiency in Australian made vehicles (Review of Australia's Automotive Industry, 2008, p. 21).

9 Policy issues

9.1 Past and emerging changes to supply and demand

Recent statistics of consumption of petroleum products reveal a strong growth in demand for diesel. The growth in demand for diesel is driven in part by the growth in mining activities in Queensland and Western Australia. However as discussed in subsection 3.1 this also reflects an emerging preference for diesel fuelled vehicles (Figure 11).

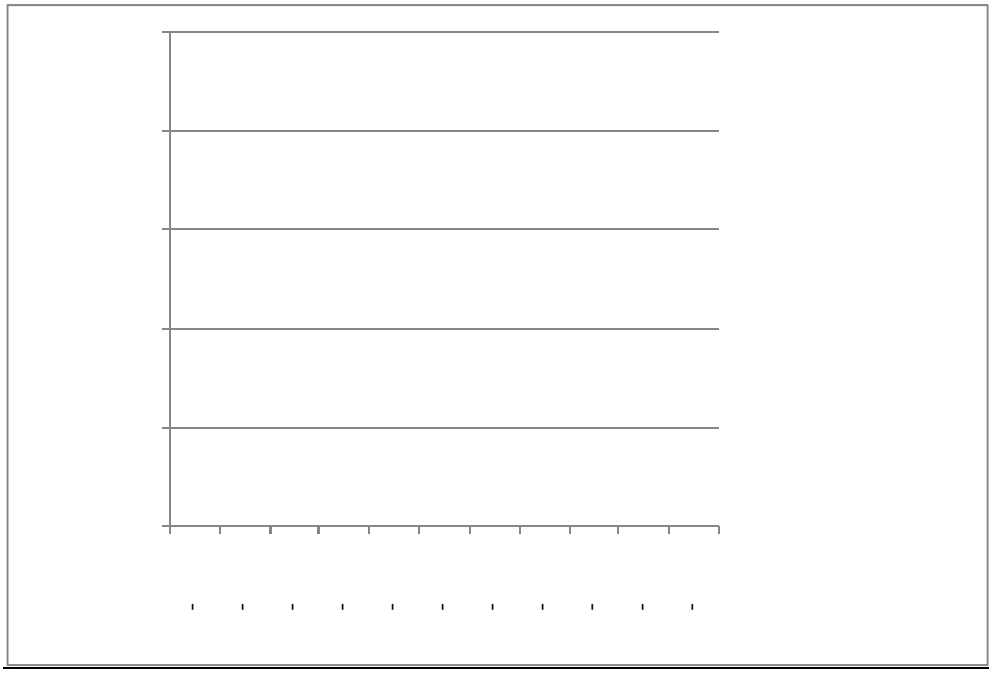
Figure 11 **Consumption of diesel, jet fuel and petrol**



Note: For these calculations 1 tonne of product =1.065 tonne crude oil equivalent
Data source: Australian Bureau of Agricultural and Resource Economics (2008)

The statistics also show that net imports increased from 2000-01 to 2004-05 while stocks held have declined. As discussed earlier commercial stocks are driven by consumption levels and have fallen largely as a result of rationalisation of the supply chain and closure of the Port Stanvac Refinery (Figure 12).

Figure 12 **Consumption, net imports and stocks**

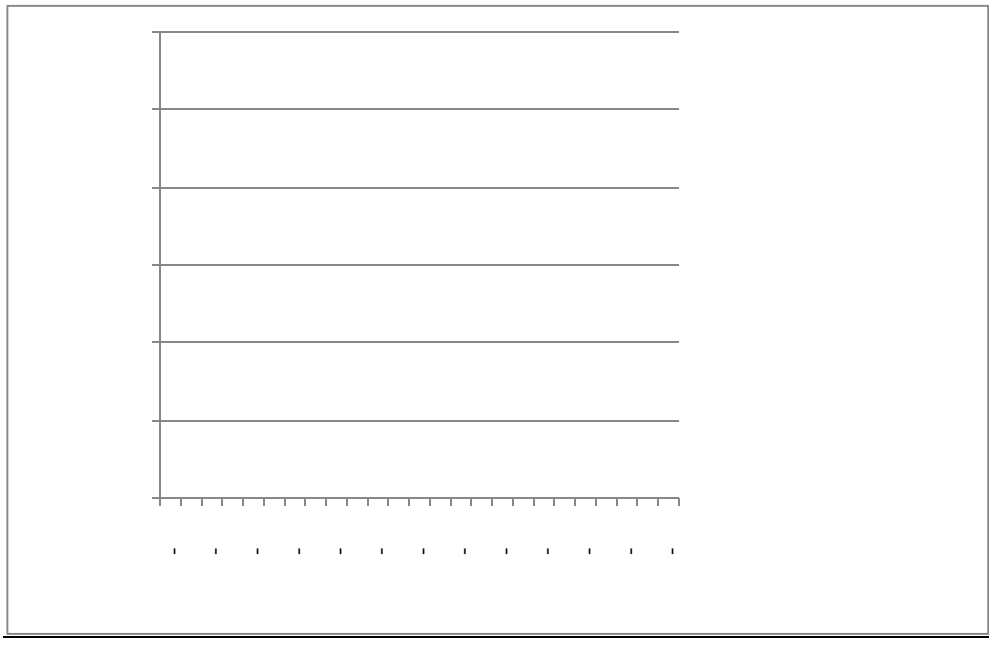


Note: For these calculations 1 tonne of product =1.065 tonne crude oil equivalent. Stocks cover in 2004-05 is 104 days of net imports,

Data source: ABARE, IEA

ABARE's 2007 projection of total petroleum consumption have remained relatively consistent with the 2005 and 2006 projections.

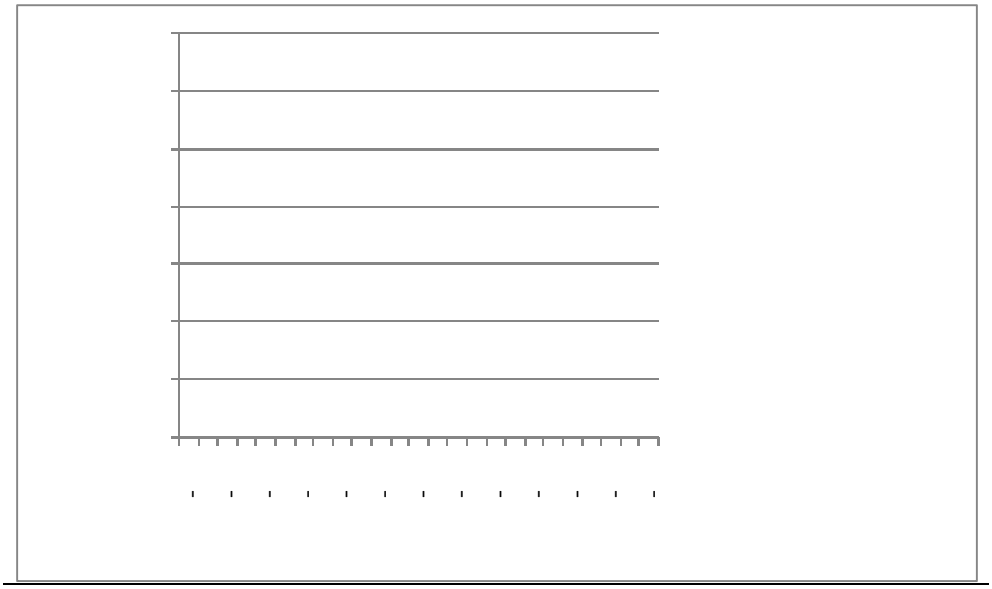
Figure 13 **ABARE forecasts of total petroleum consumption**



Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, (2007)

ABARE has increased its estimate of domestic production of crude oil in the period to 2010 compared with the 2005 and 2006 forecasts.

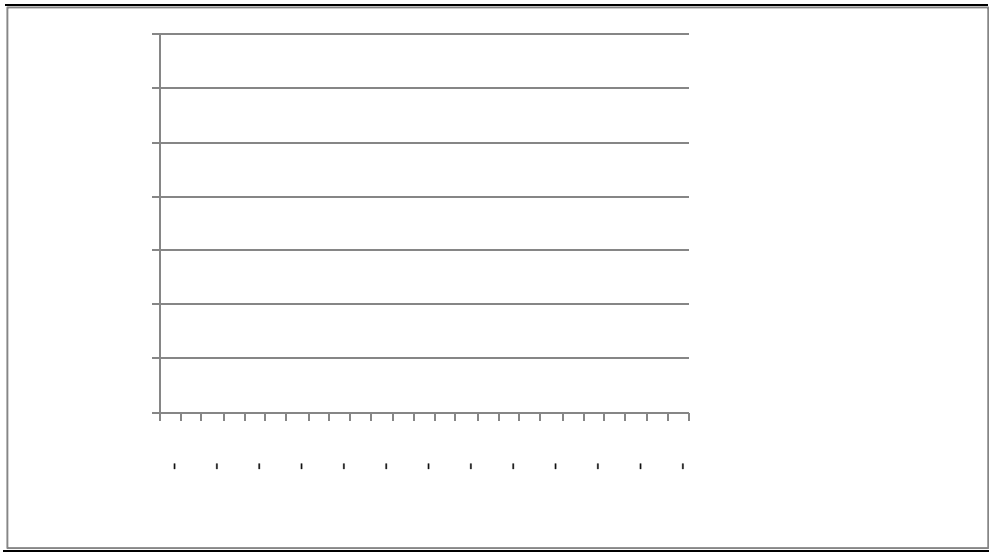
Figure 14 **Forecasts of production of crude oil**



Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, (2007)
)

As a consequence, ABARE's 2007 forecast of net petroleum imports falls in the period to 2009-10 and rises consistently thereafter.

Figure 15 **ABARE forecasts of net petroleum imports**



Data source: Syed, Wilson, Sandu, Cuevas-Cubria, & Clarke, (2007)

These trends confirm earlier observations that the Australian petroleum market

is in transition to becoming increasingly more reliant on imports of crude oil and refined petroleum products. This may have implications for stocks levels and infrastructure to manage greater imports of petroleum crude and product than in the past.

9.2 Policies to meet International Energy Agency obligations

As discussed in section 2.3, Australia has an obligation to maintain emergency stocks of liquid petroleum products equivalent to at least 90 days of net imports. Under certain circumstances member countries may be required to supply crude oil to IEA countries which may be drawn from stocks or from demand restraint measures.

In the past Australia has been able to meet its obligations on the two occasions that the IEA declared an emergency from demand restraint measures. This has been done without declaring a liquid fuels emergency under the LFE Act.

This would be the preferred approach to meeting any future IEA obligations during periods global supply problems. Australia will continue to be a significant producer of crude oil and condensate that, coupled with demand restraint, should be adequate for all but catastrophic interruptions to world oil supplies.

However it is possible that commercial stocks may not be sufficient to meet Australia's IEA obligations in the future. These are discussed below.

9.2.1 Market based

Australian petroleum products reflect import parity pricing for crude oil. Any surge in oil prices globally are ultimately reflected in Australian prices for petroleum products. The LFE Act provides that directions with respect to allocation or supply of liquid fuels during a declared emergency are not to regulate price (section 27).

Demand restraint induced by scarcity pricing during a disruption to supplies is, in ACIL Tasman's view, the most efficient and effective means for Australia to respond to IEA requirements. However, demand restraint may not be sufficient to ensure that Australia meets the 90 day requirement at all times. Governments could provide incentives to fuel suppliers to encourage them to hold additional stocks. While this might be a feasible market based approach, it could also create perverse incentives for companies to hold less stocks on a purely commercial basis.

9.2.2 Regulatory based approaches and intervention

In circumstances where a normal market response is not sufficient to meet IEA obligations, the Minister for Resources, Energy and Tourism, or his delegate, may issue directions as part of contingency planning under Part II or under declaration powers under Part III of the LFE Act.

Resorting to the provisions of the LFA Act is only one of a range of ways that the Government could intervene to ensure that Australia meets its IEA requirements. Other options include the Commonwealth Government holding stocks in its own right, legislation to mandate compulsory stockholdings, or arranging cooperative stockholding with other IEA countries.

9.3 Adequacy of stocks

As discussed in section 7.5 above, Australian stock levels have fallen below the IEA minimum requirement in recent periods. This has occurred at a time when Australian refineries have experienced both scheduled and unscheduled shutdowns. The stock drawdown would have reduced the call on imported oil supplies during these interruptions and it can be expected that stock levels will recover once the interruptions are rectified. While there is little information of likely future stock levels publicly available, it is possible that commercial stocks will not be sufficient to meet the 90 day requirement in the future.

The cost of holding emergency stocks is significant. For example, at current oil prices, the cost of acquiring an additional 286 ML of emergency stocks (around 1.8 million barrels equivalent to around 5 per cent of current stock levels) would be around $278 million at current oil prices. The question of how to ensure that the IEA requirements are met therefore requires careful policy consideration.

9.3.1 Calculation methodology

The Australian Institute of Petroleum questioned whether the methodology for calculating the stocks cover was appropriate. In calculating the level of emergency stocks, the IEA reduces the stocks of crude oil by 4 per cent to allow for the naptha content of crude oil. It then makes a further reduction of 10 per cent for 'unavailable stock'. This amount is expressed in tonnes of crude oil equivalent. Refined petroleum product stocks are also reported on a weight basis after converting to crude oil equivalent. The same 10 per cent adjustment for unavailable stocks is made on product.

The daily net import figure for any given year is derived from the net level of crude oil and product imports. The level of crude imports is adjusted

downwards by 4 per cent for assumed naphtha content, and product imports are converted to a crude oil equivalent after naphtha, stocks held in marine bunkers and stock changes are taken into account. The adjusted crude and product amounts are then added together and divided by the number of days of that year to identify Australia's daily net import level.

In Australia, all naptha content is converted to petrol. Industry argues that the 4 per cent deduction is not appropriate in the Australian case. Australia also has a higher proportion of stocks on the water than Europe and the United States because of its geographic position. Stocks on the water are excluded from the IEA calculation despite the fact that they are unlikely to be redirected to other locations once they are en route to Australia and particularly if they are in Australian waters.

The 10 per cent 'unavailability deduction' is thought to be a generally accurate reflection of Australia's stocks. However with new investment in storage in plan, it might be appropriate to review this co-efficient in future.

The IEA calculation does not include stocks held by consumers such as at mines, industrial sites and power stations. While there is little data available on the level of stocks held by mining companies they are reported to be generally sufficient to cover short-term outages and wet seasons in the tropics. The calculation methodology should be raised with the IEA in the light of the Australian circumstances.

9.3.2 New investment

Consultations with industry indicated that new investment in new stock capacity is underway in Australia. There is no compilation of what this investment might deliver in future capacity for storage. Further to this, there were numerous complaints that planning and development approvals processes could in some cases be impeding and delaying the construction of new stocks capacity.

In the current circumstances, it would be important that improved information on current and planned stock capacity be collated. In this regard the Commonwealth Government has announced that a comprehensive audit of terminal facilities suitable for importing refined petrol in Australia will be undertaken by the end of 2008 (Rudd & Bowen, 2008).

ACIL Tasman strongly endorses the Commonwealth Government's decision to undertake an audit of terminal facilities but believes the scope of this audit should be extended to cover all existing and planned storage capacity of any facility capable of storing crude oil and other refinery feedstock as well as all

refined petroleum products to provide sufficient data to form a judgement on the ability for Australia to continue to meet its IEA commitments in the medium term.

It is also important that State Governments in particular address the planning and environmental processes and procedures applying to expanding terminal storage facilities. The multitude of planning processes and approvals required to construct new infrastructure facilities increases transaction costs. In order to remove the need to go through multiple regulatory approval processes, one option could be to streamline regulatory approval processes through the development of a one stop shop where a single assessment and approval process is established. Such an arrangement applies in New South Wales with the enactment of Part 3A of the New South Wales *Environmental and Assessment Act 1979* which allows for a single assessment and approval system for major development and infrastructure projects which replaced the previous requirement to seek up to 15 different approvals and licences.

9.4 Flexibility

Currently there are impediments to flexibility in the supply chain of refined petroleum products arising from the existence of different state-based fuel specifications, the most serious of these is in regard to MTBE in petrol in Western Australia. Differing state-based fuel specifications impede the extension of supply lines from other states and the redirection of shipments in the event of a major supply disruption. In order to overcome this problem, ACIL Tasman recommends:

- That the Council of Australian Governments ensures that State Governments align their fuel standards with national fuel standards to increase the level of supply chain flexibility in the event of a supply disruption.

In addition, there are impediments to the flexibility in the supply chain of refined petroleum products arising from Australian fuel standards. A recent study by Economic Associates has found that there would be greater scope to increase the supply of petrol and diesel from both domestic and overseas refineries if packages of relaxations in fuel quality standards were adopted (Economic Associates Pty Ltd, 2007). In order to improve supply chain flexibility in the event of a LFE, ACIL Tasman recommends:

- The Commonwealth Government should consider accepting the recommendations of the Economic Associates study on lowering fuel quality standards during a LFE.

9.5 Role of market responses

This report has emphasised the importance of market responses to the management of Australia's liquid fuels vulnerability. The most efficient outcomes will require responses along all of the oil supply chain. The lowest cost outcomes may not be achieved by focusing only on the refiners and marketers.

In some circumstances it may be cheaper for consumers to increase their stock holdings. This is especially the case for major consumers of refined petroleum products. This could be important if planning constraints at metropolitan terminals increases the costs of stocks compared with holding stocks on site at mines, processing plants and power stations. Markets can only work efficiently if they are adequately informed.

In the event that informational asymmetries exist between buyers and sellers in a market, the 2001 Nobel Laureate for economics George Akerlof demonstrated that this would give rise to the problem of adverse selection (Akerlof, 1970). Akerlof used the example of the market for used cars where buyers could buy either good cars or defective cars that were described as "lemons". In the presence of asymmetric information, Akerlof showed that the used car market would either contract into a market for "lemons" or collapse altogether. In order to address the problem of asymmetric information and adverse selection, Akerlof suggested that government intervention may be warranted in some instances:

> There are many markets in which buyers use some market statistic to judge the quality of prospective purchases. In this case there is incentive for sellers to market poor quality merchandise, since the returns for good quality accrue mainly to the entire group whose statistic is affected rather than to the individual sellers. As a result there tends to be a reduction in the average quality of goods and also in the size of the market. It should also be perceived that in these markets social and private returns differ, and therefore, in some case, government intervention may increase the welfare of all parties. (Akerlof, 1970, p. 488)

There are precedents for providing market information to assist market participants in planning investments and managing through periods of interruption. Under the operating arrangements for the National Electricity Market (NEM) formalised processes have been established to provide information on future demand projections and on medium term assessments of system adequacy (see Box). While these arrangements refer to a fundamentally different market where energy cannot be stored, they provide an example of joint action to ensure that market participants have sufficient information on which to plan investments and respond to interruptions to

supply.

Box 1 **Forecasting and system adequacy in the National Electricity Market**

The National Electricity Market Management Company (NEMMCO) prepares reports on the electricity market outlook and on system adequacy as required in electricity market rules.

NEMMCO uses the outcomes of a variety of forecasting processes to determine the level of demand for every dispatch interval in the NEM. As a prerequisite for maintaining supply and demand in balance, it is important for NEMMCO's planning processes to be informed in advance of any limits on the capacity of generators to supply electricity or networks to transport electricity.

This enables the remainder of market participants to respond to potential supply shortfalls by increasing their generation or network capacity to the market. Market participants are able to signal upcoming limitations on supply by means of a variety of forecasting tools designed to improve the overall efficiency of the market.

There are two activities that may be relevant to a consideration of providing information to ensure that the market is adequately informed.

- Statement of Opportunities & Annual National Transmission Statement
  - NEMMCO publishes a 10-year forecast called the Statement of Opportunities (SOO) each year. This publication provides information to assist market participants assess the future need for electricity generating capacity, demand side capacity and augmentation of the network to support the operation of the NEM. The SOO contains forecasts of demand for electricity, details about the capacity of existing and committed generating plant, information about inter-regional transmission capabilities and advice on the impact of technical limits on sections of the network. It also contains forecasts of ancillary service requirements, minimum reserve levels, and economic and operational data to assist potential investors gain a full understanding of the NEM.
- Medium Term Projected Assessment of System Adequacy (MTPSA)
  - The MTPSA provides information on the supply/demand balance conditions in the National Electricity Market for each day during the next two years. This process has the following aims:
    - to provide information to the market about the expected level of medium term capacity reserve to allow market participants to schedule planned maintenance outages
    - to alert the market of any forecast periods of low reserve
    - to provide a basis for NEMMCO to intervene in the market through the reliability safety net provisions of the Rules
    - the assessment is updated weekly.

These reports are required under National Electricity Law. The information is reported on a regional basis and individual company's operations are not identified.

Data source: NEMMCO

AIP has recognised the importance of information flows in allowing consumers to appropriately assess their level of risk in the event of a supply disruption and make contingency arrangements:

> AIP member companies believe that consumers are best able to make decisions about their need for liquid fuels and the way they use those fuels based on information about price and availability. Consumers are also able to make decisions about how they will manage the risks of a supply disruption so that their economic and social interests are handled in the way that best suits their interests. Some consumers may invest in extra stockholdings while others may change the way they do things to avoid or minimise the impacts of possible disruptions. (Australian Institute of Petroleum, 2008, p. 18)

There are some concerns with the provision of additional information on the operation of the market. There may be concerns that the release of certain information might be commercially sensitive or create unnecessary panic in the market. In addition, the release of certain information may also have implications for the operation of competition law. In relation to concerns over panic buying, if more information is regularly provided to the market place then it is envisaged that the possibility of any initial over-reactions would eventually abate.

ACIL Tasman recommends that action be taken to improve the information available to participants in the downstream petroleum industry and all stakeholders. This would include:

- provision of forecasts of demand of refined petroleum products by product by ABARE or an appropriate forecasting body
- provision of forecasts of harvest periods by ABARE or an appropriate forecasting body, to allow suppliers of refined petroleum products to make better projections of peak demand from the agriculture sector and to ensure that major customers are aware of overall supply pressures
- notification by the Australian Defence Force to major regional suppliers of refined petroleum products of upcoming major defence force exercises
- provision of planned maintenance periods at refineries and terminals
- notification of unplanned shutdowns of critical infrastructure including refineries, terminals, pipelines and port facilities that would cause a disruption to normal supplies
- information on stock levels on a regional market basis
- the supply of information should be made voluntary in the first instance through a code of practice for industry participants with the information integrated in a single government endorsed website. If an industry code of practice should prove inadequate in improving information flows, then consideration should be given to imposing more formal information

disclosure requirements upon the industry through a regulatory mechanism.

This information should be integrated at a central location. A NOSEC web site would appear to be the most appropriate location for this information. Alternatively publicly accessible page on Australian Petroleum Statistics web site could be established.

The provision of information on unplanned shutdowns of critical infrastructure would have several advantages. It would provide consumers with improved information on the reliability of refined petroleum product suppliers upon which they can make a better informed risk assessment. In addition, it would provide critical infrastructure facility operators with an additional incentive to maintain reliability.

As previously discussed in section 5.2, a commercial risk is posed to domestic refiners from imported fuel if overseas refineries do not share the same cost burden from the introduction of an emission trading scheme as domestic refiners. The introduction of an emission trading scheme that unfairly impacts upon refined petroleum products produced by domestic refineries as compared to overseas refineries could distort product markets in Australia and lead to the unnecessary closure of domestic refineries. In order to address this concern, ACIL Tasman recommends that the Commonwealth Government take steps to ensure that domestically produced refined petroleum products are not put at a commercial disadvantage compared to overseas sourced product in the implementation of an emission trading scheme in order to maintain a diversity of supply.

9.6 Role of demand restraint

Based on the discussion in section 8.6, it is likely that increasing levels of taxation on refined petroleum products could contribute to demand restraint in the long run. However, the contribution of taxation to demand restraint in short run would be expected to be minimal. Demand restraint could also be achieved through improving the fuel efficiency of motor vehicles. ACIL Tasman notes that the Commonwealth Government is currently investigating improved fuel efficiency in motor vehicles through its proposed Green Car Innovation Fund.

9.7 Role of surge production

There is little prospect that Australian production of crude oil or domestic production of refined petroleum products could be significantly expanded in the event of a major supply disruption. Under these circumstances, there is

little to no role that could be played by surge production in addressing a major supply disruption.

9.8 Price response

In its 2007 report on petrol prices, the ACCC observed that all eight states and territories have legislation under which petroleum product prices could be regulated (Australian Competition and Consumer Commission, 2007a, p. 3). In the event of a major supply disruption, interference with price signals through the imposition of price regulation could thwart attempts to constrain demand in event of diminishing supply through market based incentives. ACIL Tasman believes that price regulation should play no role in mitigating the effects of a major supply disruption or a NLFE.

9.9 Fuel mix response

None of the alternative liquid fuels considered are likely to play a major role in improving Australian energy security in the foreseeable future. LPG will continue to provide a useful complement to petrol as a source of fuel for the vehicle fleet while LNG will probably emerge as a useful complement and alternative to diesel for the heavy duty vehicle fleet leading up to 2020. Biofuels provide a useful extender of fuel supplies but are limited in their ability to substitute for supplies of conventional refined petroleum products. GTL and CTL technologies offer potential substitution for diesel. However, these are only likely to replace diesel in very limited quantities in the period to 2020.

There is probably a case for government intervention in regard to research and development (R&D). The case for public intervention in R&D is premised on the basis that the private sector will under-invest in socially beneficial R&D, following the work of prominent American economists Professor Richard Nelson (Nelson, 1959) and Nobel Laureate Kenneth Arrow (Arrow, 1962).

Firms undertake innovation through R&D to improve their competitiveness. R&D can help a firm lower its costs of production and/or produce better products giving it a competitive advantage over its rivals in the market place. Left to compete in terms of price alone, with given products and technology, there is little scope for an individual firm to enhance its profitability even temporarily. The ability of a firm to change its products or processes increases the field over which it can compete. The benefits which firms seek to capture through R&D will ultimately lead to higher rates of economic growth.

Government intervention in the area of business R&D can be justified on the basis of the generation of positive externalities. Externalities occur when

participants to an economic transaction do not necessarily bear all of the costs or reap all of the benefits from the transaction.

The creation of knowledge through R&D activities also gives rise to the process of diffusion, whereby knowledge created by an organisation spreads through to the general community. This transfer of knowledge allows other parties to benefit from knowledge created so that other products and processes can also be improved upon.

The transfer of knowledge from the creator to others gives rise to positive externalities known as 'spillovers'. Spillovers from R&D refer to any unpaid benefit or unrecompensed cost from R&D that flows to individuals or organisations other than those undertaking the R&D.

Because a knowledge creator may not be able to capture the full benefits from R&D activity, the private incentives to undertake R&D may be inadequate to ensure that a socially optimal level of R&D is attained. Spillovers create a disincentive towards knowledge creation; the more a firm believes that its rivals will capture some of the benefits of the R&D it undertakes, the less inclined it will be to undertake R&D in the first place. If there are inadequate private incentives, firms will under-invest in R&D. Private underinvestment in R&D leads to market failure as the market is unable to generate an efficient outcome.

The main justification for government intervention in private R&D is to induce socially valuable R&D to proceed in those instances where the private returns are inadequate for it to occur otherwise. While the provision of government assistance through R&D in relation to future transport fuels has a strong policy foundation, ACIL Tasman believes that governments should leave it to the market place to develop the next generation of transport fuels and avoid mandating the development of any one particular type of fuel over another or demonstrating any sort of a preference through the provision of targeted incentives. Such a policy approach would risk the government getting involved in the process of trying to 'pick winners' in regard to future transport fuels which could come at a significant cost to taxpayers if governments pick incorrectly. In discussing the merits of nuclear power for the United Kingdom's energy requirements, Professor Dieter Helm of Oxford University warned the UK Government against attempts to pick winners in its recent review of energy policy:

> There is a strong presumption against government picking specific technologies in the energy sector, and in particular prescribing a given number of new nuclear power stations. The reasons are well researched and understood: government does not have an informational advantage over the private sector, and it is very vulnerable to technology capture. The history of energy policy in general, and nuclear policy in

particular, is littered with examples of "picking losers" rather than winners. (Helm, 2006)

9.10 Role of emergency responses

The case for government involvement and oversight in energy markets is predicated on energy security being a public good. According to the former Executive Director of the IEA Claude Mandil:

> Government action is needed as energy security is a public good. (Mandil, 2007)

There are public good characteristics to energy security in that one person's benefit from increased energy security does not reduce another person's benefit from it (non-rivalry in consumption). It is also not economically feasible to exclude people from receiving the benefit (non-excludability). Non-rivalry and non-excludability may cause problems for the market production of such goods. According to Christoph Frei, Director of Energy Industries and Strategy at the World Economic Forum and Professor at the Energy Center of the Swiss Federal Institute of Technology in Lausanne, markets fail to provide energy security by themselves because there are always opportunities for windfall profits and free riding (Frei, 2007).

When markets may fail altogether in the event of a NLFE then it is entirely appropriate that governments step in and intervene, as such events will likely precipitate major social and economic upheaval which in turn could lead to a partial breakdown in civil society. Under these circumstances, it is entirely appropriate for government to reserve what available liquid fuel resources are available in order to maintain emergency services and other essential functions. As ACIL Tasman commented in its 2004 review of the LFE Act:

> When 'force majeure' spreads throughout a market, price can no longer be used to allocate the remaining supplies. This breakdown in the market mechanism may provide a clear point for government intervention in the allocation of supplies. (ACIL Tasman Pty Ltd, 2004, p. 45)

On the other hand, if there are sufficient stocks of liquid fuels available to allow the general public to have some access, then the allocation of such stocks should be determined through markets with product going to the highest value users. Governments should resist attempts to micromanage markets under these circumstances as they are not well equipped to perform such functions. Previous attempts by governments to micromanage supplies of liquid fuels have not been successful, with the most famous example coming from the United States in 1979 which resulted in lengthy queues at retail service stations with Stephen Chapman observing:

> The gasoline lines owed their existence mainly to the Government allocation system,

> which dictated where, and in what quantity, supplies of gasoline would go. (Chapman, 1980, p. 47)

An issue raised during the course of consultations was the ability of the domestic refiners to coordinate their efforts in the period between the identification of an existing or emerging Liquid Fuel Emergency (LFE) and prior to the declaration of an LFE by the Federal Energy Minister (the so-called 'pre-planning' or 'alert' phase of the LFE Management Plan). Such early coordination would facilitate the development and implementation of a national industry response, thereby more efficiently managing the disruption and mitigating the prospect of stock-outs in a timely way through such means as:

- co-ordinated release of stocks around the country
- co-ordinated refinery production of output to minimise the need for movement of products between regions
- co-ordinated approaches to suppling essential users whether through bulk supplies or through designated service stations.

AIP has emphasised that, based on current arrangements, domestic refiners would not co-ordinate supply efforts until an LFE has been formally declared. Concerns have been raised that any attempt by the domestic refiners to co-ordinate their actions would raise issues under section 45 of the Trade Practices Act. According to AIP:

> The LFE legislation provides for exemption from the provisions of the Trade Practices legislation once a liquid fuel emergency has been declared. This provision is essential if the oil industry is to participate effectively in national and regional co-ordination bodies with governments to manage the production and distribution of liquid fuels to essential users and others during an emergency.
>
> However, AIP believes consideration must be given to how industry and government can more effectively co-operate on essential preparations prior to an emergency being declared.
>
> Industry believes there is a case for development of guidelines and appropriate legislated powers for handling matters during this period that might otherwise raise trade practices concerns.
>
> The key concern is to remove uncertainty about what can be discussed so that pro-active, rather than cautious, preparatory work can be undertaken. (Australian Institute of Petroleum, 2008, p. 19)

Section 45 of the Trade Practices Act prohibits the following conduct:

- agreements which have the purpose or likely effect of substantially lessening competition in a market
- agreements between competitors which have the purpose of restricting the

supply or acquisition of goods or services from particular persons or classes of persons, known as an exclusionary provision or primary boycott, are subject to a *per se* prohibition.

Concerns expressed that any attempt by domestic refiners to co-ordinate their efforts in any way would raise competition law compliance issues are entirely legitimate. While not providing legal advice, however, ACIL Tasman believes that the co-ordination of refinery production and the release of stocks by domestic refiners during the period of a major supply disruption likely to precipitate the declaration of an emergency under the LFE Act is unlikely to breach section 45 of the Trade Practices Act. In regard to supplying essential users, it is envisaged that State and Territory Governments would enact their own arrangements or that a NLFE would have been declared by the Commonwealth Government before the domestic refiners would have to engage in any co-ordinated behaviour to withhold supplies of refined petroleum products from certain categories of customers. ACIL Tasman sees no need for amendments or overriding exemptions to the Trade Practices Act to cover situations of severe supply disruptions.

10 Conclusions

Australia's liquids fuels vulnerability has changed since the 2004 White Paper. In terms of the three criteria through which energy security is generally assessed, ACIL Tasman makes the following findings:

- Despite a growing dependence on imported sources of oil and refined petroleum products, adequacy in terms of suppliers being able to keep up with demand has generally been maintained. This is likely to continue, although capacity constraints in global oil infrastructure may see continued upward pressure on prices.
- The biggest change since 2004 has been in regard to the reliability of the system. There have been some offsetting impacts on reliability of supply since the last assessment. While the incidence of refinery production disruptions has not changed, their impact can now be more severe. This is due to increased interdependency between refinery production units with the move to cleaner fuels. There is also little to no spare refining capacity left in the system to cover the loss of production capacity. The extent to which a production disruption becomes a supply disruption to end users depends on a refiner's stockholdings and ability to source alternative supply. Recent experience suggests refiners have become adept at managing production disruptions, with no major supply shortages in any market for which close substitutes were not available. This outcome also reflects the improved reliability of the international supply chain for crude oil and products imported to Australia. There remains, however, some pressure in the supply chain from bottlenecks in importing and distribution infrastructure. While the industry is responding to this pressure with plans for investment in new and upgraded infrastructure, the nature of this problem requires a more detailed investigation, as planned by the Government, given our growing reliance on imports. Overall, while refineries will likely incur unplanned shutdowns in the period to 2020, the prospect of a major supply disruption to end-users arising from refinery problems in Australia or overseas is extremely low.
- Affordability on an individual and household level has deteriorated. However, if affordability is defined in terms of maintaining international competitiveness then, given that oil and refined petroleum products are commodity products traded on international markets, it is unlikely affordability has deteriorated since 2004 and is unlikely to change in the period leading up to 2020.

There is unlikely to be a significant constraint on crude oil supplies arising from a peak in world oil production prior to 2020. While supply of oil will continue to expand, a risk for Australian energy security is presented by the

prospect that global production expansion may not be sufficient to satisfy global demand growth in the period from 2012 onwards. Ongoing tightness on the world oil market between supply and demand will put upward pressure on prices that would inevitably flow through into Australian prices for refined petroleum products.

Australia is now more likely to experience interruptions to the supply of some products in the short to medium term. There are several reasons for this:

a) Adoption of tighter fuel standards has created greater interdependence between components of refinery processes so that a breakdown in one component tends to affect other production processes.

b) Reductions in Australian refining capacity, coupled with higher levels of demand for liquid fuels, has resulted in the elimination of spare refining capacity. This means that refineries have limited scope to increase production or divert export cargoes into the domestic market in the event of a breakdown. Domestic production losses resulting from an unplanned outage can be readily replaced with imported product, however, this may take time to organise and deliver due to the longer supply chains associated with imported petroleum products.

c) Infrastructure is also an important factor. Infrastructure involved in the distribution of refined petroleum products, such as pipelines and terminals, is being worked harder and in some places is reaching the level of its capacity constraints, particularly in Sydney, increasing the likelihood and impacts of breakdowns.

Australia will face greater exposure to global crude oil and refined petroleum product markets as the margin between domestic production and domestic demand for both crude oil (from declining domestic production) and refined petroleum products (from increasing domestic demand that outpaces any domestic production expansion) widens over the next 12 years:

1. Newer offshore oil fields in North West Australia tend to produce heavier crudes that are not suitable for processing in Australian refineries and condensates that are not attractive for processing in Australian refineries due to refinery product yield considerations and are consequently exported.
2. The production life of some of the newer oil fields is too short to justify further investment by domestic refineries to process heavy crudes.
3. Imports of refined petroleum products are subject to variations in global markets.

Interruptions to supply from domestic refineries or from problems at receiving terminals and pipelines will have a greater impact than in the past due to:

1. less spare capacity resulting in supply interruptions having a greater impact on the market
2. replacements of refined petroleum products coming increasingly from imported cargoes rather than diverting cargoes from Australian production, therefore increasing supply chain delays for products by between three to six weeks.

The major sources of interruption to supplies are more likely to be from:

1. breakdowns at Australian refineries
2. breakdowns at terminals and associated infrastructure
3. interruptions to imported crude oil supplies and a possible supply side constraint in the period up to 2015 from a lack of spare capacity rather than a lack of petroleum resources
4. global problems in crude oil and refined petroleum product markets resulting from natural and/or geopolitical factors.

Interruptions to global supplies of crude oil and refined petroleum products are likely to lead to price spikes in liquid fuels in the short to medium term.

The establishment of further refining capacity in the Asian region, such as the mega refinery being constructed at Jamnagar in India by Reliance Petroleum from 2008 onwards will reduce Australia's exposure to interruptions from both world and domestic problems.

Australia will need more investment in product storage at terminals and associated pipeline infrastructure in response to greater volatility in supplies:

- to manage commercial and supply risks identified above; and
- to meet IEA obligations.

There appears no lack of willingness to invest in new storage capacity for refined petroleum products, however, concerns have been raised in regard to a number of impediments to further investment such as lengthy and complicated regulatory approval processes, compliance with competition law requirements and land constraints at port locations around the country.

Alternative liquid fuels to refined petroleum products will not provide material reduction in supply risk management over the period to 2020:

- LPG will continue to provide a useful complement to petrol as a source of fuel for the passenger vehicle fleet
- LNG will probably emerge as a useful complement and alternative to diesel for the heavy duty vehicle fleet leading up to 2020
- Current generation biofuels provide a useful extender of fuel supplies but are limited in their ability to substitute for supplies of conventional

petroleum based fuels

- Gas to liquids and coal to liquids offer potential substitution of diesel but only in limited quantities in the period to 2020.

Concerns were raised by customers of the domestic refiners that there were significant information asymmetries in the event of a supply disruption. There was an acknowledgement by the domestic refiners that they now communicate with each other less in the event of a supply disruption for legal and commercial reasons.

A commercial risk is posed to the future viability of domestic refineries from imported fuel if overseas refineries do not share the same cost burden from the introduction of an emissions trading system as domestic refiners.

11 Recommendations

In order to improve Australia's energy security in regard to the supply of liquid fuels and lessen the level of vulnerability, ACIL Tasman makes the following recommendations:

- ACIL Tasman recommends reform to planning and approvals processes to ensure the timely and efficient delivery of storage and associated infrastructure by the petroleum industry and business consumers.
- ACIL Tasman recommends several measures to improve the flow of information to the market so that participants are in a better position to assess their own level of risk and vulnerability in regard to the supply of liquid fuels and thereby improve the operation and functioning of markets.
  - provision of forecasts of demand of refined petroleum products by product by ABARE or an appropriate forecasting body
  - provision of forecasts of demand in harvest periods by ABARE or an appropriate forecasting body to allow suppliers of refined petroleum products to make better projections of peak demand from the agriculture sector and to ensure that major customers are aware of the overall supply pressures
    - … these might be undertaken as part of the quarterly Commodity Statistics released by ABARE
  - notification by the Australian Defence Force to major regional suppliers of refined petroleum products of upcoming major defence force exercises
  - provision of planned maintenance periods at refineries, terminals, pipelines and port facilities
  - notification of unplanned shutdowns of critical infrastructure including refineries, terminals, pipelines and port facilities that would cause a disruption to normal supplies
  - information on stock levels of refined petroleum products on a regional basis
  - the supply of information should be made voluntary in the first instance through a code of practice for industry participants with the information integrated in a single government endorsed website. If an industry code of practice should prove inadequate in improving information flows, then consideration should be given to imposing more formal information disclosure requirements upon the industry through a regulatory mechanism.
- It is noted that the Government has accepted the recommendation of the ACCC that an audit of terminals suitable for importing petrol into Australia

be conducted. ACIL Tasman recommends that the scope of this audit be extended to include existing and planned storage capacity of any facility capable of storing crude oil and other refinery feedstock as well as all refined petroleum products.

- ACIL Tasman recommends that the Council of Australian Governments ensure that State Governments align their fuel standards with national fuel standards to increase the level of supply chain flexibility in the event of a supply disruption.
- The Commonwealth Government should consider accepting the recommendations of the Economic Associates study on lowering fuel quality standards during a LFE.
- ACIL Tasman recommends that the Commonwealth Government take steps to ensure that domestically produced refined petroleum products are not put at a commercial disadvantage compared to overseas sourced product in the implementation of an emissions trading scheme in order to maintain a diversity of supply options.

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B Terms of reference

OUTCOMES REQUIRED

The Department of Industry, Tourism and Resources is seeking a report addressing the following key issues:

• An assessment of Australia's current level of vulnerability to disruptions and/or heightened risks to the supply of liquid transport fuel, both in the short and longer terms. This analysis should include both the risk of a national liquid fuel emergency occurring and its likely impact;

• An assessment of whether Australia's liquid transport fuel vulnerability has changed since the 2004 Australian Government Energy White Paper *Securing Australia's Energy Future*;

• An assessment of whether Australia's liquid transport fuel vulnerability is likely to change in the period to 2020;

• Identify the most likely scenarios which might escalate into a national liquid fuel emergency in Australia;

• If Australia's liquid transport fuel vulnerability has changed, or will change, explain the key areas of change and factors underpinning the change, including whether there are different levels of vulnerability for different products and regions across Australia; and

• If Australia's liquid transport fuel vulnerability has changed, or will change in the period to 2020, what Australian and/or State Government policies or practices and/or industry policies or practices should be adopted to address this. Included in this should be an assessment of the effectiveness of market based demand restraint policies, as currently adopted by Australia, compared with other more regulatory based policies.

The vulnerability assessment is to be utilised by the National Oil Supplies Emergency Committee (NOSEC), a committee of the Ministerial Council on Energy, for further informing the management response to a national liquid fuel emergency.

SCOPE

The vulnerability assessment is intended to be a clear and coherent explanation of demand and supply side risks impacting on liquid transport fuel vulnerability in Australia. The vulnerability assessment will identify critical issues affecting the level of liquid fuel vulnerability and assess the current and future level of

liquid transport fuel vulnerability, including the risk of a national liquid fuel emergency occurring and its likely impact.

The vulnerability assessment is to have regard to:

- Planned and/or proposed investment and divestment in liquid transport fuel supply capacity in Australia and for major sources of supply, particularly in the Asian region, including a discussion of the general prospects for investment and the impacts of ageing infrastructure;
- Available and forecast oil reserves in Australia, refinery diet, nature of local and regional crude oils, prospectivity in Australian frontier/exploration areas, including a brief discussion of peak oil concepts;
- Domestic transport fuel production trends/forecasts until and including 2020, and expectations (ABARE data to be utilised);
- • Ability of the industry to withstand disruptions or contingency events, including the adequacy of stock holdings in the supply chain and flexibility of domestic and international supply chains;
- Trends/forecasts in demand, both in Australia and our region;
- Effect of increasing reliance on imported products;
- Availability of fuel meeting Australian fuel specifications;
- Existing production and demand data for alternative fuel sources, including biofuels, and discussion of the future role for alternative fuels;
- Differential levels of fuel vulnerability for particular fuel types;
- Differential levels of fuel vulnerability for particular regions;
- Trends in international supply and product type;
- Relative comparison of the most likely sources of a supply disruption, and whether there are practical steps that can be taken by consumers and/or large fuel users to minimise that risk; and
- The merits of alternative policies for responding to fuel supply disruptions and addressing fuel supply vulnerability, e.g. market based versus voluntary or regulatory approaches and stockholding policies.

RELEVANT BACKGROUND MATERIAL

The following reports should be taken into consideration in addressing this request:

- The Australian Government Energy White Paper[1];
- The Australian Institute of Petroleum Supply Security Paper[2];
- The Senate Standing Committee on Rural and Regional Affairs and Transport Australia's future oil supply and alternative transport fuels Final Report[3];
- The International Energy Agency Medium Term Oil Market Report[4]; and

- The 2004 ACIL Tasman Review of the Liquid Fuel Emergency Act 1984 Report[5];
- The Australia Government Response to the ACIL Tasman Review[6]; and
- The report of the Jet Fuel Taskforce[7].

DELIVERABLES

The following deliverables are required:

- • A plan for how the consultancy will be conducted including proposed methodology, timing and milestones and a plan for consultation with stakeholders incorporating as a minimum:
  - Meetings with key government areas including DITR, GeoScience Australia, Australian Bureau of Agricultural and Resource Economics (ABARE), Department of Transport and Regional Services (DoTaRS) and relevant state government representatives;
  - Meetings with key industry participants including Australian Institute of Petroleum, Australian Petroleum Production and Exploration Association and consumer representatives.
- Preliminary outline, draft and final reports addressing the issues identified under the heading **Outcomes Required** as outlined in this 'Statement of Requirement'.
- The timetable for contract deliverables is subject to negotiation, however the Department envisages an indicative timetable as follows:
  - Contract commencement date – December 2007
  - Preliminary outline - January 2008
  - Draft report – early March 2008
  - Final report and findings presentation – end March 2008

PROJECT MANAGEMENT

The vulnerability assessment will be managed by the Fuels and Uranium Branch, Resources Division, the Department of Industry, Tourism and Resources (DITR), and guided by a Steering Committee consisting of representatives from the National Oil Supplies Emergency Committee (NOSEC).

DEFINITIONS

The assessment is to acknowledge the following definitions of:

- Energy security the adequacy, reliability and affordability of the provision of energy;
- Vulnerability assessment the identification of areas of improvement to withstand, mitigate or deter a liquid fuel disruption;
- Vulnerability the degree of exposure of the Australian liquid fuel supply chain;
- Liquid fuel means liquid petroleum, a liquid petroleum product, a liquid petrochemical, methanol or ethanol;
- Supply chain the linked activities associated with providing liquid fuels from a raw material stage to an end user as a finished product;
- Adequacy the provision of sufficient energy to support economic and social activity;
- Reliability the provision of energy with minimal disruptions; and
- Affordability the provision of energy at a price that does not adversely impact on the competitiveness of the economy whilst supporting continued investment in the energy sector.