Review of Market Resilience to Oil Supply Disruptions

Prepared for the Department of Industry, Canberra

27 June 2014

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Executive Summary

The petroleum industry supply chain, which delivers refined petroleum products to customers, is a dynamic, complex, and global web of interlinking facilities and operations that has developed over decades. As with any business delivering a product to a customer, dependable supply is critical – a customer will go elsewhere if the desired product is not available. Hence, there is a commercial imperative for companies to build resilience into supply chains to ensure they are safe and reliable.

This explanatory report examines the levers Australian suppliers use to provide resilience in their supply chains and how these are used to mitigate disruption events. The report focuses on resilience to events that put the system under intense pressure, but do not significantly interrupt the market’s ability to function. Companies supplying petroleum products to Australia were consulted on their resilience systems and to obtain examples of how they used these processes to manage disruptions.

A disruption event which impacts or is likely to impact the supply chain will set off a reasonably orthodox organisational approach to managing risk. The oil industry is no different from other industries in that regard, except that these responses will take place within the timeframes to which the industry operates.

Supply chain levers used to create resilience

For the first step in the supply chain, crude oil supply to refineries, the generic levers companies use to promote resilience include:

- A diverse supply of crude oil sources (countries, production locations and counterparties);
- Establishment of long term deals and/or structural arrangements that provides crude availability for a significant portion of demand;
- Internal systems with the ability to buy and sell crude cargoes at short notice;
- The ability to switch cargoes within system prior to cargoes loading;
- Holding enough crude oil inventory at a refinery to manage normal disruption events; and
- The ability to access crude oil from storage at short notice (likely to be at a cost premium).
The finished product supply chains are also global in nature, with petroleum products moving over distances from a variety of locations including local refining. For product supply, companies use the following levers to create resilience in their supply chains:

- The ability to vary refinery throughput and the mix of products produced;
- Use of operational inventories (intermediates and blending components) to manage refinery production variation;
- A diverse range of product supply options (location, refineries and counterparties); Ability to adjust product mix and destinations of cargoes (prior to loading) by using the company’s total network to assist the location which is short; and
- Ability to purchase cargoes from traders or blenders at short notice if the price paid is sufficient.

Within Australia, companies also have levers in their supply chains that can be used to manage disruption, including:

- Flexible options on shipping contracts that allow companies to vary discharge location within Australia of any import and coastal distribution vessel;
- Ability of purchase locally from competitors’ refineries;
- Ability to trade locally with other market participants (purchase part of competitors’ import cargoes);
- Inventory normally held in system; and
- Use of available inventory around the whole country to meet a disruption in a particular location; and
- Companies allocating available supply to their customers.

Companies have built resilience into their supply chains by using the structure of the global market. The market has evolved significantly since the 1970s, gaining in depth and transparency. There is a greater flow of crude oil and products with more physical trading and more physical assets dedicated to this trade, giving greater capacity for storage strategies. The move to more closely align product specifications between countries is also assisting global flow of product grades, and the large ‘mega’ refineries can load larger product tankers which can trade at greater distances.

These developments characterise the current market, and provide levers to respond to disruption, both on a local and global basis.

**Resilience in the Australian market**

**Crude oil supply**

Australia’s sources of crude oil are diverse and cover a wide range from Malaysia to West Africa. Major supply disruption would likely see reallocation of this supply to mitigate the disruption.

**Petroleum product supply**

While a large proportion of Australia’s petroleum product imports ship from Singapore (the Asia-Pacific regional trading centre), this is changing as more product comes directly from North Asia (e.g. South Korea and Japan). Asia-Pacific is also linked with other global trading centres and products flow between them when market price differentials provide an incentive (e.g. when Hurricane Katrina hit the United States Gulf coast in 2005 prices quickly adjusted so there was an incentive to send cargoes to replace supply that normally came from the disrupted refineries).
Importantly, as the regional trading, storage and export centre, half the petroleum products exported from Singapore are not refined there, but are imported from other locations, and stored and blended there as part of companies’ optimisation strategies.

If there was a major disruption in this region (e.g. Singapore or surrounds) prices would increase (and this would be passed through to the domestic market). The price signal will attract supply to the region. Supply chains would adjust to replace any lost supply from that region and shipping routes would adjust to avoid the disrupted region. For Australia, this might mean product supplied from India, South Korea, Europe or the United States replacing normal supply sources. Cargoes would come directly from these other refiners (not via Singapore) to avoid any affected sea lanes, which is part of normal supply chain management practices.

For disruption within Australia, companies will look at the various options, initially using inventory in the system and then, if necessary, purchasing from competitors. With the ability to move large quantities of stock around the country by ship (by changing discharge destinations), the inventory in various parts of the country can be used to cover disruption in another location. This provides time to secure and ship replacement cargoes to restore inventory levels to normal operating levels. These options in managing available inventory also provide the time needed, should supply chains need to be adjusted for a more major disruption.

**Further Australian market observations**

Australia’s petroleum market is changing rapidly as refinery closures increase the proportion of product imports and as commodity trading companies play a more significant role in the supply chain and in marketing directly to customers. While refinery closures shift the import requirement from crude to product, both crude and product imports are supported by dynamic global and regional markets that operate with depth and flexibility. It is difficult to conclude that there is a significant difference in supply risk between crude and product imports. Product imports also provide suppliers with a lot of flexibility in responding to domestic disruption as they can easily adjust discharge location within the country.

While commodity traders can operate quite differently to the international oil companies (IOC) that have traditionally dominated Australian supply, they essentially use the same or similar levers in their supply chains to manage disruption. In terms of the flow of product through supply chains, commodity traders are substantial operations, giving them similar opportunities to reorganise flows in response to disruption. We would not expect commodity traders to act differently to an IOC in responding to disruption events.

Under some extreme, rare scenarios, the market may cease to function as normal (i.e. in the most efficient and cost effective way in response to price signals). This may be the result of events such as widespread global conflict, an outbreak of hostilities in a globally significant production area or systemic collapse of the global financial system which impacts global trade flows. The extent of any response to such an event will likely involve sovereign national interests that may cut across or override what oil markets might see as an efficient and desirable outcome; supply chains and respective levers described in this report may be prevented from operating in a normal, efficient way. Nevertheless, major supply disruptions impacting on the global market have occurred reasonably frequently in the past and the market has continued to operate.
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Photos courtesy of Department of Industry image library except storage terminal on page 6 (Horizon Singapore Terminals) and storage terminal on page 15/16 (Oiltanking.com).
1.0 Introduction

The Department of Industry requested Hale & Twomey (H&T) provide a report on the management practices and the way in which resilience is built into supply systems to manage disruption in the petroleum supply chain.

The petroleum industry supply chain, which delivers petroleum products to customers, is a dynamic, complex, and global web of interlinking facilities and operations that has developed over decades. For this review of market resilience to disruption events, we focus not only on the facilities or components of the supply chain but also on the business processes (levers), and the way the industry uses them, that underpin the flow of material through the supply chain. This covers the processes from the start of the supply chain to delivery to the market, including planning and securing crude oil supply, shipping crude, refining, trading, bulk storage, securing direct product supply, shipping product, domestic storage and management of domestic market supply.

Over time these components and processes have developed into a set of generic features (e.g. contracting formats, operational understandings) across the industry. Some processes (e.g. feedstock selection strategy) are a regular feature because they are an integral part of wider business planning process; other processes (levers) operate as a range of tools available for managing different risks through the chain.

The report examines events that place a supply chain under intense pressure (including disruption to international supply) but which do not significantly interrupt or negate the market's ability to function or respond.

Under some extreme, rare scenarios, the market may cease to function as normal (i.e. in the most efficient and cost effective way in response to price signals). This may be the result of events such as widespread global conflict, an outbreak of hostilities in a globally significant production area or systemic collapse of the global financial system which impacts global trade flows.

The extent of any response to such an event will likely involve sovereign national interests that may cut across or override what oil markets might see as an efficient and desirable outcome; the supply chains and respective levers described in this report may be prevented from operating in the normal, efficient way. Nevertheless, events impacting on the global oil market have occurred reasonably frequently in the past and the market has continued to operate. This review focuses on market and industry responses to such events and how supply chains are established to give companies options to manage those disruptions.

This market response is a lot more dynamic than was the case in the 1970s. At the beginning of the 1970s, the flow of oil through the supply chain (after production) was concentrated in far fewer companies with less transparency and very little involvement from independent traders and/or national oil companies. Following the oil shocks in the 1970s, more market based mechanisms began to develop.

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1 For this report we distinguish between bulk storage, which are large international storage terminals that receive, store, blend and ship out crude and product, and domestic storage, which covers in-country storage terminals that receive product and distribute to customers.
The market has continued to evolve and develop over the following three decades, gaining in depth and transparency as time has passed. The development trends in the last decade adding to the depth and transparency include traders increasing their investment in the physical asset base, greater capacity for storage strategies and a closer alignment in product specifications assisting the global flow of product grades (the development of larger “mega” refineries capable of loading larger product tankers has also encouraged this flow). This development has enhanced the levers available to respond to disruption, both on a local and global basis.

Many of the levers that companies have in responding to supply chain disruption, particularly larger disruption events, use market mechanisms. As described in sections 5.1.2 and 5.2.3, in a major disruption event, market price movement will quickly see the global supply chains respond and mitigate the disruption impacts. This may or may not be supplemented by a response from the IEA, but in either case the same market mechanisms will be operating.

The International Energy Agency (IEA) is mentioned in two case studies in Section 5.0 and was established in 1974 as a way for OECD member governments to intervene in the market during a severe supply disruption to share oil between its members. While not directly in scope for this report, the IEA has a role in oil supply disruptions if its member countries agree, as it can intervene in the market to increase supply of crude or product. Its foundation oil sharing mechanism relied on the cooperation of international oil companies operating in IEA member countries to directly allocate or share oil between members based on need.

By the mid-1980s, the IEA had adjusted its response mechanism to be more flexible and use the market for distribution by tendering stocks rather than allocation as laid out in its establishment documents. This system provided a more rapid disruption response than a physical allocation system between IEA members. This change was formally adopted in 1984 and is known as Co-ordinated Emergency Response Mechanism (CERM). All IEA responses since then have used the CERM approach. Because CERM is effectively a mechanism that provides additional supply to the market during a disruption event, on the occasions the IEA has intervened it can be difficult to assess what might have been the market impact if that intervention had not occurred.

2.0 Methodology

For the review, H&T initially developed a “process overview” of the petroleum supply chain, which describes the features of a supply chain and the way product moves through the supply chain. The process overview covers the components of the supply chain and the business models of different participants in the chain. Despite there being accepted categories of market participant, in practice there can be overlap between the business models they operate and in some cases significant variation between companies that on the surface are in the same or similar category.

The core business processes used for putting a supply chain in place were then examined. These included:

- Establishing demand – the volumes and range of feedstock required to service the participant’s market;
- Options for supply – for example, the upstream relationships carrying equity crude entitlements to be absorbed or marketed as part of the marketing relationship;

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2 Organisation for Economic Co-operation and Development
The flexibilities participants may retain – a minimum volume contracted as a firm commitment and how balancing volumes might be secured; and

Components that a participant controls or has access to, including:

- The arrangements a supplier has for refining;
- The arrangements a supplier has for accessing product supply without direct refining capability (supply from other refiners, or storage and blending providers);
- Arrangements for shipping capacity; and
- Supply of finished product (significant end users, e.g. mining, aviation).

The nature of this business process is described, how these components are executed in the planning phase (e.g. annual and monthly planning), the execution phase (doing the deal) and the operational phase (physical movement of product). The discussion includes the influence of:

- Timeframes that supply chains operate to;
- Steps required at each stage of the process;
- The different scale firms operate to – e.g. being single facility, regional or globally focused;
- How decisions are informed by the range of information and data available to the market, and how these decisions interact with, and help to inform market information systems;
- The key risks involved including physical (operational) risks and financial transactions risk (counter party); and
- The impact of legislation and regulations on the decisions made.

We examined how these business processes (levers) are shaped to manage risks that could potentially threaten flows through the supply chain, with a focus on how these levers can provide resilience when the supply chain is disrupted.

In preparing this report, H&T consulted with industry to obtain:

- Confirmation that the process overview provides an acceptable description of the business processes (levers), and feedback where additional material should be included;
- Comment and any additional material relating to the business processes (levers) used to manage disruption risk; and
- Feedback on how these levers have been used in real world disruption events and/or how these business processes (levers) might be used in possible future events.

We then considered, taking into account industry feedback, the effectiveness of the Australian and international oil industry’s current processes in light of possible contingencies that would have a major impact on the oil industry. This is discussed in section 5.0 under the categories of supply chain process (crude/product) and type of disruption event. For both crude and product supply disruption we consider relatively recent (last ten years) major disruption events to illustrate how the levers are used to mitigate the disruption. Although these events (Libya for crude, Hurricane Katrina for product) also involve a political response (IEA members releasing stocks) the market responses clearly illustrate the levers in action.
3.0 Features of a supply chain

This section describes the features (components and participants) that constitute the international supply chain for petroleum. We examine features of the market that have allowed the supply chain to develop other structures that reinforce and/or add greater depth to it.

3.1 Supply security

The aim of building resilience into a petroleum supply chain is to deliver products to customers reliably and safely. As with any business delivering a product to a customer, dependable supply is critical – a customer will go elsewhere if the desired product is not available. Hence, there is a commercial imperative on any market participant to ensure that its supply chain is reliable. In addition for the petroleum industry, the loss of income from lost sales is likely to be greater than the cost of taking action to mitigate the disruption; there is a strong commercial driver on participants, if they are to maintain their competitive position, to ensure that supply is maintained.

3.2 Supply chain components

The supply chain covers the process from the extraction of crude oil to the delivery of useable products to customers. Table 1 illustrates the key components of the supply chain.

Table 1: Supply chain components

<table>
<thead>
<tr>
<th>Supply Chain components</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration and Production (Upstream)</td>
<td>Upstream refers to all elements of the petroleum industry involved in exploring for and producing petroleum to a point of sale or entry point into the supply chain. As well as the producing facilities, this may involve infrastructure such as pipelines, storage tanks (including floating storage) and offtake facilities. It may also include production from unconventional technologies such as gas or coal to liquids technologies.</td>
</tr>
<tr>
<td>Shipping</td>
<td>Petroleum tankers provide the means of transporting crude and product between various components in the supply chain.</td>
</tr>
<tr>
<td>Physical (or commodity) trading</td>
<td>Physical trading is the buying and selling of crude and products in international markets. Trading can be confined to the transactions required to support a company’s own supply chain (sometimes understood as supply trading) and as a business in its own right (trading for profit), or both.</td>
</tr>
<tr>
<td>Bulk storage (crude and product) and product blending locations</td>
<td>The supply chain depends on storage to accrue, hold and make petroleum parcels available for delivery, transport and receipt. Storage can be for a specific supply chain or available generally for market participants to use as they see fit (e.g. renting storage to hold stock for later delivery or for blending product components to make finished or on-specification product) – there is significant storage in the supply system (for both crude and product), in which the business model provides facilities for petroleum to be traded into and sold out of. Bulk storage (which may include the use of tankers for storage) may be held by independent storage companies, traders, integrated oil companies or customers.</td>
</tr>
</tbody>
</table>
Refining and refining locations

Refining covers the process of refining crude oil into finished petroleum products that can be supplied and used by customers. Refineries are themselves very large storage facilities with significant crude, intermediate and product component storage. Refineries blend components produced into finished product grades. Many refineries also incorporate a petrochemical plant that uses products from the refinery as feedstock.

Domestic fuel storage

Domestic fuel storage covers in-country facilities used to receive and store product for distribution to the market.

Distribution/Wholesaling/Marketing

The process of distributing and selling product from a terminal to customers (via pipeline and/or truck).

3.3 Market participants

While there are many companies active in only one or a few components in the supply chain (e.g. a crude oil producer or a shipping company), there are many that operate as fully integrated suppliers, in which they are active in most components of the supply chain. The degree of concentration in each component may vary. Some companies may place greater value on ship ownership as opposed to control by contract, or some may undertake trading as a profit centre rather than purely as a function to provide supply to affiliates. In Australia, integrated suppliers control a large proportion of the flow of petroleum through to the customers.

3.3.1 Major market participants

Table 2: Major global market participants

<table>
<thead>
<tr>
<th>Company Type</th>
<th>Examples</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Oil Companies (NOC)</td>
<td>Aramco (Saudi Arabia), Petronas (Malaysia), Statoil (Norway)</td>
<td>These are companies owned by national governments. In most cases, NOCs were initially developed to look after the country’s production interests (upstream), but subsequently, NOCs have had a greater integrated downstream participation, including shipping, refining, storage and marketing assets (in their home country and in other countries).</td>
</tr>
<tr>
<td>Producers</td>
<td>Anadarko, Woodside, Santos</td>
<td>Companies which are focused on the production (upstream) sector of the petroleum market (likely to cover both oil and gas) with activities concentrated on marketing their upstream production.</td>
</tr>
<tr>
<td>International Oil Companies (IOC)</td>
<td>BP, Chevron, ExxonMobil, Shell, Total</td>
<td>Large publically listed multinationals operating in all facets of the petroleum supply chain. Companies' activities may vary in focus and emphasis (e.g. some own ships, some don't; some will have a greater trading focus) but in general they are active in most segments.</td>
</tr>
<tr>
<td>Independent refining companies</td>
<td>Reliance (India), Valero (US), Refining NZ</td>
<td>Independent refining companies focusing on the refining segment of the market. In many cases, refining companies are also represented in distribution and wholesaling in order to provide an outlet for their product.</td>
</tr>
</tbody>
</table>
Physical trading companies (or commodity traders) tend to be private companies, seeking profit opportunities by trading crude and product as it flows through the supply chain. Providing infrastructure to support the trading activity is common; many trading companies have purchased physical storage assets, ships and/or marketing assets, and sometimes the entire downstream business including refining assets.

Specialist storage providers provide storage for lease to market participants to manage crude or product flows, supplement trading activity and/or provide assets for the blending of petroleum to meet market requirements.

Companies which market product (wholesale and retail) using their own (or leased) storage facilities. Typically they are supplied by other market participants (e.g. an IOC, refinery marketer or trader).

These companies are similar to independent marketers although in this case they import a particular fuel for their own use.

3.3.2 Intermediaries

There are various intermediaries that provide a valuable role in informing and bring transparency to the market, the output from which feeds back into the supply chain decision making process. These include:

- Futures and forwards markets (NYMEX, ICE Futures) – these markets allow for trading in petroleum many years into the future, providing a reflection of how the market sees the supply and demand in the future, today;
- Pricing agencies (Platts, Argus) – report daily on petroleum markets, giving industry subscribers a transparent, regular and close to real time view of how events are impacting on the supply chain (through price);
- Specialised consultancies – examine market trends affecting supply chains going forward (e.g. FACTS global refining reports, tanker loading statistics and movements, shipping brokers);
- Brokers which provide a service connecting buyers and sellers (brokers are involved in physical petroleum, futures, shipping and compulsory stocks markets); and
- Data monitoring and reporting agencies (e.g. the U.S. Energy Information Administration (EIA), the International Energy Agency (IEA), and the International Energy Fund (IEF)’s Joint Organisations Data Initiative (JODI))

These participants are not directly involved in the movement of petroleum but contribute to the timely information and services enabling the supply chains to work more efficiently and respond more effectively to change or disruption.

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3 NYMEX (New York Mercantile Exchange) is a Designated Contract Market owned by the CME Group
4 Formally the International Petroleum Exchange based in London
3.4 Petroleum market generic features

As covered in the Introduction, over the past four decades petroleum markets have developed features which add further depth and granularity to the nature of petroleum supply chains and to the options available for supply issues that arise from time to time. These include the global nature and the commoditisation of the product streams.

3.4.1 Global in nature

Because petroleum can and is shipped over great distances, a supply chain servicing a market can extend from production areas nearby to areas half a world away. Hence, petroleum supply chains have evolved to be global in their nature and reach, both for crude oil and refined products. It is therefore possible for disruptions that affect part of a supply chain to be remedied from sources elsewhere, including sources from long distances.

The supply of petroleum over long distances is supported by the generic quality of petroleum, and the nature of refining capacity which has developed greater complexity over time to be able to manufacture and blend to a range of specifications. Any imbalances in product streams or components give rise to the development of storage and blending as a business in its own right, providing another supply source for finished product.

The global dimension and international trade upon which the supply of petroleum is based means that the features of the supply chain (and the processes linking the components) will be the same, or similar, regardless of the actual location. This has allowed the market to develop more granularity in the components supporting the chain which adds depth to the options available to handle contingencies that arise from time to time.

3.4.2 Commoditisation

The common features of each component have allowed each to evolve as its own commodity. This international connectedness and commoditisation has been facilitated by global markets providing benchmarks by which petroleum is priced. Furthermore, commoditisation has resulted in the development of greater transparency to the supply chain, although much of the data that reinforces market behaviour only becomes widely available sometime after an event.

The commoditisation extends to both the material flowing through the chain (crude oils, petrol, diesel, etc.) and significant components of the chain (e.g. shipping). In each of these cases, there are active daily global markets reflecting the price and availability of the material or component, which prompts continuous reassessment of both the opportunities and the risks to resilience.

3.5 Trade flows and arbitrage

Crude oil is produced in most parts of the world. While the Middle East remains a significant source (supplying approximately 30% of global demand), crude produced in other regions also moves globally (e.g. North Sea to the US and North Asia; West Africa to Asia-Pacific).

The trade of refined petroleum products is also global. Trade of clean petroleum products (gasoline, jet fuel, diesel) is centred on a number of markets, but three are considered to act as the main benchmarks (US Gulf for the Americas; Rotterdam for Europe; Singapore for Asia-Pacific). These markets are linked by product movements within and between each centre (e.g.
European petrol to the Americas; fuel oil from Europe to Asia; Asian middle distillate (jet fuel, diesel) to the Americas.

The opportunity to move product between various trading centres is known as arbitrage. If the price for a product in market A is higher than the price in market B (including the cost to transport it to market A), then the arbitrage is open and product will move from market B to market A while the arbitrage window stays open.

Moving product between markets is a continuous feature and is monitored on a daily basis. Disruption in one region will affect price; these higher prices will attract product from other markets and regions until the market rebalances such that there is no longer a profitable arbitrage (i.e. the supply-demand balance has been restored to that which existed prior to the disruption).

3.6 Contracting in the petroleum market

Each step in a petroleum supply chain is supported by a contract in some shape or form. Most transactions are for the supply of the crude, feedstock or finished product, and for the associated shipping or other logistics options (pipeline, rail, storage). These underpin the movement of material through the supply chain.

There are also contracted transactions to support ancillary services (e.g. quality inspection, ship agency service), but, although numerous, these transactions are minor compared to the petroleum and shipping transactions.

Other supply options, such as blending in third party storage, or contracting with a third party refinery to process the participant’s crude, are covered by more specific contracts, which recognise the nature of the transaction. However, even these specific contracts contain the same generic elements necessary to operate in the supply chain.

3.6.1 Nature of petroleum contracts

Contracts for supply and purchase can include:

- Longer duration (term) contracts – a number of parcels over an extended timeframe (e.g. 1-3 years); or
- Short duration (spot) contracts – supply of an individual cargo or parcel of product.

Regardless of duration, contracts will contain provisions for setting the timings for a shipment and the responsibilities for any delay. Shipping is central to petroleum logistics, hence contracts are drawn in a way that allows the parties to deal with the inherent characteristics of shipping where delay can arise through weather, congestion or mechanical breakdown.

Suppliers of crude will prefer to limit the window for loading or ‘lifting’ a cargo (1-3 days) so they can avoid the impact of shipping on offtake from production facilities. Receivers, however, will look to maximise their flexibility both for volume and timing to be able to handle the delays that can arise, or to provide commercial opportunities to improve efficiency of its supply (e.g. the ability to defer lifting to secure a more attractive shipping option). These drivers also operate in transactions for supply of refined product. The extent of any flexibilities will depend on the
volume produced, storage flexibility, shipping available and terms offered by other suppliers that will be factored into a buyer’s decision making.

Contracts are designed in a way that provides a high degree of flexibility initially (both to timing and volume), which gradually reduces as the commitment comes closer to being operational. Typically, the contractual process would start with a broad nomination (e.g. cargo to be lifted in a 15 day window), which gradually reduces to a narrower window (5 days), and finally fixes on an even narrower contractual window (3 days) when the tanker is obliged to arrive and the parcel is to be available. Contract terms will then address how risks are to be allocated for the impact of contingencies on these time dimensions (e.g. delays, weather etc.). However, this inherent flexibility provides the opportunity to make adjustments to the supply chain (e.g. to delay or advance timing).

For volume, the supplier may offer flexibility in the volume that can be accrued before a lifting is required or flexibility on the final cargo size (e.g. +/- 5%). This can be useful to the purchaser to provide some flexibility to manage changes to their refining requirement. The volume has to be declared using the same timeframes as when the lifting windows narrow.

### 3.6.2 Nature of shipping contracts

Shipping contracts are also key to the movement of petroleum through the chain along with the purchase contract. The buyer will use different ship contracting structures depending on the nature of the task and the risks it has to manage in the particular supply chain. These include:

- **Voyage charter**: Used when sourcing crude and products from supplying locations where good vessel liquidity is available.
- **Contract of affreightment**: Used with term purchase of crude or products where there may be reduced or poor vessel liquidity for ongoing cargo requirements (i.e. ensures ship availability).
- **Time Charter**: Used with there is limited or no liquidity of vessels required to perform task with specific operational requirements (e.g. coastal operation).
- **Demise or bareboat charter**: Similar to a time charter, but in this case the requirement includes controlling the crewing (e.g. in coastal operations where domestic crews are required).

### 3.6.3 Force majeure

The force majeure clause is a key component of any supply contract. While these clauses vary, in basic terms the force majeure clause gives the seller the right not to supply for any event listed (generally regarded as events outside the seller’s control). Force majeure clauses usually include acts of God (weather, etc.) and facility failure (e.g. a production unit or refinery experiencing an unplanned shutdown).

With the ability to declare force majeure there is no liability on the seller to fulfil its obligation to the buyer. As the downstream consequences of not supplying could be substantial (and very difficult to quantify), the market has developed these structures to manage the risks between buyers and sellers.

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5 The H&T report “Australia’s Maritime Petroleum Supply Chain” June 2013, has more detail on ship contracting
While force majeure is a key feature of contracts, in practice companies are reluctant to declare force majeure unless they have no alternative. Frequent use will damage their reputation as a reliable supplier; it is not uncommon for a seller to find a replacement cargo to honour their contract with the buyer if it is their facility that has had the problem.

But given these features of contracting, a supply department always knows there is a risk (albeit small) that a purchase contract could get cancelled, even relatively close to loading (note: once loaded, the contract has been exercised so this clause no longer applies). Hence, the processes (levers) they have for managing the supply chain still need to be ready to respond to such events.

### 3.7 Supply Chain Timeframes

With the numerous steps required to deliver product to the market, a supply chain needs to allow sufficient lead time in order to accommodate the timeframes required for each step. Therefore, time dimension is a key consideration.

The time dimension for a supply chain can mean that for product delivered in one month (M), the process for selection and purchase of crude and feedstock, shipping to refineries, shipping finished product from refineries, and holding inventory before distribution to market will be occurring between 2-4 months before delivery (including the planning process) (Figure 1). At any time in this 2-4 month time horizon, each of these stages and activities will be occurring as a continuous process (i.e. stock is always being planned for and is continuously moving through the chain). Hence, time is an ongoing dimension for responding to events and making any adjustments required.

The operational phase deals with the actual movement of product through the chain which at any one time could include organising or confirming the crude and product ships, loading arrangements, monitoring stock on the water, discharging, management of refinery production and monitoring inventories.

**Figure 1: Supply Chain Timeframes**

Any disruption impacting or likely to impact the supply chain will set off a reasonably generic or orthodox approach to managing the contingency or risk. The oil industry is no different from other industries in that regard, except that these responses will take place within the timeframes to which the industry operates. The response approach is likely to involve the steps as shown in Figure 2.
3.8 The influence of demand

Demand can be dynamic, varying with a large number of factors, including season, a country’s economic performance, population growth and the weather. Demand for petroleum products is the driver of the supply chain.

At a local level the supply system needs to be able to manage variation in demand, particularly the influence of seasonal swings. This is managed through forward planning (e.g. for seasonal variation) and local inventory. Communication between fuel suppliers and their customers is critical to ensure secure supply and to allow customers to assess their own level of risk and vulnerability in regard to supply security. A report to government on Liquid Fuels Vulnerability by ACIL Tasman had a number of recommendations on this subject.

These same factors influence demand at a regional and global level, but at these levels, demand is a key driver of price movement. Demand variation is monitored closely by the market to anticipate how price may be influenced.

Many consuming countries support this by publishing regular demand statistics. Government or market agencies, such as the International Energy Agency (IEA) and Organization of the Petroleum Exporting Countries (OPEC), publish demand forecasts as part of their service to the market. The US Energy Information Administration (EIA) publishes regular updates on petroleum usage, which often provides the supporting evidence to changes already seen in market price.

3.9 The role of inventory

Unlike electricity, petroleum is not a product that can be delivered instantaneously. Holding inventory provides a buffer throughout the supply chain, which allows the supply chain to function while managing variation (e.g. production variation, ship timing, demand variation). There is inventory held throughout the supply chain, including at upstream production facilities, at refineries, at bulk fuel terminals and near to domestic demand centres. Companies will make decisions around inventory levels on a continual basis and adjust these in response to changing

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*An Assessment of Australia’s Liquid Fuel Vulnerability; Prepared for the Department of Industry by ACIL Tasman, November 2008, pg. 167*
market environment, weather, operational performance, season, customer requirements and risk tolerance. Major and/or essential use customers can secure higher levels of inventory security through their contracting arrangements or direct holdings. This is the case for both crude and product inventory.

Inventory also provides a trading opportunity where profit can be made by buying and storing oil for later sale. Futures and forwards markets facilitate this trade by providing the ability to hedge the value of these transactions against sudden price shifts. Generally this activity is more likely to occur in or near large trading centres, such as Rotterdam or Singapore.
4.0 Supply chain processes (the levers)

This section describes the processes (levers) used to move material through the supply chain and how these processes (levers) might be used to manage disruption in the chain. Disruption by its nature is unexpected, and it is often not clear initially how much impact it may or may not have. This “immediacy” means disruption will test the supply chain more often when it is operational. However, the supply chain has also been put together from a plan. The planning phase is the opportunity to build preparedness and robustness, and hence, the planning phase is important in contributing to resilience of the supply chain.

While a petroleum supply chain is often viewed as a linear process from production to refinery to market (and the majority of the flow is through this linear process), in reality the flows can be more dynamic. Crude may be put into storage or taken from storage to feed a refinery where it is more economic to do so than a traditional sale or purchase. With product trade, the flow is even more dynamic with large bulk storage and blending facilities effectively providing an alternate supply route. In Singapore, for example, almost the same amount of product is exported from storage and blending facilities as is exported directly from its refineries. Over time, trading strategies that use these facilities have developed, building more depth in the system and providing suppliers with more levers to respond to disruption.

Figure 3 shows the possible pathways petroleum may flow through the market. The arrows depict the movement of crude, feedstock and petroleum product through the chain by ship or pipeline (or trucking movements to market). Ultimately, all the petroleum is meeting a market demand, but the dynamics of the supply chain may see it follow different paths in the process of getting there. To simplify this dynamic, we consider these processes in three steps:

1. Crude oil sales, trading, storage and supply;
2. Refining, product sales, trading, storage and supply; and
3. Domestic storage infrastructure and managing market demand.

Figure 3: Petroleum flow
4.1 Crude oil sales, trading and supply

<table>
<thead>
<tr>
<th>Supply Chain Component</th>
<th>Supply Chain Process Considerations</th>
<th>Supply Chain Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seller</td>
<td>Production plan (volumes/quality)</td>
<td></td>
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<tr>
<td></td>
<td>Marketing and contracting strategy (term/spot sales, agency, shipping and storage)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Execution and operations</td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>Feedstock selection strategy (optimisation, ranking)</td>
<td></td>
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<tr>
<td></td>
<td>Contracting strategy (term/spot balance, operational tolerances, destination flexibility)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shipping strategy (ownership or contract)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trading strategy (within system or for profit)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Execution and operations</td>
<td></td>
</tr>
</tbody>
</table>

4.1.1 Planning and execution

Sellers of crude develop marketing and contracting strategies that reflect their production capabilities (including the requirements of any joint venture), the demand for their production and the region or geopolitical context in which they operate. Many NOCs allocate their oil production to a number of buyers for periods of time (“term” deals), rather than on a cargo by cargo basis (“spot” deals). Some NOCs place restrictions on what can happen to the cargo after sale (e.g. a number of NOCs, particularly in the Arabian Gulf, do not allow buyers to on-sell their production), while others allow full flexibility with no restrictions. Based on its production profile, a seller will schedule cargoes for a period (monthly for period 2-3 months in advance) and allocate these to crude owners/equity holders (for production ventures with multiple owners) and buyers (for term deals).

A crude buyer assesses a range of crudes that might be suitable for its refinery(ies) – referred to as feedstock selection. This could cover a range of crudes available from over half the globe (an Australian refinery might select crude with a geographic range extending from West Africa through to Eastern Siberian (Russia), and all locations in between). This may initially be done on an annual basis to assist the crude trading departments make decisions on where to seek term deals for crude supply. For ongoing operation, the list of preferred/acceptable crudes will be continually assessed and ranked, based on processing value (covering purchase and shipping cost). This provides flexibility to adjust supply chains for each refinery, and to access alternative crudes (particularly when market forces are changing the cost and relative value of alternative crudes).

In the planning phase, options for addressing potential disruptions focus on the contract mechanisms to provide flexibility and optionality. A large consumer of crude will manage risk by:

- Securing term supplies of crude they know suits their system (including with NOCs);
- Having access to a geographically diverse supply of crude;
- Securing a supply of ships either through ownership or term capacity arrangements with ship owners; and
- Maintaining an active trading entity that interact with the market to provide options and deal with any imbalances.

Large and integrated oil companies (NOCs and IOCs) with global reach may aggregate the demand of their affiliates and centralise this on a regional or, in some cases, global basis. A centralised team matches production streams with demand, secures shipping arrangements that optimise the shipping of affiliate requirements and, in managing its system supply-demand balance, either keeps cargos within its supply chain or trades them where there are mismatches or opportunities to enhance value.

Execution means contracting the necessary requirements that will operate over the period of supply (e.g. volume, lifting obligations, shipping contracts). This applies equally to sales between affiliates as to sales to different companies. The buyer is typically expected to put in place the shipping of crude, although occasionally the sellers may organise their own shipping (e.g. when production is isolated from regular shipping markets or there are specific requirements for the ships lifting crude).

4.1.2 Operation

An operations function will manage the cargo as it is introduced and moved from one point in the chain to the next. This operational aspect is focussed on ensuring the commitments made under any contract are acted upon, particularly with respect to shipping as the lifting window approaches and decisions on any operational tolerances are exercised. Elements within these contracts cover management of possible operational disruption such as weather, production variation and shipping delays.

Both the seller and buyer will monitor their inventories and adjust liftings or deliveries to ensure no production or supply impacts. For a seller, this may mean organising an additional sale, adjusting lifting timings or placing some production into storage (including floating storage). A buyer may also look to adjust lifting timings or cargo volumes to manage its inventory.

For an integrated company, a crude shortage for one of its refineries may be managed by switching available cargoes (before loading). In effect, they use inventory throughout their system to manage a shortage in any one refinery. If this isn't an option, they may look at a complete switch (i.e. buying a replacement cargo, selling the delayed one). In all cases, they will assess the impacts of these decisions against the alternative of choosing to reduce refinery rates and increase the purchase of product from other sources. The length of the supply chain, particularly for Australia, provides more time to make these decisions and reduce supply impacts.

Where there is less flexibility (e.g. due to the location of the refinery), a refiner may choose to run a more conservative (higher) crude inventory strategy at the refinery.

4.1.3 Crude oil trading and storage

Trading is a regular feature of oil markets as participants go about securing crude oil for feedstock. However, not all crude is immediately sold for processing. While ultimately crude oil needs to be processed, it can be stored for later processing for the following reasons.

- **Stored by a NOC as part of a marketing strategy**: Some NOCs want to be able to sell their oil for more immediate delivery into key refining centres. To do this, they establish (or lease) storage facilities close to markets and ship their oil to these facilities.
This gives the ability to trade (hopefully at a higher price) for immediate delivery into that regional market. Examples of this strategy are Aramco (Saudi Arabia) holding their own oil in facilities in Rotterdam and South Korea, or Statoil (Norway) holding oil in South Korea. These facilities can also provide an outlet for production that is difficult to sell (i.e. putting crude into storage for later sale rather than selling at a significant discount if there is little demand for it at the time).

- **Stored by a NOC due to difficulties with selling oil.** This typically means holding more oil in storage than would normally be held (generally there is not a lot of spare capacity at production facilities) or to hold inventory on ships. For example, Iran has held (and is currently holding) substantial volumes of oil in tankers due to sanctions constraining its oil sales.

- **Stored by trading companies as a storage strategy.** Traders are active in the market buying and selling crude oil. A number of trading companies have contracts with NOCs where they purchase and sell some of the production. While the bulk of the volume is traded directly to a refinery, there is also the option of storing crude for a period (either in leased storage or on ships if shipping rates are low). A trader may use market pricing mechanisms (e.g. where forward prices 2-3 months ahead are higher than prompt spot prices) to hedge the cost of holding inventory or to profit if the pricing structure is sufficient to reward these strategies.

This kind of market activity means that, as well as the usual supply of crude from producers, there can be crude oil available (usually in or near major trading centres) on a more immediate (but likely more expensive) basis. Many countries and agencies monitor inventories at various locations, and changes in inventory will be picked up in their reporting.

### 4.1.4 Australian focus and summary of levers

The participants operating in Australia that require crude oil all follow the planning and operational processes outlined above. In general, the crude selection processes (including the timing requirements for cargoes) will be done by the Australian operation, forwarding its requirements to a centralised trading department. The centralised trading department will secure the crude and manage cargo operations. The networks that the trading departments establish are a key feature that provides optionality in the supply chains.

<table>
<thead>
<tr>
<th>Key risk management strategies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diverse crude oil supply sources (countries, production locations and counterparties)</td>
</tr>
<tr>
<td>System-owned crude (or &quot;term&quot; deals) covering significant portion of demand</td>
</tr>
<tr>
<td>Trading system to manage portfolio with ability to put in place replacement cargoes (or sell cargoes no longer needed) at short notice</td>
</tr>
<tr>
<td>Ability to switch cargoes within system prior to the cargoes loading</td>
</tr>
<tr>
<td>Holding enough crude oil inventory at refineries to manage normal disruption events</td>
</tr>
<tr>
<td>Accessing crude oil from storage (likely to be at a cost premium)</td>
</tr>
</tbody>
</table>
4.2 Refining, product sale, trading and supply

<table>
<thead>
<tr>
<th>Supply Chain Component</th>
<th>Supply Chain Process Step</th>
<th>Supply Chain Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refiner (as a seller of product)</td>
<td>Production profile</td>
<td>Trader</td>
</tr>
<tr>
<td></td>
<td>Contracting strategy</td>
<td>Buying/selling opportunities</td>
</tr>
<tr>
<td></td>
<td>Utilisation of capacity</td>
<td>Arbitrage opportunities</td>
</tr>
<tr>
<td></td>
<td>Product mix</td>
<td>Storage and blending strategies</td>
</tr>
<tr>
<td></td>
<td>Inventory strategy (crude, intermediates and blending components)</td>
<td></td>
</tr>
<tr>
<td>Buyer</td>
<td>Term or spot (annual, longer, shorter)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product mix</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contracting (trading flexibility, operation tolerances)</td>
<td></td>
</tr>
</tbody>
</table>

4.2.1 Planning and execution

Traditionally, refineries have been designed to meet specific market demand (e.g. Australian refineries were built in the major demand centres). Over time, the increase in refineries targeting export markets and the development of increased depth in product trading has seen many product supply chains adjust to a mix of refineries dedicated to a market and product supply from other locations. This trend has been occurring in Australia over the past decade.

Where refineries are not dedicated to a particular market (e.g. large export refineries), the owner will implement a contracting strategy to ensure a core part of its production capacity is covered by committed demand. Refineries typically need to operate at a certain throughput to be economic so will support this with long term supply contracts or associated marketing demand. These refineries may not commit all their capacity in the planning phase. In this case there is an economic decision to be made – the crude to operate the refinery at full capacity will only be purchased if sufficient refinery margin is generated (i.e. it makes economic sense\(^7\)).

The supply planning function will model the refinery production based on the crude purchased and the refinery’s processing capacity. Supply will then be balanced either by supplementing the refinery production with product purchases (direct imports in Australia’s case) or, if refinery

\(^7\) The margin generated by refineries reduces at higher capacities. Up to certain rates, the margin may be higher due to complex upgrading units or associated chemical plants. However, the remaining capacity may be of a less complex nature (generally lower) with lower refining margin (i.e. involve less upgrading).
production exceeds demand, exports. Therefore, as well as refinery planning, there is a trading activity to balance supply.

Companies will often look to balance supply needs through a contractual arrangement for a period ("term" deal), especially in the case of independent marketing companies which may not have the dedicated trading resource. Larger integrated companies have the trading resource so may leave an element of their supply open to spot purchases in order to actively participate in the market.

In all cases, buyers of product will look to manage risk by ensuring:

- A diverse range of supply options (countries, refineries, counterparties);
- For larger companies, a mix of term and spot supplies;
- A secure supply of ships as required either through ownership or term arrangements with ship owners; and
- The ability to trade (or have a relationship with a supplier which has this ability) if something happens to primary supply, including knowledge of product storage strategies and where product might be available.

For import cargo execution the buyer gives its supplier notice of when a cargo will be required (in Asia-Pacific, usually about six weeks’ notice). Where shipping is required, this is secured 2 to 3 weeks before loading. In spot markets, execution and operation are relatively closer.

4.2.2 Operational

Operationally, product supply is reviewed on a continual basis – this may involve monitoring rundown from a local refinery, managing import cargoes, sales and purchases with competitors and monitoring offtakes to the market. The actual output of refineries can vary from what is planned, due to:

- Plant performance (e.g. unplanned shutdowns);
- Crude quality received; or
- Late requests to adjust product mix due to changes in marketing demand.

Where there are impacts on production, these would be fed back into the planning phase. Variability is initially managed by the refinery using its crude, intermediates and finished product (usually held as blending components) inventory. Where production impacts are more significant, the impacts will be balanced by the inventory held downstream of the refinery, along with any supply adjustments such as increasing or re-scheduling imports, or purchases from a competitor.

An export refinery would manage disruption by negotiating timing changes to the lifting programme, purchasing a replacement cargo to meet its supply commitment or, in severe circumstances, declaring force majeure on export cargoes.

Where one product is affected, there can be an opportunity to adjust the import cargo product splits prior to loading. Companies with a large product supply network may manage available cargoes between various destinations prior to loading. For example, supply to one destination might be delayed in order to bring forward a cargo for a destination where cover is required.

Once the cargo is loaded, there is limited destination flexibility except in the choice of ports within the country of destination. This is because the specification of the product will be matched to the
market it is destined for and the company buying the product has an ownership interest (and, therefore, the right to direct the ship) once the cargo is loaded.

For near term disruption (e.g. issues with import cargoes or local refinery issues), and when local purchases are not available, companies will look to secure prompt (short notice) cargoes. They can do this by purchasing from companies holding product inventory, from export refiners which may have flexibility, or by blending stocks suitable for making the grades required. Typically, these cargoes will be at a premium to encourage the seller to meet the prompt demand.

4.2.3 Trading, blending and storage

As for crude oil, there is substantial trading activity in all major products (i.e. petrol, naphtha, jet fuel, diesel, fuel oil) not associated with the immediate shifting of product from a refinery to use for customer demand. There is also depth to the market provided by trading companies which take positions in the market by securing rights to refinery offtake and/or securing deals to supply independent marketers.

Commodity trading companies describe their process as putting a matrix of opportunities together covering numerous supply options and numerous demand requirements. Rather than dedicating a certain supply option with a particular demand requirement, they will have a number of supply options including term purchases, processing deals and occasionally refineries. They will supplement this with spot purchases. Their market demand (referred to as "shorts") will be their own system demand (related marketing companies), supply deals to independent marketers and sales to other market participants. They will optimise their matrix of opportunities on a continual basis as the market provides opportunities to trade.

Disruption may require adjustment to the supply matrix although it can also provide opportunities to further optimise the supply. This may involve selling a cargo intended for system demand at short notice to cover another company’s requirement and replacing that cargo from another source making a margin between the sale price of one cargo and the purchase of the replacement.

This optimisation is supported by physical assets such as large storage facilities. These provide an option of putting product into storage if there is no market demand (at the right price) for the product at the time or to build product inventory to provide security and supply options for future demand. As with crude, the forward market pricing structure can impact the attractiveness of storage strategies.

The requirement to have good regular demand for product ("shorts") has seen both trading companies and companies with excess product (e.g. South Korean refiners) looking to secure independent market outlets in Australia in the last couple of years.

There are also companies that specialise in blending activities (including traders). In this case, refineries may produce components which cannot be absorbed within their blending pool. Blenders purchase these components to take into their storage facilities. These are then blended with other components to make finished grade quality for various markets. In Singapore, the blending of components in this way produces as much finished product for export as is actually refined in

*While most petroleum suppliers operating in Australia take ownership of cargoes at the load port this is not the case for all operators, particularly those affiliated with or supplied by commodity traders.*
Singapore. Hence, blending in some markets is a substantial activity, giving an alternative supply option for product buyers.

Product trading, blending and storage strategies add more depth to product markets. In effect, these provide extra inventory that can be called on to supplement market supply in a disruption. As with other market activity, these inventories are actively monitored and reported on. Changes in the volumes stored can alter market perceptions on the overall supply-demand balance and influence market price.

4.2.4 Australian focus and summary of levers

The four major suppliers in Australia (BP, Caltex, ExxonMobil and Viva Energy) all use a mix of domestic refineries and imports to meet their market demand – with market growth and refinery shutdowns, the proportion met by direct imports is increasing. The domestic refineries are associated largely with a core marketing demand in their locations. Finished product can also be shipped from the refineries to other locations, although in general this will still be in the same or neighbouring states. As refineries close, distribution from the remaining refineries will tend to become more localised (less coastal distribution to other locations)⁹.

All Australian market participants plan their supply as outlined above, with any refinery production or local purchases balanced by import cargoes from offshore refineries. Typically, local refineries are planned to operate at capacity, except for scheduled maintenance shutdowns. Companies note that the increase in import cargoes (more ships in the supply chain) over recent years has increased the optionality to respond to disruption events.

All marketers have links into groups that are trading product in the regional market. Marketers may form links with trading departments within the same global company (IOCs, trading companies), establish a trading office in Singapore to provide this service or establish a supply relationship with a company who has this ability.

A particular feature of the Australian market is that oil companies and independents often buy petroleum products from each other in local markets where they do not own refineries or where they do not directly import. This feature developed as an efficient and cost effective way for companies to service customers in markets where they did not have a refining presence. It means that a single refinery is likely to provide more than one company’s marketing demand in its location, and also provide a lever for companies to vary purchases from other competitors should

Key risk management strategies:

- Ability to vary refinery production slate (to a limited extent once crude supply is committed)
- Increasing refinery throughput (where not planned at capacity)
- Ensuring a secure and committed offtake for refineries (so production is not impacted by changes in offtake)
- Using operational inventory (intermediates and blending components) to manage production variation
- Using a diverse range of product supply options (location, refineries and counterparties)
- Ability to adjust product split on mixed cargo imports
- Ability to purchase cargoes relatively quickly if necessary through the trading system
- Ability to purchase product from competitors (locally) to cover temporary shortages
- Shifting cargo destinations (prior to loading) within system by using the company’s total network to assist the location which is short of product
- Ability to purchase cargoes from traders or blenders on shorter notice if the price paid is sufficient

⁹ For example the Lytton Refinery in Brisbane is going to supply BP’s South Queensland petrol and diesel requirements once the Bulwer Island refinery shuts down (http://www.bp.com/content/dam/bp-country/en_au/media/media-releases/facts-about-closure-bulwer-island-refinery.pdf)
they have an issue with their own supply chain.

### 4.3 Domestic storage and managing market demand

<table>
<thead>
<tr>
<th>Supply Chain Component</th>
<th>Supply Chain Process Step</th>
<th>Customer demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>■ Monitoring and managing demand variability (e.g. demand surges)</td>
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<tr>
<td></td>
<td>■ Managing weather related disruption</td>
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</tr>
<tr>
<td></td>
<td>■ Managing supply chain disruption (near demand centre refinery, shipping disruption, distant refinery issue)</td>
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</tr>
</tbody>
</table>

#### 4.3.1 Planning and execution

As noted in section 3.1, security of supply is key for meeting customer requirements. A supplier with a reputation for being unreliable will risk losing customers to a more reliable competitor. As well as the supply decisions outlined in the previous sections, the key decisions made by marketers will be decisions on domestic inventory levels. Companies will make decisions on how much inventory to hold in order to meet their customer demand on a number of factors. These include:

- Reliability of the supply chain;
- Options if a key component of the supply chain is disrupted;
- Ability to respond to changing market demand;
- Cost of inventory and the appetite of customers to pay more for additional buffer stock; and
- Supplier reputation.

Holding inventory has a financial impact on a business, so increasing the inventory levels needs to be weighed against the cost and risk of stock outs. Generally, a company with a number of supply options (multiple refineries, a lot of import options) may be more comfortable with a lower inventory level than a company with a single or limited supply options. This consideration of inventory levels will be both company wide and by location – a location on the main import shipping routes generally holds less inventory (in days cover) than a location more difficult to reach.

Operational experience is also likely to influence inventory decisions – recent events causing lower than planned stocks are likely to encourage a more conservative strategy for a period. Another factor taken into account is possible disruption to the supply chain – for example, companies will hold higher inventory in locations that might be impacted by cyclones during the cyclone season.

Once minimum planned inventory levels are established (usually minimum working stock plus operational buffer stock), the level for cargo arrival times will be set – the cargo planning process works backward from this timing.

One aspect not covered in this report is that customers, particularly major customers, also need to make decisions on their supply security. For those which hold their own inventory, the decision will be on the minimum level they are prepared to drop to before they request resupply from their supplier. Customers with critical fuel requirements may decide to operate a more conservative
inventory strategy than their supplier, and therefore, hold more stock. Other critical users, particularly those which rely on diesel as backup for power generation (e.g. hospitals), are likely to keep stock on site as they require instant access should backup be required.

This report does not look at that aspect of the supply chain but notes work done by the National Oil Supplies Emergency Committee (NOSEC) and the Australian Institute of Petroleum (AIP) in encouraging customers to take responsibility for supply security\(^\text{10}\).

4.3.2 Operational

Operationally, inventory at all key marketing terminals are monitored on a continual basis. While many Australian market locations (refineries, or import terminals) are isolated, disruption in one area can be managed by using inventory in another area. This might be done by diverting a ship going to one destination to the location where stocks are short to partially discharge (effectively buying time and shortening the supply chain for resupply by relying on the stock available at another location).

Companies will generally not carry enough inventory to handle all contingencies at every location as the cost would not be justified (due to the very small likelihood of some contingencies). However, both the inventory held in the domestic storage system and the inventory already in ships on the water give companies time and space to use the various operational levers. For example, a disruption in the south of Australia might see part of the cargoes supplying more northern areas diverted to the south. The resupply would then be required in the north of the country, which has a shorter sailing time for the replacement import cargo.

Where a company is forecasting an actual stock shortage that cannot be managed in the near term, the company would allocate available stocks to its customers ensuring supply to customers with critical responsibilities. Certain large consumer groups (e.g. airlines) have pre agreed allocation systems.

4.3.3 Australian focus and summary of levers

In the Australian market, decisions regarding inventory levels are made at a local level, including by independent marketers.

Key risk management strategies:

- Flexible options on shipping contracts that allow companies to vary discharge location of import and coastal distribution vessels
- Ability to purchase locally from competitors’ refineries
- Ability to trade locally with other market participants (purchase part of others import cargoes)
- Inventory normally held in system (buffer stocks)
- Use of available inventory around the whole country to meet disruption in a particular location; and
- Companies allocating available supply to their customers.

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\(^{10}\) Maintaining supply security and reliability for liquid fuels in Australia, Australian Institute of Petroleum, pg. 20.
5.0 Disruption events and response

Petroleum supply chains are always subject to change and are constantly being adjusted to take account of changing variables, such as production delays, shipping delays and demand variation. Supply chain managers are continually dealing with matters that could lead to disruption and use the levers at their disposal to ensure petroleum is supplied within the planned timeframes. In this section the focus is on responses to larger disruption events and the levers used in these circumstances. Examples are used to illustrate these responses and show how commercial levers may work in similar circumstances.

While the focus of this paper is on the levers used by petroleum supply companies themselves to mitigate disruption and the likely market response, in any major global market disruption, the IEA can be expected to consider its role and its option to intervene in the market by releasing public stocks held or controlled by its member countries, or increase its preparedness to do so. The two largest events used in this section as examples to discuss commercial responses both also had an IEA action during the life of the event. As discussed in the introduction, the IEA now uses market channels to allocate any additional supply during a disruption event. This means, on the occasions the IEA has intervened, it can be difficult to assess what might have been the market impact if that intervention had not occurred. However, the key reason for selecting these two events is that they do show commercial levers at work even if the market response was supported by actions the IEA member countries took to increase supply.

5.1 Crude supply

To assess the supply levers to manage disruption in the crude oil supply chain, we first consider minor disruption (e.g. loss of particular field or location) and then consider major disruption by using the example of the loss of Libyan supply from the market in 2011.

5.1.1 Minor disruption

With Australian refiners receiving five to six cargoes of crude oil a month, adjustment to crude supply that need to be managed happen relatively frequently. Adjustment may be caused by a production variation, weather (e.g. cyclones) or shipping delays (either load or discharge). If the situation is severe, a producer may declare force majeure (cancelling cargoes). Once a supply department becomes aware of an issue, they will review appropriate responses following the process in Figure 2 (pg. 14), taking into account the impact on inventories. Responses could include:

- Delay loading until the cargo is fully available using the buffer inventory and other cargoes to cover the delay;
- Load the crude available (part cargo) and make up the difference by maximising loading tolerances (see Section 3.6) on other cargoes and/or loading the following cargoes earlier than planned (part cargoes are sometimes a feature, allowing a buyer to partially fill a ship at another load port);
- In a more severe situation with the loss of a whole cargo, immediately enter the market to seek a replacement cargo; or
- Consider the option of reducing processing rates at the refinery and balancing supply by increasing product imports.

As noted in section 4.1.1, the planning process for crude selection will include a list of suitable alternatives for the refinery, which includes the impact on processing value. As a substitution
crude is likely to be needed quickly, there will be more limited options as to crude type available. This may result in processing a less optimal crude, which will primarily impact on the margin the refinery can generate (therefore the refinery’s income) rather than volume of products made from the crude. While the Asia-Pacific crude oil market typically trades well in advance of loading, there is usually crude available on a shorter term basis (although generally at a price premium). The buyer may find another participant in the region that is selling a cargo due to refinery problems.

For all the responses listed above, especially in more severe cases, there may be an impact on refinery throughput and production. Generally, the risk of insufficient feedstock will involve a slowing down of the production process to maintain the operating integrity of all the refinery processing units. Because the impact on crude will be known in advance (as indicated in the planning process in Figure 1, pg. 13), the resulting production impact is built into the product demand balance, and product import cargoes will be adjusted (via increased loading tolerances, bringing planned cargo loadings forward, etc.) to compensate.

Since most crude used in Australian refineries comes from outside Australia (~10-20 days voyage), there is normally time to make the adjustments discussed above. Similar decisions are made if there is a disruption to the supply of any Australian crude the refineries plan to process. While there is less time available if Australia crude supply is disrupted, on the very few occasions that there has been a major incident of this nature (e.g. the Longford gas explosion in 1998 that also affected crude supply), refineries have obtained replacement cargoes in order to avoid major production impacts.

5.1.2 Major disruption (Libyan supply disruption, 2011)

The section above covered disruption to particular crudes and/or supplying fields. This section assesses the supply levers in a more major disruption where the global market, and market prices are affected. For this assessment, we consider an event which although significant and with a geopolitical component, did not prevent the market from operating. This enables us to assess the market response, rather than the political response.

In the early months of 2011, Libyan crude supply was disrupted during the so-called Arab Spring when, during an overthrow of the Libyan Government, almost all Libyan oil exports ceased. Within a couple of months Libyan oil exports went from a consistent level of around 1.6 million barrels per day (mb/d) to under 0.2 mb/d (Figure 4).

Figure 4: Libyan monthly crude production 2011

The loss of nearly 1.5 million barrels (~2% of global crude supply) had a significant impact on global supply. And, at the time, the market was experiencing other disruptions, including loss of some Nigerian supply. Hence, crude supply was relatively constrained.

As crude is traded on a continuous basis (with markets operating in different time zones around the world), any major disruption is quickly reflected in market price. Figure 5 shows the price of Dated Brent (the European crude price marker grade...
which is used as a benchmark across other markets, including Asia-Pacific) over the first seven months of 2011.

**Figure 5: Dated Brent crude oil price 2011 (January-July)**

![Graph showing Brent crude oil price from January to July 2011.](Image)

The market rose from around USD95/barrel (bbl) in January to over USD100/bbl during February as the initial impacts of disruption were felt (a drop to ~1.4 mb/d). The major disruption impact happened in late February with the market responding by jumping to around USD115/bbl. By April, almost all Libyan crude exports were affected and the market peaked around USD125/bbl.

A market price increase has the effect of discouraging demand (so less crude is required) and encouraging supply (incentivising producers to increase rates where possible). As with any commodity market, the price response operates to ensure market demand is met by allocation of available supplies to those willing to pay the higher price or by encouraging other production.

Most disruptions of this type have generated a short term rise in price to a peak value (in Libya’s case, USD125/bbl in April), which has then dropped as the market responds to the price signal (more supply/less demand). This was observed during the Libyan supply disruption, where prices fell in May from the April peak, despite the production disruption continuing through until exports started to recover from October 2011.

During this disruption an IEA intervention was initiated, although not until 23 June 2011, which was well after the market responses previously discussed. The IEA response led to a release of crude and product, with a preference to release lighter, higher quality crude of the type Libya normally produced.

While the Libyan disruption had little operational impact on crude supply to Australia (other than the price increase that followed through to the market), it did have an impact on countries and companies normally taking Libyan crude, such as those around the Mediterranean. The loss of supply meant the companies with Libyan crude in their programmes were forced to find replacements. While other crude was available, there were constraints since refineries configured to run on the light Libyan crude could not take heavier crudes more generally available from elsewhere. Again, the market responded to the restricted availability of lighter crudes by increasing the price of lighter, lower sulphur crudes (represented by Brent prices) relative to heavier, higher sulphur crude (represented by Dubai prices). The price premium for Brent over Dubai increased from USD3.50/bbl to USD7.00/bbl over the same January to April 2011 period. This acted as an incentive for refiners which had the capability of processing heavier higher sulphur crude, to process more of this heavier crude, thus freeing up other lighter crudes for those refineries that had less flexibility.

While the market adjusts to the altered supply dynamic over time, in the short term there can be some disruption to refineries normally dependent on the disrupted source of supply. This was observed during the Libya supply disruption. The loss of supply can be compensated by increased
product imports into those regions served by those refineries (using the lever of changing from local refinery supply to imported product).

**Figure 6: Australia’s crude supply**

A disruption of this type to one of the crude oil producing countries in the Asia-Pacific region supplying Australia would likely see a similar market response. There would be an immediate price response, with some cargoes that had been expected to load being cancelled (with possible force majeure declaration). Using the supply levers covered in 4.1.4, companies would seek out replacement crude cargoes and/or, adjust the refining throughput and secure additional product supply to balance market demand.

Australia has a diverse range of crude supply primarily between 14 and 28 days sailing (Figure 6). This diversity and the shipping times means there are considerable options should there be disruption to one country or region. Where crude with longer sailing time replaces crude with shorter sailing time, companies adjust by using inventory in the system along with any options for adjusting the volume of crude cargoes that are not affected by the disruption. Hence, Australia has less dependence on a single country or region for crude supply, compared to the high dependence some Mediterranean refineries had for Libyan supply. Given Australia’s diverse supply chain, replacement crude should be secured and domestic refineries would not be significantly impacted.11

If crude disruption impacted refineries in other countries that were expected to supply Australia, the disruption would move quickly to a regional product supply disruption, which is covered in the following section.

### 5.2 Refinery and product supply disruption

To assess the supply levers that manage disruption in the product supply chain, we consider three types of disruption, including:

- Australian refinery disruption;
- Offshore refinery/product import disruption; and
- Major product supply disruption using Hurricane Katrina as an example.

#### 5.2.1 Australian refinery disruption

In some respects, disruption to local refinery supply is one of the more challenging events to manage since the disruption is relatively close to the customer, which grants less time for

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11 Australia produces crude oil and condensate in Bass Strait and North West Shelf. While most is exported about 26% goes to the Australian refineries making up 15% of their feed (2012/13 year). New Zealand supplies about 5% of import volumes.
responses. As with other events, the initial supply response is to assess the supply and inventory forecast, taking into account the expected timing of any disruption (Figure 2, pg. 14). A supplier will then start working through the options of managing the production loss. This will include:

- Drawing down on blending stock at the refinery and finished product in the system (i.e. inventory buffers) to cover the disruption period (these give time to put in place other responses);
- Make purchases from other suppliers in the area (in effect buying some of another supplier’s inventory to provide short term cover);
- Divert import ships on the water into the affected location (e.g. an import that was going to discharge in Sydney might only partially discharge there and then discharge the balance in Melbourne to cover a Melbourne refinery disruption). This means inventory in various locations around the country can be used to support a disruption at a particular location;
- Similar to the above point, but in this case purchase part of a cargo from a competitor; and/or
- Purchase a replacement cargo from offshore (this is discussed in the next section). The response will consider all of the above options with the aim of giving sufficient time for replacement import cargoes to reach Australia.

In the worst case, the supplier may need to restrict sales. There have been occasional events where refinery performance has impacted on the market supply (e.g. Sydney jet fuel disruption in 2003, Victorian diesel disruption in 2012). In these cases, it was not a single refinery event but rather a combination of events (multiple refinery shut downs, product quality issues and demand increases occurring around the same time) that restricted the resupply options, albeit only for a temporary period.

5.2.2 Offshore refinery/product import disruption

Disruption at an offshore refinery is generally easier to manage than a local refinery as it usually forms a smaller part of a supply network designed by the trading department (i.e. operating on a diverse supply portfolio). Disruption at an offshore refinery also allows more time to respond (the impact is further back in the supply chain).

While the product market in the Asia-Pacific normally trades around six weeks in advance of loading, it is possible to get cargoes on much shorter notice (even within days), although likely at a premium over market prices. This is because, as discussed in section 4.2.3, there is a lot of product stock in the system, particularly with a greater level of blending and product storage, which can be accessed on a shorter term basis. Many of the companies supplying the Australian market are active in both trading and blending activities in Asia-Pacific, so are well positioned to respond in such circumstances.

This aspect of the market continues to deepen with substantial storage developments in Singapore and neighbouring countries over the past 10 years. In addition, petroleum product specifications, while still diverse, are becoming more aligned as more countries in the region move to product specifications similar to those in Australia, the United States and Europe. This increasing fungibility is enhancing the scope for purchasing product on short notice. Where a replacement cargo is delayed relative to the cargo it is replacing, the company will manage this by:

- Using its in-country buffer inventories;
- Diverting cargoes already on the water to cover any gaps due to the slippage in import cargoes; and/or
- Purchase, permanently or for a period, product locally from a competitor.

5.2.3 Major product supply disruption (Hurricane Katrina 2005)

The largest disruption to international product markets in recent years occurred in 2005 from damage caused by Hurricane Katrina. This event provides a good example of the way product markets respond to a major disruption event.

While Katrina impacted crude oil producing facilities in the Gulf of Mexico, the more significant impact was the damage to the substantial refining industry situated on the Gulf Coast of the United States (one of the main global product trading hubs). In the immediate aftermath, 2 million barrels of refining capacity was affected (impacting about 10% of US petrol consumption). Supply via the major product pipelines taking product north from the Gulf Coast was also affected.

The first thing to note from the price changes over this period (Figure 7) is that Hurricane Katrina and its aftermath had very little impact on the international crude price represented by Dated Brent.

**Figure 7: Price changes during Hurricane Katrina (2005)**

Despite having little impact on the crude price, the hurricane significantly disrupted a major refining centre, which impacted product supply to a large consumer market. The response of product prices in the immediate region (US Gulf Coast and New York Harbour) was immediate (prices starting increasing in anticipation of the hurricane’s arrival). Due to the local disruption, prices rose over 50% within a couple of days.

The damage was such that the lost refining capacity was unable to be restored quickly. This meant the disruption and response quickly became global. The price difference between the US market and those in Asia and Europe encouraged the immediate flow of product from those locations to the US. This was a normal market response to the arbitrage opportunity that had

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12 US Energy Information Administration – Hurricane Katrina Reports.

13 The IEA response including crude release from the United States of America’s Strategic Petroleum Reserve would have assisted in keeping crude prices stable.

14 Note the peak in USGC prices later in September was due to Hurricane Rita. In this case prices rose even more prior to the hurricane’s landfall.
opened, although the substantial price difference encouraged as much flow of product as there were ships available to transport it\(^5\). Within a day, the other main product markets were responding and in Singapore over the next three days, the petrol price rose by USD10/bbl (petrol was the main product import required for the US).

Despite the long term damage, in less than a week after the hurricane landfall US product prices were reducing, although were still at a level to incentivise product flow from other refining centres. Likewise, the Singapore product market also started to decline from its short term peak (Note: some of the decline was also due to crude oil prices declining over this period).

Hurricane Katrina provides a good example of the global interconnectedness of petroleum markets and a good case study for considering Australia’s possible supply responses were there to be a similar disruption in the Asia-Pacific region.

Singapore is the centre of product trade in the Asia-Pacific and currently supplies approximately 45% of Australia’s product imports\(^6\). There have been concerns raised that should something happen to Singapore, Australia would quickly have no supply, especially as Australia becomes more dependent on product imports with refinery shutdowns\(^7\).

A major product disruption in the Asia-Pacific region would see the markets respond in a similar way as they did during Katrina, with Australian suppliers quickly adjusting their supply chains as the US companies had to. Product prices in this region would immediately rise to a level well above those in the US Gulf or Europe. Local prices would follow (because Singapore prices act as the benchmark for prices in Australia), which would impact market demand.

These price changes would open the opportunity for arbitrage, incentivising changes to the destination of cargoes (e.g. Indian product exports to come east rather than going west, or North Asian product to come to Australia whereas it might normally be exported to the Americas). It would also incentivise product cargoes into the Asia-Pacific region (including Australia) from Europe and the United States (both the US Gulf Coast and Europe are major product exporters so the infrastructure is readily available for this trade).

Were there to be any geo-political disruption in Singapore and/or its surrounds, Australia would likely see cargoes trading directly into the country, avoiding affected sea lanes. While the replacement product supply chains to Australia would be longer, in some cases this is not significant (e.g. India, North Asia). In addition, markets further afield (Europe, US) trade on a shorter term basis meaning replacement cargoes could be on the water very quickly, as was the case during the Katrina response. Product specifications from markets further afield would not be a constraint as these locations all produce product of similar quality to Australia’s specifications.

The companies supplying Australia are all active in these global markets as part of their supply chain management. A major disruption would require a reshaping of their supply chains, which would be encouraged by the market price movements. All the levers covered in section 4.2.4 would be used with the reallocation of cargoes in this case being global. There could be a timing delay with replacement cargoes arriving later than cargoes lost but the companies would manage

\(^{5}\) The bulk of product imports came from Europe and the IEA response which included a preference for releasing product stocks (in Europe) would have assisted in the flow of product from Europe to the US.

\(^{6}\) Australian Petroleum Statistics to June 2013

this by adopting the same levers described in section 5.2.2. These levers include using in-country inventories, and adjusting the discharge ports of cargoes already on the water, as well as those planned, but not affected, by the disruption (e.g. cargoes from South Korea if the disruption is in Singapore). While market prices would rise in such an event, any actual supply disruption to the market would likely be limited to specific products or locations for short periods, rather than being country wide.

It was noted during consultations that most market participants are expecting Australia’s product supply sources to get more geographically diverse anyway over the next few years due to market developments such as the United States becoming a major product exporter, the likelihood of Indian export refineries looking for outlets in South Asia-Pacific and more North Asian product being supplied into the Pacific region.

5.3 Shipping risk

Trade movements of petroleum (crude and product) within and between countries are a significant part of the market dynamic for delivering petroleum to markets, particularly for Australia. Global seaborne trade represents around 65% of current global demand for petroleum, but over 90% for Australia. Therefore, minimising disruption to shipping is fundamental to ensuring the resilience of the supply chain.

From time to time, disruption events occur that threaten or impact shipping. Disruption events may include:

- An outbreak of hostilities between two countries in a significant petroleum producing area (e.g. the invasion of Kuwait in 1990, which threatened a number of suppliers in the Arabian Gulf);
- Hostilities (or the threat of) around or near major shipping lanes (the Straits of Hormuz; South China Sea); and
- Piracy.

Industry participants monitor developments that might impact on major production areas (as noted for Libya). As the availability of a supply source reduces, tanker owners will adjust deployment of vessels to the areas that industry participants look to for alternative supply. They may continue to operate near hostilities but, ultimately, charter parties enable an owner to call force majeure (the master has the overriding responsibility not to endanger the vessel and its crew). Where vessels are operating in areas at risk of conflict, the owner is entitled to recover war risk insurance premiums from the Charterer.

Where there is a risk to an established shipping lane, market participants will be factoring the potential threat into their risk management, including looking at potential alternative supplies. Depending on the seriousness of the event, a participant as charterer may direct the vessel to take an alternative route which will likely mean increased voyage time. This time impact will be factored into the supply chain and changes made to other options if required to maintain resilience. For Australia, there are options on many of the shipping routes into the country should there be issues on a particular route.

In the case of piracy, of which there has been a greater incidence around the Horn of Africa, participants have had to adjust the shipping arrangements in ways that minimise the exposure to these threats. These include:

- Alternative routings;
- Operating with other tankers or in ways that minimise opportunities for pirates; and/or
- Increasing levels of security on board.

Industry participants noted that these strategies are leading to a reduction in the frequency of piracy events.

### 5.4 Financial market risk

Like any other market, the flow of oil through the supply chain is dependent on the financial system continuing to process transactions relating to the sale and purchase of petroleum. Finance and credit are major considerations in each transaction.

As normal terms for payment for cargoes are 30 days following loading, the financial stability of the buyer is a major factor in the transaction. Any buyer that a seller considers is not of suitable financial status (and since the 2008 Global Financial Crisis, this risk has increased), will be required to guarantee payment, normally via a letter of credit from a bank. In more severe circumstances, a seller will require payment before the cargo is loaded. Companies active in the market have developed specific capacity to continually assess counterparty risk, credit and who they are willing to trade with (and to what value).

Where there is a counterparty failure (e.g. a supplier goes into receivership), there is a strong incentive for the entity taking control (e.g. a receiver) to keep the product flowing through the supply chain as this supports any value remaining in the company. The physical assets of the company (e.g. crude production, cargoes, marketing assets) also retain value and in most instances there is a fairly rapid sale of these assets to other market players so the receiver can recover funds for those to whom the company is in debt.

The most significant event in recent years affecting financial markets was the Global Financial Crisis (GFC) in 2008. While for a short period the flow of financial liquidity was impeded; in terms of crude and product supply to Australia, no impact was seen. In part, this may have been due to the fact that many of the transactions, while between entities in different countries, were between affiliates of the same parent company (reducing counterparty risk).

On a wider scale, disruption to the banking system would see the effects spread to significantly more than just petroleum flow. Hence, there is a strong incentive on sovereign governments to ensure financial markets continue to function and liquidity is maintained.

### 5.5 Domestic disruption

The focus of the report so far has been on disruption in the global supply chain (except for Australian refinery disruption covered in section 5.2.1). There are other types of disruptions that can impact product supply, including:

- Product quality;
- Internal distribution (trucking);
- Weather events;
- Industrial action; and
- Local infrastructure failure.

These disruptions largely impact local regions or areas, and are more often issues with the distribution of product to where it is required rather than the availability of product more broadly.
These disruptions are managed by the levers discussed in section 4.3.3 or by internal options, such as trucking from one location to another.

5.5.1 Product quality

The quality specifications for Australia’s fuels have evolved significantly over the past 15 years\(^\text{18}\). In line with international trends, both the operational and environmental specifications for fuels have been tightened and improved. In Australia’s case, this has been done in conjunction with improvements in capability of the domestic refineries required to meet these standards. While Australia has followed product quality trends in Europe and the United States, for a period in the past decade, Australian quality specifications moved ahead of much of the Asia-Pacific region (with the exception of Japan, South Korea and other smaller countries). At this time, this raised security concerns about the ready availability of product meeting Australian specifications in the regional market.

More recently, the Asian market is moving to similar product quality specifications, therefore improving product availability for Australia. In addition, new refineries that focus on product exports to Europe or the United States are capable of making the higher quality products. These trends are increasing the general availability of quality product for the Australian market.

In the Australian distribution chain, product quality issues (petroleum product not meeting specification) can still cause temporary disruption to the market if not managed carefully. Participants manage this by using independent testing and inspection companies to test product through the various steps of the chain, including by:

- Having a detailed inspection regime within refineries to ensure product is only released to marketing terminals when meeting the regulated specification;
- Having an inspection regime that test products at load port so any specifications issues are identified and resolved there rather than upon arrival in Australia;
- Testing on arrival, and prior to discharge, to assess risk of contamination in transit;
- Placing operating requirements on ships regarding product handling for quality integrity (e.g. tank coatings required for certain products, the order of loading different products, tank detailed cleaning requirements);
- Ability to isolate off-specification product within a terminal (if necessary) without affecting the operation of the whole terminal (i.e. multiple tanks); and
- Ability to blend off-specification product to useable product.

All product, whether produced locally or imported, needs to meet the Fuel Quality Standards. While there have been product quality issues in the past, many of the processes detailed above have continued to be improved; over the past couple of decades, disruption from product quality incidents have reduced.

Market participants noted that the more individual a country’s product specification is, the more dedicated the supply chain needs to be (there is less flexibility). The closer alignment of specifications in the Asian region with other global markets is increasing flexibility. It was noted

\(^{18}\) The Fuel Quality Standards Act is administered by the Department of the Environment. The Act, through the petrol and diesel determinations, prohibits the supply of petrol and diesel fuel that does not meet the national standards.
that bitumen is a product where the specification is more restrictive (Australian specific) which limits import options.

5.5.2 Weather and “Acts of God” events

Australia is impacted from time to time by major weather events. This can be anything from cyclones and floods to wildfires. With the size of Australia, and the diverse locations of its major cities, such events are likely to only impact one region, rather than a significant portion of the country (compared to the 2011 tsunami in Japan, for example).

These sorts of events are likely to impact supply chains but are typically managed without disruption to market. Producing fields will be shut down in the case of a cyclone threat, which may delay cargo loadings. This is managed within the levers covered in section 4.1.4. Shipping will also be re-routed to avoid major weather events resulting in perhaps 2-3 days extra voyage time. However, this would be considered within the scope of supply chain variability.

Where weather affects a major supply centre, the impacts can be more significant. These incidences may cause loss of power to a refinery forcing it to shut down, or closure of a port (as in the Brisbane floods of 2011). In this case, supply departments will use the supply levers outlined in section 4.3.3, along with internal distribution options (changing truck scheduling). In our consultation with industry, it was noted that these types of events also substantially reduce demand as people are asked (or forced to) stay at home rather than travel on roads that may be disrupted by the event. Therefore there is a natural demand offset to any disruption in the supply chain.

5.5.3 Industrial action and its regulatory process uncertainty

From time to time, the supply chain may be disrupted by domestic issues, such as industrial action or the action of regulatory agencies that market participants consider may constrain or impede operation of components of the supply chain.

Industrial relations issues may arise for a market participant, either directly or as a result of the effects of industrial action elsewhere. These sorts of disruption generally involve a build up during which suppliers can take mitigation actions (e.g. build inventories, etc.) Contractually, market participants can be expected to fall back on force majeure provisions where strikes are a recognised element.

In practice, it is expected that the market would take steps to continue supply where it could, while working within the regulatory framework applicable to any issue, including matters affecting industrial relations.

5.5.4 Local infrastructure failure

The supply chain can be affected by disruption to the local infrastructure other than refineries (covered in section 5.2.1). Examples include:

- Pipeline/wharf line failure;
- Tank failure/damage; and
- Jetty or port issues (closure/congestion).

In general, the Australian domestic infrastructure has proved reliable with no major events raised during consultation with participants (jetty and port congestion being the most frequent issue
requiring management). In most major markets, there are multiple supply routes, so supply is not dependent on a single option\textsuperscript{19}. Where options are more limited, companies are likely to see more frequent issues they need to manage to avoid disruption, which in turn is likely to lead to a review of the infrastructure and new investment where this will improve the supply security.

Terminals are normally built with multiple tanks for each product type, so failure of particular tanks will not affect any one product supply (and tanks can be switched between most products quickly). Companies normally either carry spare parts or have arrangements with suppliers for having critical spares so that infrastructure like pipelines can be repaired quickly. The dependence of a market on a facility is likely to influence the strategies in this area, such as inventory levels.

While the focus of this report is the resilience of the supply chain up to and including the domestic storage terminals during consultation a couple of issues were raised that impact resilience and are worth noting.

- **Trucking**: While truck distribution does provide some flexibility to cover supply disruption (e.g. supplying inland demand requirements from the south where flooding has closed normal supply routes from the north) it was noted that there is not a lot of spare capacity in the fleet. This can mean there is less flexibility to manage disruption in this part of the distribution section of the supply chain than other parts. We understand after recent events in Australia related to tanker vehicle safety groundings that this is an area of ongoing work between governments and industry.

- **Biofuels**: Companies raised that the biofuel supply chain has less flexibility and resilience than the petroleum supply chain which can impact the supply of blended fuels. This was highlighted during the Brisbane floods, where the floods impacted a key source of biofuel supply (ethanol in this case) so the supply of blended petrol was impacted.

\textsuperscript{19} The supply infrastructure includes the refineries in each area so to maintain supply security (number of supply routes), generally the refinery needs to be converted to an import terminal to maintain the options should the decision be made to stop refining.
6.0 Resilience and the changing Australian market

The Australian petroleum market is changing, with refinery closures and conversions to import facilities, resulting in a greater proportion of product imports and with commodity trading companies buying existing oil marketing businesses. H&T has been asked whether the changing nature of the petroleum industry servicing Australia is likely to affect its resilience to disruption or strategies used for security of supply.

What is happening in Australia needs to be considered in the context of the global market where similar changes are occurring. These include:

- Large IOCs divesting their mature downstream businesses to concentrate more investment on upstream activities and emerging markets;
- More activity in crude and product markets with expanding opportunities for blending and storage and trading around these activities;
- Continued investment in large scale export refineries that are seeking outlets for their product streams;
- Commodity traders investing in downstream markets, acquiring supply chain infrastructure, sometimes in conjunction with purchasing marketing businesses; and
- Banks and financial institutions reducing involvement in petroleum and other commodity markets due to new regulations arising from the Global Financial Crisis (GFC) that restrict their ability to be involved in physical commodities.

6.1 Refinery closures

The oil security implications for closures in Australia’s refining sector were addressed in the report Competitive Pressures on Domestic Refining*. The report showed that the closures are effectively shifting the petroleum supply chain from one dependent on imported crude to one more dependent on imported product.

This shift is increasing the levers available to supply departments due to the critical role ships have in distributing available product to cover areas with disruption.

As described in sections 3.0 and 4.0, both crude and product markets are global commodity markets that will respond to disruption in any particular location. It would be difficult to conclude there is a greater risk in being dependent on product imports in comparison to crude imports.

6.2 Commodity traders

Market trends are resulting in a continued blurring of the boundaries that used to exist between different types of participant. Except for upstream activities, commodity traders are now, like IOCs, represented in most parts of the supply chain. The question is whether a commodity trading company has and will use the same or different levers compared to an IOC to manage disruption.

In our view the response mechanisms they use will be the same or similar to an IOC, although there may be differences in emphasis on the components some may use. For commodity traders

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*National Energy Security Assessment (NESA) Identifies Issues: Competitive Pressures on Domestic Refining, Hale & Twomey June 2012*
who have invested in downstream markets there is a strong incentive to use the same levers as an IOC due to the direct interaction and reputation/exposure to major users and retail customers.

In general, commodity traders are not actively involved in exploration and production; they do not rely on upstream activity to establish their supply chains. They do, however, enter into long and short term contracts with producers for supply – in essence, they cover their supply chain risk through contract and/or by providing services to producers (NOCs and others) for the marketing and selling of production. In doing this, traders gain access to streams of crude oil that provide similar reinforcement of their supply chain as other companies who have equity crude entitlement.

Traders can still secure access or participate in substantial volumes of trade as shown in Table 3. These comparisons with some of the large IOCs are not direct comparisons (different measures of activity), but they do give an indication of size and scope of the supply chain activity.\(^\text{21}\)

**Table 3: Comparison of activity between large commodity traders and large IOCs**

<table>
<thead>
<tr>
<th>Company</th>
<th>Volumes traded, produced or sold</th>
<th>Summary volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitol (commodity trader)</td>
<td>Vitol traded 276 mln tonnes of crude and petroleum products in 2013(^\text{22})</td>
<td>~ 6mln b/d</td>
</tr>
<tr>
<td>Glencore (commodity trader)</td>
<td>Glencore handles around 3% of world daily oil consumption (approximately 2.7 mln b/d)(^\text{23})</td>
<td>~2.7 mln b/d</td>
</tr>
<tr>
<td>Trafigura (commodity trader)</td>
<td>Trafigura traded 117.8 mln tonnes of petroleum in 2013(^\text{24})</td>
<td>~2.6 mln b/d</td>
</tr>
<tr>
<td>ExxonMobil (IOC)</td>
<td>ExxonMobil produced 2.2 mln b/d liquids and sold 5.9 mln b/d of product in 2013(^\text{25})</td>
<td>2.2/5.9 mln b/d</td>
</tr>
<tr>
<td>BP (IOC)</td>
<td>BP production was 2.0 mln b/d liquids and total product sales were 5.6 mln b/d in 2013(^\text{26})</td>
<td>2.0/5.6 mln b/d</td>
</tr>
<tr>
<td>Shell (IOC)</td>
<td>Shell production was 3.2 mln b/d liquids and natural gas and total product sales were 6.2 mln b/d in 2013(^\text{27})</td>
<td>3.2/6.2 mln b/d</td>
</tr>
</tbody>
</table>

Traders also invest in supply chain components, such as refineries, storage and blending facilities and ships, in the same way as the IOC’s. Generally the focus has been on those assets which support trading, so more focus on areas of storage and shipping than on refining. However, the

\(^{21}\) We note that while supply chain activity is not substantially different, the bulk of the financial value of the IOCs is in their oil production assets and reserves, which make them substantially larger companies than the commodity traders.

\(^{22}\) [http://www.vitol.com/crude-oil.html](http://www.vitol.com/crude-oil.html)


\(^{24}\) [http://www.trafigura.com/financials/](http://www.trafigura.com/financials/)

\(^{25}\) ExxonMobil Corporation 4Q13 Press Release

\(^{26}\) BP Financial and Operating Information 2009-2013

\(^{27}\) Shell 2013 Annual Report
market is continuing to evolve and develop more granularity because of these developments, providing more supply options in the event of disruption.

This development means the commodity traders are now looking much like other global corporations and need to comply with the same transparency requirements (e.g. publishing accounts even though privately owned). Much of this transparency is required in order for companies to secure financing and credit lines. It also means, like other corporations, that they have reputation risk to manage and supply security and reliability is a key component of that.

The announcement that Shell had sold its downstream business in Australia to Vitol (now trading as Viva Energy Australia) is an indication of the changing face of the industry and the trend toward a less obvious categorisation of market participant than has been the case to date. From a resilience perspective, Vitol acquired an established business with a long standing reputation for reliable supply, so there is a strong incentive to operate with similar contingencies that Shell, as an IOC, has operated with.

6.3 Resilience of commodity traders

Banks have been reducing their involvement in petroleum and other physical commodity markets due to recent regulatory developments, higher capital requirements and lower profitability. This is creating a gap which is largely being filled by commodity traders. With commodity traders filling a role (market liquidity) formerly done by banks, the same resilience question that led to more regulations on banks is being asked of commodity traders.

The Financial Stability Board (FSB) located in Basel has commenced a study to look at potential systemic risk posed by “non-bank, non-insurer globally systemically important financial institutions”. This would cover the large commodity traders. In commenting on systemic risk, trading company representatives noted that commodity traders have gone bust in the past (e.g. Enron in 2001, Amaranth Advisors 2006) and competitors were quick to purchase the physical assets (as noted in section 5.4), which keeps supply chains flowing.

Trafigura recently released a report by University of Houston professor Craig Pirrong. The paper was written to explain the business more effectively to stakeholders and to demystify the commodities trading sector. The paper concludes that commodity traders are not a systemic risk as:

- they are much smaller institutions than the banks they are replacing;
- they have a much lower risk profile as they:
  - do not engage in maturity transactions like banks;
  - are not highly leveraged; and

29 http://www.financialstabilityboard.org/publications/r_140108.htm
- are not major sources of credit; and
- they have physical assets that can be transferred to others in the case of financial distress.