Asia-Pacific
Economic Cooperation

APEC Oil and Gas Security Exercise: A Regional Capacity Building

Melbourne, Australia

29-31 March 2017




APEC Energy Working Group

October 2017

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APEC Oil and Gas Security Initiative: EWG 01 2016S

PRODUCED BY:

Asia Pacific Energy Research Centre (APERC)
Institute of Energy Economics, Japan
Inui Building, Kachidoki 11F, 1-13-1 Kachidoki
Chuo-ku, Tokyo 104-0054 Japan
Tel: (813) 5144-8551
Fax: (813) 5144-8555
E-mail: master@aperc.ieej.or.jp (administration)
Website: http://aperc.ieej.or.jp/

FOR:

Asia-Pacific Economic Cooperation Secretariat
35 Heng MuiKeng Terrace, Singapore 119616
Tel: (65) 68 919 600
Fax: (65) 68 919 690
E-mail: info@apec.org
Website: http://www.apec.org

APEC# 217-RE-01.18

PREFACE

The Asia Pacific Energy Research Centre (APERC) has been conducting the Oil and Gas Exercise since 2013 following the APEC Energy Ministers' directive (10th APEC Energy Ministerial Meeting) in St. Petersburg in June 2012 to pursue regional cooperation on supply emergency response through workshops and exercises. Such directive intends to aid APEC economies to improve policy response and measures in dealing with or resolving any magnitude of energy supply disruption based on their respective domestic conditions.

APERC held the first two oil and gas security exercises (OGSE) in 2013 – the Joint Southeast Asian Exercise in Bangkok, Thailand, and the Indonesian Exercise. In November 2015, APERC officially launched the Oil and Gas Security Initiative (OGSI) expanding the program related to supply security consisting of three pillars, one of which is the OGSE. The Philippines hosted the 3rd OGSE and the first under the OGSI in December 2015.

This report presents the outcome of the OGSE in Australia (the 4th exercise) jointly organised by APERC and the Australian government through the Department of the Environment and Energy in Melbourne on 29-31 March 2017. The exercise was a regional capacity building with participation from other APEC economies – Indonesia, the Philippines and Thailand. The first day was devoted for capacity building workshop providing an overview of the global oil and natural gas markets, supply resilience in the APEC region, and the Australian energy policy and emergency response framework. The second day was the emergency exercise with hypothetical supply disruption scenarios for both oil and natural gas. On oil, a global supply disruption scenario was formulated, while a separate gas scenario was produced for each of the participating economies taking into account their distinctive domestic gas situations.

Seven invited experts formed the Expert Review Team to assess, comment and provide recommendations to the participating economies' responses on the presented emergency scenarios for oil and natural gas. The Team was composed of the International Energy Agency (IEA); the Economic Research Institute for ASEAN and East Asia (ERIA); the ASEAN Centre for Energy (ACE); the Institute of Energy Economics, Japan (IEEJ), the Ministry of Economy, Trade and Industry (METI) of Japan; the Department of Energy of the United States; and the Department of the Environment and Energy of Australia. The Team's comments and recommendations are also included in this report.

APERC will continue to improve the conduct of OGSE based on the experiences from the past exercises to make the activity more sensible to the needs of the economies. APERC is committed to carry on this activity as long as the Energy Ministers and the APEC economies still see the value of this program in improving resilience and mitigating the impact of any supply emergency. APEC economies are also encouraged to hold (or continue to hold) their own supply emergency exercises to further strengthen their policies, institutional arrangements and mechanisms, and response measures on supply disruption.

APERC wishes to thank all the participants and delegates who engaged in this exercise. Special thanks go to the Department of the Environment and Energy of Australian Government for co-organising this event.

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ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS

Bbl	Barrel
Bbbl	Billion Barrel
Bcm	Billion Cubic Metre
Bcf/y	Billion Cubic Feet per Year
Bcm/y	Billion Cubic Metre per Year
BPO	Business Processing Outsourcing
Cm	Cubic Metre
Kbbl	Thousand Barrel
Kbbl/d	Thousand Barrel per Day
km	kilometre
Kt	Kilo Tonne
KWh	Kilowatt-Hour
Mbbl	Million Barrel
Mbbl/d	Million Barrels per Day
Mboe	Million of Barrels of Oil Equivalent
Mcf/d	Million Cubic Feet per Day
Mcm/d	Million Cubic Metre per Day
Mmt	Million Metric Tonne
Mtoe	Million Tonne of Oil Equivalent
Tcf	Trillion Cubic Feet
Tcm	Trillion Cubic Metre
TWh	Terawatt-Hour

ACRONYMS

ACCC	Australian Competition and Consumer Council
AEMO	Australian Energy Market Operator
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
AERA	Australian Energy Resources Assessment
APEC	Asia-Pacific Economic Cooperation
APSA	ASEAN Petroleum Security Agreement

ASEAN	Association of Southeast Asian Nations
CCGT	Combined Cycle Gas Turbine
COAG	Council of Australian Governments Energy Council
CNG	Compressed Natural Gas
CSG	Coal Seam Gas
DOE	Department of Energy
DTS	Declared Transmission System
DWGM	Declared Wholesale Gas Market
EGAT	Electricity Generating Authority of Thailand
ESO	Energy Security Office
FSRU	Floating Storage Regasification Unit
GDP	Gross Domestic Product
GSOO	Gas Statement of Opportunities
IEA	International Energy Agency
IECC	Inter-agency Energy Contingency Committee
IEP	International Energy Program
ILP	Interruptible Load Program
JDA	Joint Development Area
KSA	Kingdom of Saudi Arabia
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MEMR	Ministry of Energy and Mineral Resources
MIR	Minimum Inventory Requirement
MOU	Memorandum of Understanding
NEC	National Energy Council
NEL	National Electricity Law
NEM	National Energy Market
NESA	National Energy Security Assessments
NESO	National Emergency Strategy Organisation
NGERAC	National Gas Emergency Response Advisory Committee
NGERP	National Gas Emergency Response Protocol
NGCP	National Grid Corporation of the Philippines
NGFR	National Gas Forecasting Report
NLFERP	National Liquid Fuel Emergency Response Plan
NOSEC	National Oil Supplies Emergency Committee

OGSE	Oil and Gas Security Exercise
OGSI	Oil and Gas Security Initiative
OPEC	Organization of the Petroleum Exporting Countries
PECR	Philippine Energy Contracting Round
PPP	Purchasing Power Parity
PSC	Production Sharing Contract
PTT	Petroleum Authority of Thailand–Public Company Limited
STTM	Short-term Trading Markets
SWIS	South West Interconnected System
UAE	United Arab Emirates

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EXECUTIVE SUMMARY

This oil and gas security exercise also conducted a capacity-building workshop based on Australia's experiences and approaches in addressing supply emergencies. The workshop was intended to provide important lessons for participating economies in the exercise – Indonesia, the Philippines, and Thailand – in dealing with oil and gas supply disruptions.

Capacity-Building Workshop

Australia is among the APEC economies with rich energy resources and is a net energy exporter. Despite such endowments, Australia is integrated with regional markets and supply chains to meet its domestic supply requirement, specifically for crude oil and oil products. With modest oil reserves and declining production, the economy imports around 80% of its refinery feedstock and 60% of oil product requirements. Most of the recently discovered oil is in the north-west part of the economy, which is in the form of condensates, and generally located closer to South East Asian refineries than its domestic refineries – much of which is on the east coast. The economy's refineries are also not configured to operate on condensates.

Australia's energy policy has been framed by its history and geography. The economy has a very large and isolated geography with climatic diversity and a small population. The economy's geographic characteristics have some implications for its electricity and gas systems. Due to large distances between different jurisdictions (states and territories), it has historically been impractical for the economy to have a national electricity and gas networks covering the whole continent.

The Australian governance framework on energy policy is under the purview of the Council of Australian Governments (COAG) Energy Council. The COAG Energy Council has an oversight function for all energy sectors, covering electricity, gas and liquid fuels. The majority of the Energy Council's work focuses on issues related to electricity and gas because both have national and regulated cross-border markets, while the liquid fuel markets operate on commercial basis.

Australia's energy security policy objectives are anchored on an energy trilemma theme, which guides the broader energy policy framework, namely:

- Adequacy - provision of sufficient energy to support economic and social activity;
- Reliability - provision of energy with minimal disruptions to supply; and,
- Competitiveness - provision of energy at an affordable price.

Australia established the Energy Security Office in July 2016 tasked to carry out activities that support its energy security policy objectives, and also to provide support to the Department of the Environment and Energy and the COAG Energy Council for their functions and responsibilities in the event of a liquid fuel, gas or electricity emergency.

As a long-term policy response to energy security risks, Australia has considered the importance of diversification of supply as having multiple sources and routes for oil into the economy strengthen supply security. The economy maintains a flexible supply chain through seaborne routes. The economy receives around 90 shipments, 20 for crude and 70 for oil products per month, which could be diverted in any part of the continent to deliver fuel and address short-term shortages.

Initially, the government allows market-based and fuel industry responses to manage the supply disruptions. If market and industry responses fail, government measures are then implemented, such as the activation of the Liquid Fuel Emergency (LFE) Act and the National Liquid Fuel Emergency Response Plan (NLFERP). The Act is only implemented when a supply disruption affects multiple states and territories, or it is national in nature.

The National Oil Supplies Emergency Committee (NOSEC) is the National Emergency Strategic Organisation or NESO, which reports to the COAG Energy Council. The Committee maintains close relations with industry, discusses and recommends responses to supply disruptions, and undertakes testing of disruption responses and assessments of liquid fuel supplies resilience.

Australia has also formulated a liquid fuel emergency management framework comprising of three integrated and complementary components, namely (1) market and industry-based responses; (2) government's regulatory safety nets powers; and, (3) measures relating to the International Energy Agency (IEA) obligation, Australia being a member country.

For gas, Australia has a National Gas Law in place governing the operation of domestic gas markets. The COAG Energy Council together the Australian Energy Market Operator (AEMO), Australian Energy Market Commission (AEMC), and Australian Energy Regulator (AER) have oversight and governing functions over the gas markets. In 2005, the economy created the National Gas Emergency Response Advisory Committee (NGERAC) and the Natural Gas Emergency Response Protocol (NGERP). The Committee is comprised of all jurisdictions, stakeholders from the gas sector including major users, and the Market Operator. The Committee regularly reports to the COAG Energy Council and prepares annual work program, and undertakes modelling and analysis on contingency planning, gas demand, and supply interruption. The Committee advises the jurisdictions on efficient and effective management of responses

The national gas rules (market rules) under the National Gas Law have provisions in handling gas supply disruptions.

Oil and Gas Security Exercise

Indonesia, the Philippines and Thailand[1] participated in the oil and gas security exercise (day two of the activity). The security exercise formulated hypothetical supply emergency scenarios, one common oil emergency scenario and three gas emergency scenarios – one each for participating economies based on individual domestic gas situation. The emergency scenarios were shared in advance to participating economies to give them more time to prepare comprehensive responses, including possible quantifications of each response measure (supply- and demand-side measures) and impact to their domestic economy.

Oil Emergency Scenario

On oil, the "Strait of Hormuz" has been closed due to the collision of oil tankers, which prevented Middle East crude oil, specifically from Saudi Arabia, United Arab Emirates, Kuwait, Qatar, Iran and Iraq, to be transported. Saudi Arabia, United Arab Emirates and Iraq have pipelines to bypass the Strait but on a limited capacity. Iraq has a pipeline going to Turkey. The global impact of this scenario is a supply shortfall of around 10 million barrels per day, equivalent to about 26% of global crude oil exports. The shortfall will also trigger a 100% increase in global crude oil price, reaching USD 100 per barrel.

The consequences of the emergency scenario to the economies will be a reduction in crude oil imports, thus affecting the outputs of their domestic refineries relying on Middle East crude. Likewise, some of the major exporters of oil products to the economies, which are highly dependent on Middle East crude, will also be affected by this global supply disruption. This will result in a decreased oil product exports, leading to a shortfall of imports below the required volume by the economies to meet domestic oil demand. Overall, total supply shortage:

- Indonesia – equivalent to 19% of domestic demand;
- The Philippines – equivalent to 51% of domestic demand; and,
- Thailand – equivalent to 30% of domestic demand.

[1] Although Australia participated in the oil and gas security exercise, its emergency scenario and response measures were not included in this report due to confidentiality policy of the Australian government.

Indonesia and Thailand have been experiencing declining oil production due to decreasing reserves and without new field discoveries, while the Philippines produces very small quantity of cruel oil (including condensate), which is not used domestically. In 2015, Thailand imported about 80% of its refinery feedstock requirements, Indonesia around 50%, and the Philippines is almost 100% dependent on imports. On the other hand, oil product imports provided more than 40% of oil demand of Indonesia and the Philippines. With huge refinery capacity, Thailand is producing almost all its oil product requirement with only less than 1.0% imports.

These economies have put in place policies, institutions, management frameworks and plans to deal with supply disruptions. Indonesia revised its National Energy Plan in 2014, which contains energy emergency policy framework and measures, and enacted a regulation in 2016 on the "Determination and Countermeasures in Energy Crises or Emergencies," and established the National Energy Council as a special body to address supply emergencies. The Philippines has an Oil Contingency Plan formulated in 2002, and enforces a "Minimum Inventory Requirement" to oil companies. Meanwhile, Thailand formulated an "Energy Emergency Management Framework. Only Australia and Thailand have been conducting oil and gas emergency exercise regularly.

In the event of supply emergency, the Philippines lets the industry to handle the supply emergency, and assesses whether the oil companies can still maintain healthy levels of inventories. However, the impact could be lessened with inventory levels held by the oil companies, around 40-50 days in 2015 way above the 30 days minimum inventory requirement. As the situation calls for alternative sources of crude and oil product imports, the government will streamline import processing and documentation to accelerate and speed up importation from different sources. If the oil companies are not able to respond and secure importation from other sources, the government will implement the Oil Contingency Plan. Specifically, the Plan covers demand restraint measures including rationing based on priority sectors. Being a member of Association of Southeast Asian Nations or ASEAN, the Philippines also mentioned the ASEAN Petroleum Supply Agreement (APSA) as a form of regional cooperation to address the supply disruption, but not operational at this moment due to still pending issues that need to be resolved. Once operationalised, member states in ASEAN, although also affected by this global oil supply disruption, can actually borrow or buy oil from each other.

For Indonesia, the first step the government undertakes is requiring oil companies, in particular the state-owned enterprises, to conduct an assessment if they can manage the supply emergency. In case the assessment reveals that oil companies cannot address the emergency and suggests the need for the declaration of crisis, the National Energy Council (NEC) recommends to

the President to declare a national energy crisis. Once crisis is declared, the government immediately implements the proposed crisis measures of the NEC. Among the supply side measures are delay or suspend exports of crude and oil products, and obtain additional imports from oil fields overseas operated by Pertamina, a state-owned enterprise. On demand measures, the government may restrict volume of fuel purchase per vehicles, reduce power generation from oil and implement load shedding.

Thailand sees the supply emergency to have a moderate impact given its supply surplus of oil products compared with consumption. To mitigate the effect of an increase in global oil price in domestic pump price, the government will apply price adjustment mechanism using oil fund. A priority measure of the government is to implement demand-side management, such as encouraging the use of dual system vehicle, switching from oil to liquefied petroleum gas and natural gas. When there is a much tighter crude oil supply, the government releases oil stock equivalent to 33 days and implements allocation of oil based on priority among users. Thailand likewise acknowledges the importance of the operationalisation of APSA, which could help lessen the impact of the supply disruption.

From these responses, the Expert Review Team made a list of observations, comments and recommendations. Broadly, the Team emphasised that relying on diversity of supply, although helpful, does not mitigate the disruption from a global perspective. Only adding additional supplies or reducing demand will make a global impact.

For Indonesia, among the Team's comments was on the measure to limit the economy's exports (crude and oil products), which may have implications on regional partners in the event of supply disruption. A comment on the Philippines response was to have a detailed analysis and quantification of the demand measures to include prioritisation. Meanwhile, the Team underscored that the use of oil fund of Thailand to subsidise partially the oil prices could be a costly policy for the economy.

Gas Emergency Scenario

Indonesia's emergency scenario paralysed some of the major gas platforms caused by a series of computer virus attack. The remaining gas fields in operation can only meet 80% of domestic gas supply requirement, and thus even the economy's export obligations are affected. Natural gas is one of the major sources of fuel for power generation, and used by the industry as a feedstock or raw material (i.e., petrochemical and fertilizer). To augment the gas supply, the government will increase

imports of liquefied petroleum gas (LPG from gas) and liquefied natural gas (LNG). The economy has regasification facilities including floating storage regasification unit. The government will reduce output from natural gas-fired power plants, and implement fuel switching, from gas to fuel oil for power generation. Power generation from other fuels (coal and hydropower) will be maximised to offset the shortfall from gas generation. Load shedding is considered only if system deficit persists after the implementation of other measures.

For the Philippines, a fire broke out in the control room of Malampaya gas platform, the major source of natural gas in the economy. Natural gas provides more than 20% of power generation of the economy (and 30% in the Luzon grid, one of the three power grids in the economy). The government will implement and monitor the use of alternate fuels (diesel and condensate) of the gas power plants. Other measure of the government is the Interruptible Load Program (ILP) to reduce demand during peak hours. The government is expected to issue a clear policy framework governing the development of LNG. The economy will soon have LNG facility in operation with the completion of its first LNG receiving terminal.

Thailand's emergency scenario covered two incidents – no LNG imports from Qatar due to the closing of Strait of Hormuz, and the mechanical failure occurred in the connecting point linking the offshore pipeline from Myanmar and the onshore pipeline going to Thailand. About 75% of gas import requirements of the economy is piped gas (and the remaining in LNG form). These incidents result in a 24% shortfall in domestic gas supply. Most of the natural gas-fired power plants have their own oil stock, and can switch using fuel oil and diesel, but the supply is only for 14 days. On LNG imports, which specifically affecting the eastern part of the economy, the government may call for more gas production from the concessionaire in the Thai Gulf to compensate a portion of the deficit in imports. The government may secure more LNG imports from other sources like Australia and Malaysia. The user of gas from the west (relying on piped gas) can use the linepack from the pipeline. As an option, gas from east may be sent to the west via the east-west pipeline connection. Demand-side management for electricity consumption will be implemented including load shedding.

From these responses, the Expert Review Team suggested that Indonesia considers developing alternatives to reliance on gas, in particular in the production of fertilizer for food security, given that the industry is one of the affected sector when a gas supply disruption happens. For the Philippines, the Team opined that though the 15-day supply of alternate fuels is a good strategy, the government should assess if such stockholding makes economic sense. On Thailand's supply-side

measures, the Team commented that sending gas from east to west (via the east-west pipeline) is not an appropriate emergency strategy considering the different qualities of gas.

The Team made some common observations and/or recommendations, such as:

- Continue testing existing emergency policies, instruments and institutional setups, and revise them (if necessary) to reflect national, regional and global developments;
- Consider a policy on floating price mechanism for "business-as-usual" and supply emergency situation to support faster market response and resolution of the supply shortfall;
- Build capacities of all the agencies involved by sharing and reviewing actual fuel and gas supply-related emergency responses;
- Undertake studies by Indonesia, the Philippines and Thailand on maritime oil supply routes and shipping arrangements in the event of supply emergency scenario;
- Develop better-integrated domestic and international gas markets through government policies that support market transparency and supply flexibility;
- Develop a more accurate modelling on gas infrastructure and surge capability since disruption in gas market has an impact on electricity supply;
- Ensure adequate infrastructure and the need to finance such to meet future demand. This should be linked to medium- to long-term planning exercises; and,
- Assess demand elasticity and the economic and financial cost of an emergency.

On the conduct of future OGSE, the Team suggested to have a special session on communication strategy for emergency. Electricity supply security should also be included in the emergency exercise (involving gas) to stress explicitly the importance of cross-sectoral work between institutions and authorities.

PART 1

CAPACITY BUILDING WORKSHOP

This section highlights the Australia's overall energy policy and supply emergency framework in dealing and resolving any supply emergency events in both liquid fuel and natural gas, and important lessons for the other economies to consider.

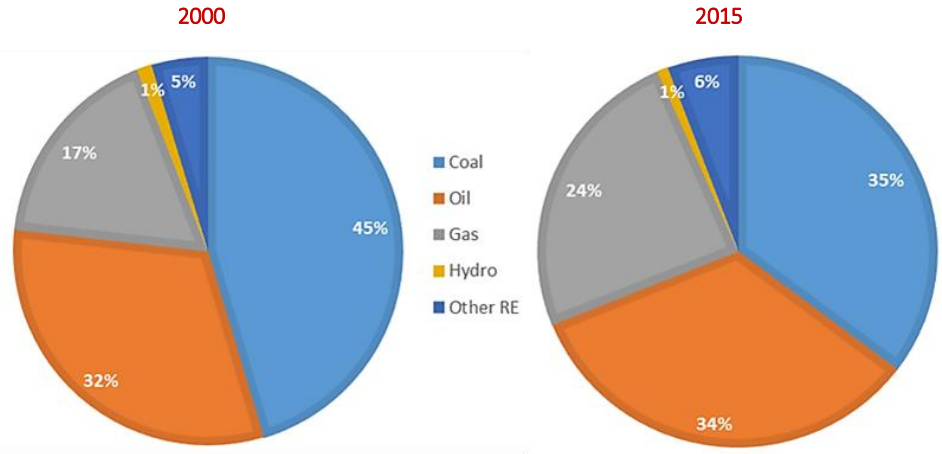
1. Background Information

Australia is the largest island economy in the world occupying a total land area of 7.7 million square kilometres (km²). In 2015, the economy's gross domestic product (GDP) reached USD 1,031 billion (USD 2011 Price and Purchasing Power Parity [PPP]) and with a total population of 23.8 million (WB, 2016). The economy has maintained a robust economic growth in the last 20 year with an average annual growth rate of about 3.4% (ABS, 2016).

The economy is one of the largest energy producers in the world (ranked 8th globally in 2013) accounting for around 2.4% of global energy production. It is the world largest exporter of metallurgical coal (27% of total global coal exports in 2014), as well as a major exporter of uranium and LNG, about 10% of total global LNG exports (DIIS, 2016c).

Considering the economy's huge energy resources and its geographical proximity to growing energy markets in the Asia-Pacific region, it is positioned to be a significant energy exporter providing a portion of the global energy demand. The economy is on track to become one of the world's largest LNG exporters by the end of the decade. [2]

Figure 1.1: Primary Energy Supply (% Share), 2000 and 2015



Source: IEA, 2016b

The economy's primary energy supply requirement increased at 1.4% annually, reaching 131 million tonnes of oil equivalent (Mtoe) in 2015 from 106 Mtoe in 2000 (Figure 1.1). Among the

[2] On current projections, Australia will overtake Qatar as the world's largest LNG exporter in 2019, when the economy's LNG exports reach 76 million tonnes. However, this is not yet certain as the difference between the projected exports of the two economies is narrow, and downside risks to the outlook for Australia's LNG exports remain (DIIS, 2017).

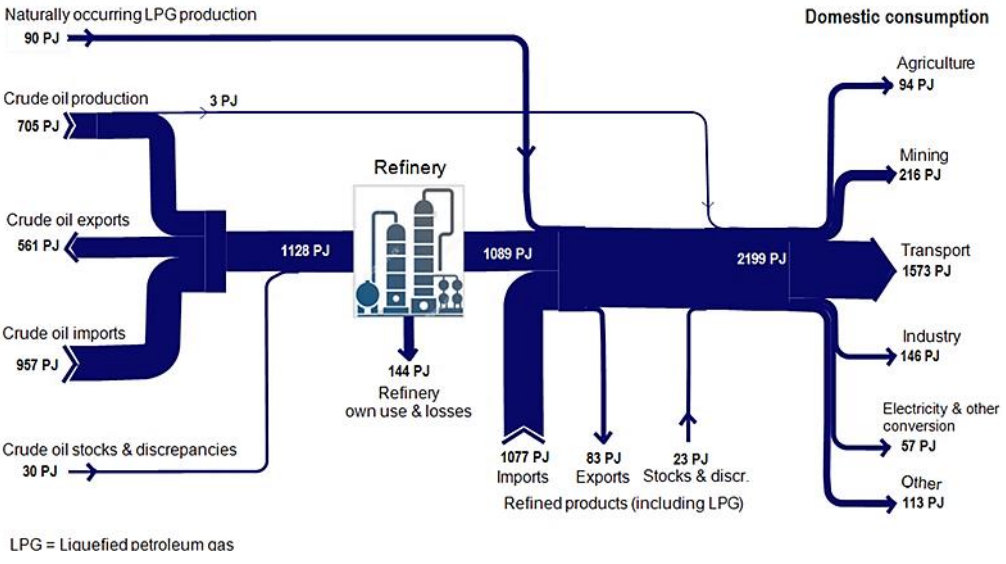
fossil fuels, natural gas exhibited the fastest growth rate at 3.8%, which resulted in increasing its share of primary energy supply to 24% in 2015 from 17% in 2000. Oil grew at 1.9% a year and expanded its share, from 32% in 2000 to 34% in 2015. Coal requirement gradually decelerated, decreasing at 0.3% annually, due to reduced usage in power generation and industry.

1.1. Oil Situation

With modest proven oil reserves, estimated at 4.0 billion barrels (Bbbl) (BP, 2016), the economy is a net oil importer (both crude oil and oil products) with import dependency of almost 40% in crude oil and around 50% in oil products in 2015 based on production over demand. As the economy is both an oil producer and consumer, its liquid fuel market has been linked and fully integrated in the global market through the open movement of crude oil and petroleum products.

In 2015-2016, Australia's oil consumption stood at 349 million barrels (Mbbl) (347 Mbbl in 2015 only), or equivalent to 956 thousand barrels per day (Kbbl/d) (DIIS, 2016b). The transport sector was the largest user of oil taking 70% of total oil demand, followed by the mining sector with 10% and the industry sector with 6.6%. Oil consumption for electricity generation was only 3.0% of total (Figure 1.2).

Figure 1.2: Oil and LPG Flows



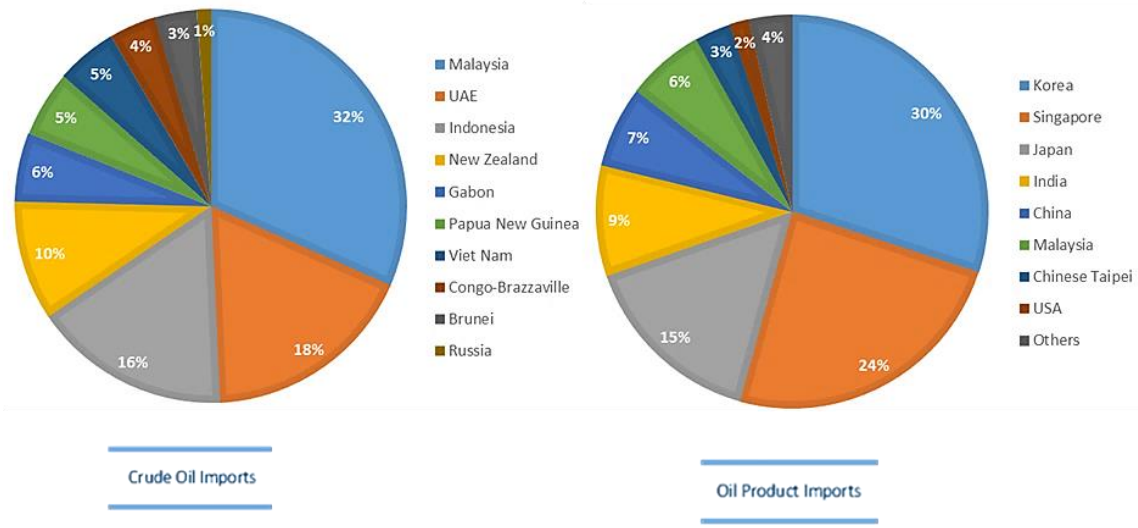
Source: Department of the Environment and Energy

The economy's petroleum product mix comprised mostly of diesel fuel with a 43% share (2015-2016), and gasoline fuel (unleaded and premium unleaded petrol, and propriety brand[3]) with 29%. The gasoline with E-10[4] blend was about 4.0% of total mix. Jet fuel for aviation was 16% of total mix and the liquefied petroleum product (LPG) with 6.0%, a large portion of which was for transport and commercial and industrial uses.

The economy sourced its crude oil imports (2015-2016) from over 30 countries/economies, maintaining significant supply diversity. In the same period, Malaysia was the largest crude oil import source, providing 32% of total imports (Figure 2.3). Other major suppliers were United Arab Emirates (18%), Indonesia (16%), New Zealand (10%), Gabon (6.0%), Papua New Guinea (5.0%), Viet Nam (5.0%), Congo (4.0%) and Brunei Darussalam (3.0%) (DIIS, 2016b).

On the other hand, imports of petroleum products (2015-2016) were sourced from over 50 countries, with no one economy/country providing more than 30% of total imports. Korea recently replaced Singapore as the largest supplier, with other significant suppliers including Japan, India, China, Malaysia and Chinese Taipei (Figure 1.3) (DIIS, 2016b).

Figure 1.3: Crude Oil and Oil Product Import Sources (% Share), 2015-2016



Source: Department of the Environment and Energy

[3] Propriety brand gasoline is gasoline sold under a company brand name. Each major company typically adds proprietary additives to the basic gasoline recipe, in order to provide or enhance performance features. It is not possible to split proprietary brand fuel into unleaded and premium unleaded (source: Australian Petroleum Statistics)

[4] Gasoline with 10% bioethanol blend.

To meet the economy's domestic oil requirements, about 80% of refinery feedstock and 60% of oil product are imported. Despite being a net oil importer, the economy exports around 75% of its domestically produced oil. Most of the recently discovered oil is in the north west of Australia, in the form of condensates and is generally located closer to South East Asian refineries than its domestic refineries. Likewise, the economy's refineries are not configured to operate on condensates, and much of the refinery capacity is on the east coast.

The economy also exports oil products, about 16.5 Mbbl in 2015-2016. Bulk of its exports was LPG (75%) and the rest comprised of gasoline, diesel, fuel oil, and lubricating oil. From 2010, the economy's exports had been declining at 5.0% annually up to 2016.

Over the past 20 years, the structure of the economy's liquid fuel market has changed considerably. The downstream petroleum industry now consists of many different players and encompasses a range of different market segments, as follows:

- Refiner-marketers;
- Supermarket petrol retailers;
- Independent wholesalers;
- Independent retail chains; and,
- Independent terminal operators.

The big four refiner marketers and refiner wholesalers - ExxonMobil, Caltex, British Petroleum (BP) and Viva Energy – continue to be the largest suppliers into the market with around 80% aggregate market share. At the retail level, major supermarkets, such as Woolworths and Coles have become significant market players. Independent terminal operators, wholesalers and retailers are also increasing their market shares, currently at 20%. The industry has also seen the entry of international commodity trading companies, and Japanese oil companies such as TonenGeneral Sekiyu and Mitsui.

Fuel Supply Diversification

Australia recognises that diversification of supply sources is one of the important elements of supply security, and as a policy response to energy security risks. As such, the economy has significant liquid fuel supply diversification.

Flexible supply chains are also an important factor in ensuring a robust liquid fuel security. The seaborne routes by which crude oil and oil products arrive in the economy provide maximum flexibility. It only takes 7-14 day shipping period from many Asian oil suppliers. The economy

receives around 90 shipments, 20 for crude oil and 70 for oil products, per month, and at any stage, these shipments could be diverted to address short-term shortages in any part of domestic market. For instance, a shipment may be diverted in order to deliver a partial load of fuel into a particular terminal, if required, before continuing on its scheduled route. Further, there are also many shipping routes to the economy. In the event of a supply disruption in a specific region or a specific shipping route, the economy could rely more upon supplies from other regions or utilise other shipping routes. Occasionally, the economy receives oil shipments from non-traditional sources. As the economy has been importing more oil products, the diversity of product supply has progressively increased. The number and location of seaboard terminals in the economy mean that there is a great deal of flexibility in terms of entry points for oil products.

Oil Stockpiling

As of December 2016, industry stock was equivalent to 49 days of net imports (IEA, 2016). About 14-21 days of supply is typically on the water (at any time), with a large proportion already within the economy's waters – representing around 30% of all stocks owned by the big four oil companies operating in the economy (ExxonMobil, BP, Caltex and Viva Energy). There is also significant overseas stock already committed/contracted by Australian companies and awaiting delivery to Australia (with ordering and scheduling occurring three months from delivery).

Refining Capacity

Currently, Australia has four operating refineries with total capacity of 475 Kbbl/d. Since 2012, three refineries have ceased operation.[5] The remaining refineries process both indigenous and imported crude oil to supplement oil product supply. Geographically, refineries are in the southern half of the continent, with three on the eastern seaboard and one on the west coast. These refineries process 20% of indigenous crude oil with the rest imported. In 2015-2016, the refineries supplied around 47% of total petroleum products required by major industries and the fuel distribution network with around 6,400 service stations. Imports of petroleum products, largely from Asia, supplied the remainder of domestic consumption.

1.2. Gas Situation

Australia is a major gas producer contributing 1.9% to global gas production in 2015. The economy has an estimated 3.5 trillion cubic metre (Tcm) of gas reserves, about 2.0% of world

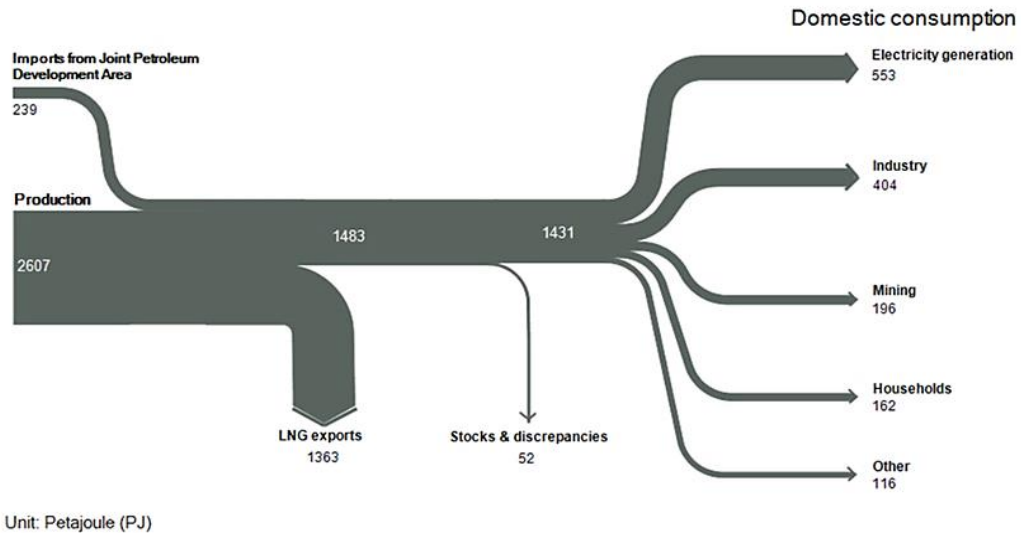
[5] In 2012, there were seven refineries operating in Australia with a total capacity of 760 Kbbl/d.

reserves. With such huge reserves, the economy's reserves-production ratio is about 52 years in 2015 (from more than 60 years in 2014) (BP, 2016). However, based on identified potential gas resources, production capacity is equal to around 106 years at current production rates.

The economy's natural gas supply requirement grew at 3.8% annually, which stood at 32 Mtoe (35 billion cubic metres [Bcm]) in 2015 from 19 Mtoe (21 Bcm) in 2000 (IEA, 2016b). This is translated to more than a 60% increase in natural gas supply. Gas has become a significant energy source for the economy not only to meet its domestic demand as observed in expanding share in the primary energy supply mix, but as one of the major sources of export earnings. The economy is the second largest LNG exporter with export volume reaching 39.8 Bcm in 2015, a yearly increase of 8.0% since 2000 (IEA, 2016b). About two-thirds of its LNG exports went to Japan, with the economy becoming the largest source of LNG for Japan in 2012. Other exports destination were China, India, Malaysia, Pakistan, Singapore, Korea, Chinese Taipei and Thailand. Around 96% of its total LNG exports was sent to APEC economies (BP, 2016).

The economy also imports gas through a pipeline from the Joint Petroleum Development Area (JPDA) with Timor Leste. In 2015, total imports from JPDA was 6.4 Bcm. However, imports from JPDA is mainly for re-export by the economy in the form of LNG.

Figure 1.4: Natural gas Flows, 2014-2015



Source: Department of the Environment and Energy

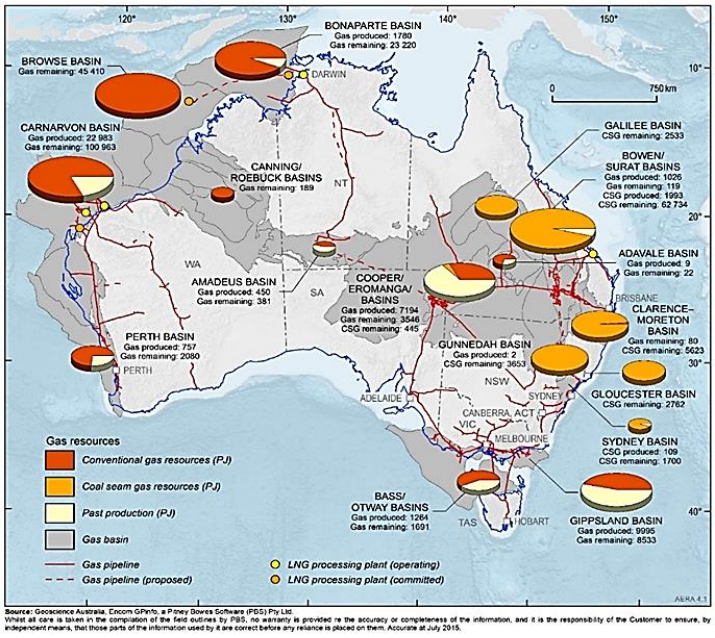
The economy's natural gas consumption was recorded at 16.5 Bcm (2014-2015). More than one-third of domestic gas requirement is used for power generation, almost 30% for industry

application (largest users are non-ferrous metals, chemicals and non-metallic minerals), and 14% for mining. The household sector accounted for 11% of total gas consumption (Figure 1.4).

Gas consumption in Victoria and New South Wales is dominated by the residential and commercial sectors, while Queensland and South Australia's consumption is mostly in industry and the gas power generation sectors. Victoria has a high peak demand for gas in winter due to reliance on gas for residential heating and the low temperatures experienced during winter in the said state.

It is projected that the economy's gas supply requirement will keep on increasing at an average rate of 2.1% (APERC, 2016).

Figure 1.5: Gas Resources



Source: Geoscience Australia

The economy has several gas basins, producing either conventional gas or coal seam gas (CSG) (Figure 1.5). The Carnarvon Basin, Cooper Basin, Gippsland Basin, the Bonaparte Basin produce most of the conventional gas of the economy. The Carnarvon Basin contributed about half of total gas production in 2015, while the Victoria provided 15%. Queensland and New South Wales, main sources of coal seam gas, comprised around 19% of total production. The remaining production came from onshore basins (Cooper and Amadeus) and from small offshore fields in the Bonaparte Basin. The economy has a significant amount of resource potential for coal seam gas

and shale gas. Commercial production of coal seam gas began in 1996. On the other hand, estimates for technically recoverable reserves from shale gas is 12 Tcm (EIA, 2017a).

The economy's gas production is projected to continue to grow over the next five years, by more than 12% a year on average. This growth in production is driven by the economy's LNG exports, predominantly to Asia, which are expected to triple by the end of the decade. Unconventional gas plays an increasing role in domestic gas production. In 2015-16, coal seam gas accounted for nearly one-third of Australia's gas production, and around two-thirds of east coast gas production.

Domestically, gas producers sell wholesale gas to electricity generators, other large gas users and energy retailers, which sell it to business and household consumers. While most wholesale gas is sold under bilateral contracts, the eastern gas market has developed some smaller wholesale gas markets. In 2014-15, just under 50% of total gas production went to LNG exports.

Currently, the economy has seven existing LNG export facilities with a total capacity of around 82 billion cubic metre per year (Bcm/y) as follows:

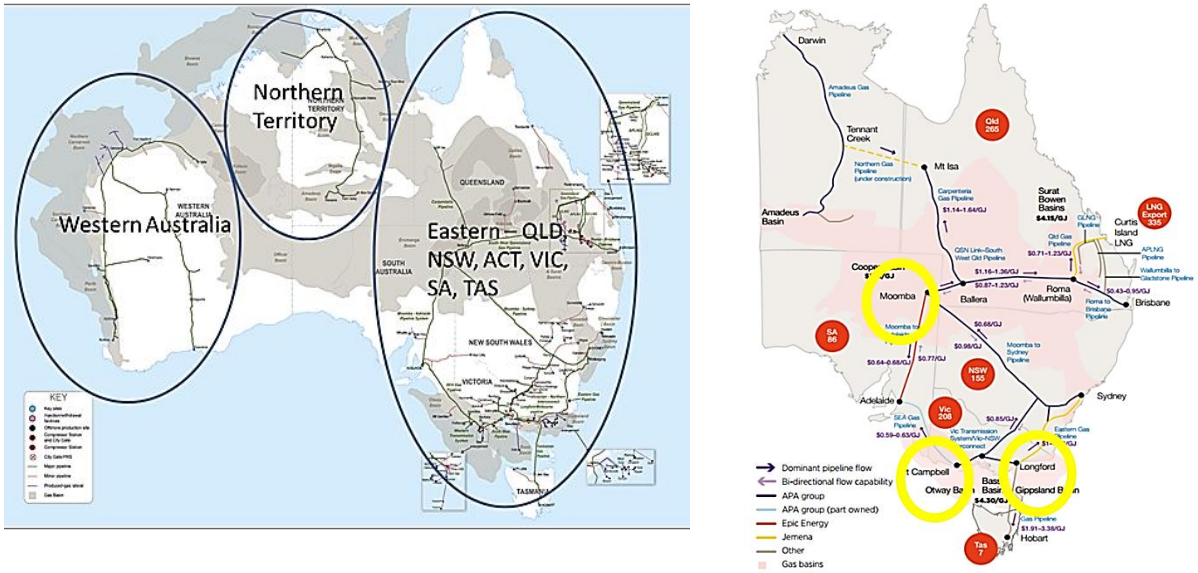
- The North West Shelf Venture (five production units or trains);
- Darwin LNG (one train);
- Pluto (one train);
- Queensland Curtis LNG (two LNG trains);
- Gladstone LNG (two trains);
- Australia Pacific LNG (one train); and,
- Gorgon (one train).

The largest is the North West Shelf LNG, 28% of total capacity, is owned by a consortium of Australian and international oil companies and commenced operation in 1985. The Gorgon LNG is the second largest (17% of total), and commenced operation in early 2017. There are three additional LNG facilities under construction. These production facilities, particularly in Queensland, are taken into account in the economy's emergency response policy and modelling.

The economy has three extensive and well-developed gas transmission networks. The eastern Australia pipeline system transports gas from production areas to main demand centres and links five states and one territory – New South Wales, Queensland, South Australia, Tasmania and Victoria, and the Australian Capital Territory (Figure 1.6). The eastern market has three major

supply points for domestic gas use – Longford in Victoria, Moomba in South Australia, and Iona, near Port Campbell, also in Victoria. The Northern Territory and Western Australia have their own respective pipeline systems. To enhance the eastern network, the proposed Northern Gas Pipeline will connect the Northern Territory and the Eastern Gas Market, running between Tennant Creek in the Northern Territory and Mount Isa in north-west Queensland. Construction is expected to be completed by 2018.

Figure 1.6: Gas Transmission Pipeline Network



Source: Department of the Environment and Energy & Energy Quest (2016).

In total, the economy has over 20,000 km of gas transmission network and pipelines in eastern Australia, operating with bi-directional flows that allows for flexibility in gas trading. Gas pipelines are privately owned and operated with the exception of Victoria's Gas Declared Transmission System, which is owned by APA Group and operated by the Australia Energy Market Operator (AEMO). The Australian Energy Regulator (AER) regulates transmission pipelines and eight distribution networks, and the Economic Regulation Authority (ERA) serves as regulator for Western Australia.

The economy has also gas storage facilities with an estimated capacity of 6.6 Bcm being used to meet peak demand. Historically, South Australia has a high summer peak demand due to high gas power generation. During times of peak demand in South Australia, key transmission pipelines regularly reach 100% daily utilisation.

2. Summary of the Capacity Building Workshop

2.1. Australian Energy Policy

Australia's key energy policy priorities are best summarised as ensuring reliable, secure and affordable energy in the long-term interests of consumers – an objective that is included in Australia's National Electricity Law (NEL). The NEL underpins the statutory powers for the Australian Energy Market Commission (AEMC) in relation to the National Energy Market (or NEM, the electricity grid that covers the South East part of Australia), and is applied as law in each participating jurisdiction of the NEM. While it relates specifically to electricity, these priorities apply broadly across all energy sector and sources.

Energy is a vital input to the Australian economy, and being able to ensure lowest-cost supply is key to its economic competitiveness. The economy has historically enjoyed reliable, secure and affordable energy at low prices due to its abundant natural resources. However, like all economies, it also faces challenges of needing to meet climate goals and the rapid changing energy technologies. Energy is also one of economy's major exports and most of its key trading partners are in the Asia-Pacific region. The economy is highly regionally integrated, relying on regional markets and supply chains for liquid fuels.

Australia's approach to energy policy has been shaped by its history and geography. The economy is geographically very large and isolated with a very small population. This means that there is a strong reliance on road freight for the domestic transport of goods, and strong reliance on maritime supply routes both for international and some for domestic trade. The economy also has a range of climate zones, ranging from tropical in the north, dry dessert conditions around central Australia and temperate zones in the southern part of the continent. The economy's geographical and climatic diversity characteristic brings some key challenges in terms of energy supply security.

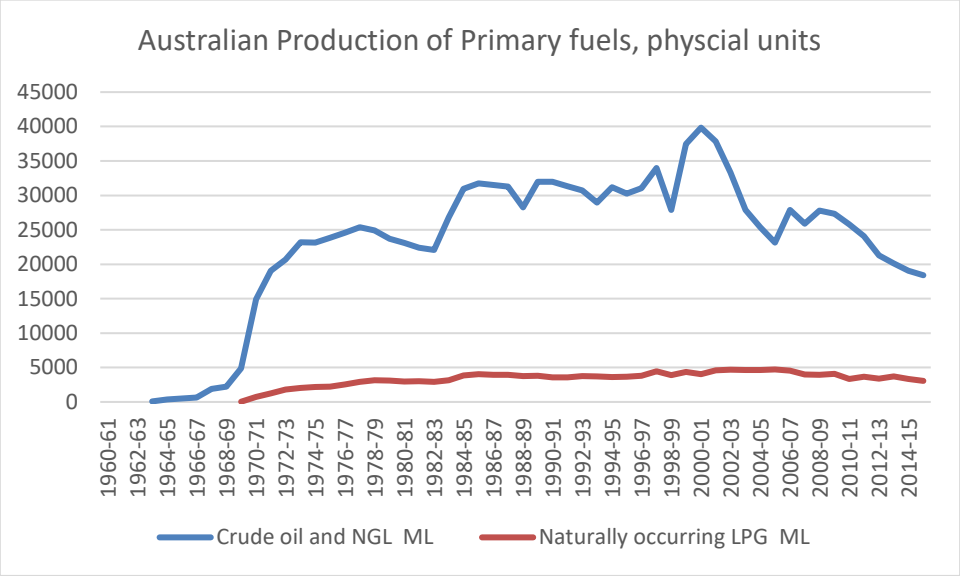
2.2. Energy Reserves

Australia has large energy (including renewables) and mineral reserves. The scale of these resources means that overall the economy is a net energy exporter, including coal, gas and uranium (not used domestically for power generation). The exception to this is oil, for which the economy is now a net importer with its currently modest and declining production levels.[6] Net oil imports are

[6] Oil production takes places in the Armadeus Basin; Bonaparte Basin; Carnarvon-Perth Basins; Cooper-Eromanga Basins; Gippsland-Otway Basins; and, Surat-Bowen Basins. Production from these basins is undertaken by multiple companies, with the exception of Armadeus Basin operated by Central Petroleum.

a relatively recent historical development for Australia. From the late 1970's onwards there were large amounts of domestic oil production, predominantly from offshore reserves in the Bass Strait. However, production level peaked in the early 2000s and since then has steadily declined (Figure 1.7).

Figure 1.7: Australian Production of Primary Fuels (Million Litres), 1960-2015



Source: ABS, 2016

While exploration activities continue and there is the possibility of crude reserves being developed in the future, this remains a commercial decision by the oil companies undertaking these activities. Most recently, British Petroleum was active in offshore exploration in the Great Australian Bight, but withdrew from this process in late 2016 for commercial reasons (ABC, 2016a). Chevron Australia has also recently publicly confirmed that they would be seeking to drill a number of wells in the Great Australian Bight in 2017-18, subject to the relevant approvals (ABC, 2016b). Until such time these resources are developed and the level of crude production increases, the economy will remain a net oil importer.

2.3. Energy Exports

Australia's net energy exports are crucial to the economy. Globally, Australia is a mid-sized economy – the 13th largest economy in terms of nominal gross domestic product (GDP), or only about 1.7% of total. Historically, Australia has relied on sectors like agriculture, manufacturing and resources, and consequently has always been export oriented. The economy is increasingly shifting

towards a service-based economy. The services sector contributes about 70% of GDP,[7] and exports of energy and resources remain major contributors to GDP and economic prosperity (DFAT, 2016).

The growth in energy exports has been largely driven by rapid economic growth in the Asia-Pacific region. Around two-thirds of the economy's total production was exported in 2014-2015 – including around 50% of gas production (in liquefied natural gas or LNG form), 90% of black coal production, and around 80% of crude oil production[8] (note that the economy also imports crude oil for domestic refiners) (DIIS, 2016a).

Australia's medium sized economy means that there is a significant amount of investment in energy and resources sectors.[9] These factors also influence Australia's market-based – underpinned by strong regulatory powers – approach to energy policy and energy security. The Australian Treasury is responsible for oversight and development of the economy's policy position on foreign investment, which is essential to support national interest and economic growth. All foreign investment proposals in businesses or corporations valued at or over USD 231 million are reviewed on a case-by-case basis to ensure they strike a balance between ensuring that the economy remains an attractive investment destination, while protecting the economy's interests.

2.4. Electricity and Gas System

Australia's geographical characteristics and economic development have implications for its electricity and gas systems. NEM operates on the electricity grid that supplies the states and territories of eastern and southern part of the economy, the longest geographically connected power system in the world. The grid incorporates around 51,000 km of networks and cables and covering a total distance of around 5,000 km.[10] NEM is a wholesale market for electricity that trades through a spot market, where supply and demand are matched in real time through a centrally coordinated dispatch process.

The electricity network that supplies Western Australia is the South West Interconnected System (SWIS). The SWIS has historically been a capacity rather than a wholesale market, but work

[7] Note that this figure does not account for differences in the growth rate of different service sub-sectors.
[8] Percentages derived from: Australia Energy Statistics 2016, Table A2 – Australian energy supply and consumption, 2014-15, energy units, Office of the Chief Economist, Department of Industry, Innovation and Science.
[9] Foreign direct investment accounts for 40.1 per cent of investment in the mining and quarrying sectors, and 1.8 percent of electricity, gas and water supply investment. Australian Trade and Investment Commission: *Why Australia – Benchmark Report 2017*, Page 15.
[10] NEM Factsheet, https://www.aemo.com.au/-/media/Files/PDF/National-Electricity-Market-Fact-Sheet.pdf

is currently underway to implement the NEM wholesale market model and governance arrangements within SWIS. [11]

Unlike electricity, there is no national wholesale market for gas, and most gas is traded bilaterally via long-term contracts. Some wholesale market trading of gas takes place within the eastern gas region through a short-term market trading held at demand hubs in Sydney, Brisbane and Adelaide, but this is still relatively small. There are three key regions for gas – the eastern and western regions, and the northern region gas network, which are currently not connected. However, a 622 km northern gas pipeline linking the western and eastern regions, from Tennant Creek in the Northern Territory to Mount Isa in Queensland, is currently in the planning phase. Construction of the USD 800 million project is scheduled to commence in 2017 with the first gas scheduled to flow in 2018.

Historically, the very large distances means that connectivity across national electricity and gas markets has been challenging. This is one of the factors that has influenced market-based approaches to the provision of gas and electricity. In the past, electricity infrastructure, including generation, was state-owned. Much of this infrastructure was privatised throughout the 80s and 90s with a clear shift away from state-owned towards privately owned or state incorporated ownership. Given this shift, developing (regulated) markets for electricity and gas allowed for the provision of energy more effectively, efficiently and at a lower cost. A key part of this process was ensuring that processes for ongoing monitoring, review and reform were built into these markets and their overarching governance structures.

A good example of why these processes are crucial is the emergence of renewables, which present challenges in terms of network integration for all economies. This is one of the issues under consideration as part of multiple energy policy reviews currently underway in Australia. [12] In many ways, technological change is moving much faster than governments and the institutions designed to oversee the markets. As change is constant in energy systems, the economy puts high priority for review structures to reassess policies and that are adaptive to changes.

[11] The WA Government's Electricity Market Review has recommended the transition of the WA power system to the National Electricity Law and Relevant National Electricity Rules – the governance system of the east coast National Electricity Market (NEM). See: https://www.finance.wa.gov.au/cms/Public_Utilities_Office/Electricity_Market_Review/Electricity_Market_Review.aspx
[12] The Independent Review into the Future Security of the National Electricity Market' (the Finkel Review) and the Review of Australia's Climate Change Policies.

2.5. Australian Policy and Governance Framework

Government's Policy Framework

The Australian Government's policy framework includes a range of initiatives to deliver competitively priced and reliable energy supply to households, business and international markets. The key guiding principles are:

- Encouraging competition to provide adequate supply, choice of suppliers and informed consumers;
- Improving energy productivity to reduce business and household costs through giving consumers the choice, information and tools to source and use energy appropriate to their needs, as well as through more efficient buildings, transport, and equipment and appliances; and,
- Enhancing Australia's investment attractiveness to provide a reliable supply of energy, whether it is electricity, gas or transport fuels, and investment as an essential part of realising the potential of Australia's natural resources and technology innovation.

The Government also supports a technology neutral approach for future electricity and transport fuel supply.

Achieving these outcomes relies on coordinated partnerships between government agencies, the Australian, State and Territory Governments, and private sector companies. All State and Territory governments are members of the Council of Australian Governments (COAG) Energy Council. The Energy Council oversees ongoing multiple projects and reviews across the energy sector, for the purpose of helping the economy address the energy trilemma of ensuring stable, secure and reliable energy, while transitioning to a lower carbon and emissions future. Addressing the energy trilemma remains the key underlying theme to the economy's energy policy framework – to balance trade-offs between stability, security and reliability and adaptation of energy policy and program settings to help meet this balance.

Australia's Federal System

The structure of Australia's federal system is another factor that shapes the economy's approach to energy policy. The division of responsibilities for energy policy arise from the historical development of Australia's electricity grids and infrastructure, as well as the responsibilities of the Commonwealth set out in the Australian constitution.

The Commonwealth

The Commonwealth is responsible for external affairs (international trade, treaties), trade across different states, as well as national emergency management and defence. The constitution also provides the states with responsibilities for managing issues within their own borders, including management of services such as health, education and energy, and responsibility for localised oil, gas and electricity disruptions. States and territories have their own systems and measures in place to deal with localised disruptions, with the Commonwealth only becoming involved when oil and gas disruptions occur across multiple states or at a national level.[13]

This does not mean the Commonwealth is not involved in the event of a state-based disruption. The Commonwealth still closely monitors these events, and there are structures and networks in place to support ongoing and regular communication between the Australian government, states and industry when localised events occur.

The Council of Australian Governments Energy Council

The Australian governance framework on energy policy takes place under the COAG Energy Council. The Commonwealth Energy Minister chairs the Energy Council, which is composed of all state and territory Energy Ministers. It has the role of 'policy maker', with responsibility for policy reforms of national significance and issues that require cooperative action by federal, state and territory governments. There are three key institutions under the Energy Council accountable for different parts of the system: the Australian Energy Market Commission or AEMC (the rule-maker); the Australian Energy Market Operator or AEMO (the system operator), and the Australian Energy Regulator or AER.

The COAG Energy Council has oversight function of all energy sectors – gas, electricity and liquid fuels – but in practice most of its day-to day focus is on electricity and gas. This is not because liquid fuels are less important, but is the result of some key differences between these sectors in the Australian context:

- Both electricity and gas have national and regulated cross border markets. There is no equivalent for liquid fuel markets, which operate on a purely commercial basis. Consequently, the 'rules' in the liquid fuel market fall under competition law and the Australian Competition and Consumer Commission (ACCC), rather than the AEMC.

[13] For electricity, there is no mechanism for Commonwealth intervention in the event of a disruption.

- The nature of current issues in the electricity and gas sectors are very different to liquid fuels, and as a result, these two energy sectors have been given much focus in the council's current agenda.

The Energy Council has a key oversight role in the event of a national liquid fuel emergency, and has budget and governance responsibility for the National Oil Supplies Emergency Committee (NOSEC).

2.6. Energy Security Policy

Australia's energy security policy objectives are variations on the same energy trilemma theme that guides the broader energy policy framework with the following specific meanings:

- Adequacy - provision of sufficient energy to support economic and social activity.
- Reliability - provision of energy with minimal disruptions to supply.
- Competitiveness - provision of energy at an affordable price.

This definition encompasses the total energy supply system for liquid fuel, electricity and gas, and covers all segments of the supply chain (both international and domestic) from production to final consumption. It is worth noting that energy security has different meaning for different economies, shaped by each economy's circumstances. In a paper published in 2015 (Ang B.W. et al, Renewable and Sustainable Energy Reviews), there were over 83 definitions of energy security identified and used around the world. The economy also has technical definitions of "power system security" and "reliable operating state" in the National Electricity Rules and set out by the AEMC.

Energy Security Office

The Energy Security Office (ESO) was established in July 2016 to undertake activities that support the energy security policy objectives, as well as to support the Department of the Environment and Energy, the Energy Minister, and the COAG Energy Council in their functions and responsibilities in the event of a liquid fuel, gas or electricity emergency. The ESO also has responsibility for international engagement on energy security issues, including with the International Energy Agency (IEA), APEC, and through other multilateral and bilateral fora. One of the ESO's roles is the ongoing monitoring and assessment of energy security through the National Energy Security Assessments (NESA). The government also conducts on-going monitoring and assessment of the economy's energy security situation by commissioning external studies on specific issues, and

undertaking internal analysis across government agencies. In recent years, the government has commissioned a range of reports on issues such as the implications of declining refining capacity in the economy, the resilience of maritime supply chains, and testing of various global disruption scenarios. Testing of responses to disruptions and assessment of the resilience of liquid fuel supplies is being undertaken regularly through NOSEC.

While the role of the ESO is to monitor the market related aspects of energy security, it also has a role in monitoring the broader national security context in collaboration with relevant government agencies. The ESO reviews and monitors a range of potential threats to the economy's energy supplies, which include: geopolitical instability; maritime chokepoints; cyber security; increasing intensity and occurrence of severe weather events; and critical infrastructure.

Critical Infrastructure Centre

The Critical Infrastructure Centre was established in January. The Centre is based within the Australian Government's Attorney-General's Department. The purpose of the Centre is to work cooperatively across government agencies, and with states and territories, regulators and private owners and operators to proactively identify and manage national security risks from foreign involvement, including foreign investment, in the economy's critical infrastructure, and wherever possible leveraging existing policies and frameworks. The Centre's creation is in line with the economy's Critical Infrastructure Resilience Strategy, which explicitly recognises that in most cases, neither business nor government in isolation have access to all the information to understand and appropriately mitigate risks. One single party also lacks the ability to influence operating environments to the extent required to ensure the continuity of essential services. It aims to ensure that the government is working closely and collaboratively with experts from states, territories and industry. This emphasis on relationships, networks and collaboration is a recurring theme in economy's approach to energy security.

2.7. Regional and Global Energy Security

Australia's position is that open, transparent and efficient markets and flexible approaches to managing risks are the best way to meet regional energy security outcomes. The economy sees a high value in supply diversity through enhancing trade to help manage risks.

The Asia-Pacific region faces some key energy challenges with a long-term outlook dominated by rapid economic growth:

- Total energy demand is projected to increase by 44% in 2030; and
- By 2040, Asia will be the final destination for 80% of regionally traded coal, 75% of oil trade, and 60% of natural gas trade.

The region is expected to remain an overall net energy importer, with a high reliance on crude oil and LNG from unstable regions and a high dependence on fossil fuels. Regional economies are also highly diverse in terms of their energy endowments, physical infrastructure, social and cultural attitudes to risk, and economic systems.

The policies adopted by the Asia-Pacific economies will play a key role in determining developments in their energy sector, and the security of the region in general. Satisfying energy demand depends on each economy's objectives regarding energy equity and cost (ensuring access and affordability), energy security (ensuring availability), and environmental sustainability (ensuring acceptability). As these objectives involve trade-offs, resulting in an "Energy Trilemma."

The economy sees itself playing a significant role as part of the Asia Pacific region, which also shapes its approach on energy and energy security due to physical proximity, and well-established trade relationships and bilateral and multilateral cooperation.

2.8. Australia's Oil Emergency Response Framework

Domestic oil supply requirements are met through integration within the global oil market. Around 80% of refinery feedstock and 60% of oil products are imported. As the economy relies on oil imports (both crude and oil products), maintaining a high level of diversity has been a key focus, with supplies sourced from over 30 and 50 countries/economies for crude oil and oil product imports, respectively (DIIS, 2016b). Diversification of supply sources is one of the most important elements of supply security, and therefore one of the economy's longer-term policy responses to energy security risks.

The fuel supply industry also maintains commercial stockholding levels that they consider commercially efficient. Domestically, the majority of fuel is transported using trucking, which also provides a level of flexibility in moving fuel around the country and targeting areas of need.

In the event of supply disruption, the economy allows market-based responses and the fuel supply industry to manage supply disruptions in the first instance. Due to the complexity of the domestic liquid fuels market, the industry already has contingencies in place to manage disruptions,

and thus is best to handle its own supply in the event of a minor or localised event. The government sets a broader policy framework, monitors the market, and maintains a close relationship with the fuel supply industry through its role as the chair of NOSEC.

The main stakeholders in a liquid fuel emergency include the Department of the Environment and Energy, the Minister, the fuel industry, NOSEC, and state and territory governments. Stakeholders responsibilities cover the preparation for an emergency, communicating effectively with each other, and providing advice to ministers, which may include the implementation of the **Liquid Fuel Emergency (LFE) Act of 1984** and the National Liquid Fuel Emergency Response Plan (NLFERP). The LFE and NLFERP are only implemented when a liquid fuel supply disruption affects many jurisdictions (states and territories), or is otherwise national in nature. The NLFERP outlines the range of protocols for managing a supply disruption.

National Liquid Fuel Emergency Response

The NLFERP is a collection of manuals that set out protocols for different aspects of a response to a national liquid fuel emergency, such as policy options, operations, communications protocols, and the roles and responsibilities of key stakeholders (government and industry players). It was developed in the early 2000s and underwent a major review in 2009/2010. Because the Plan is a living document, other improvements have been incorporated over time, such as the inclusion of the Essential Users Guidance and Rationing Guidance Note and Framework. The NLFERP also sets out the options that may be used to respond in a national supply emergency, including demand restraint, bulk allocation and retail rationing.

a) Bulk Allocation

In the event of a national liquid fuel disruption, the first line of defence is bulk allocation, a method used by industry to control the flow of fuel at the terminal level. Bulk allocation occurs when a particular company or terminal determines to meet only a certain percentage of its contracted customers. For instance, a company may be short of a particular oil product in a particular market, and so the terminal in that market may limit bulk customers to only certain percentage of their contracted volume for a specified period, thus allowing supply to last longer until the time the flow of supply normalises.

b) Demand Restraint

The NLFERP also contains a demand restraint policy. In the event of a disruption, the

government initially implements light touch demand restraint measures (light-handed demand restraint). The policy requests that the public undertake certain actions, but these actions are not mandated by legislation.

In the unlikely event that bulk allocation and light-handed demand restraint are insufficient to manage an emergency, the Commonwealth Minister has the power under the LFE Act to apply rationing at the retail level. Rationing is a more visible indicator to the public that fuel conservation is important. The Commonwealth Minister also has the power to identify essential users in the event of a national emergency. In 2008, the Minister set out the seven categories of essential users (in addition to defence) that are separately identified in the LFE Act. These essential users are:

- Ambulance services;
- Corrective services;
- Fire or rescue services;
- Police services;
- Public transport services;
- State Emergency Service or an equivalent organisation; and,
- Taxi services.

Following the Essential Users Determination of 2008 (an enforceable legislative instrument), NOSEC developed the guide note for essential users to help inform stakeholders and advice on the things non-essential users should do in order to understand their own fuel use and mitigate against disruptions. Demand restraint messaging is critical to ensure that remaining fuel can be used as effectively and efficiently as possible.

Overall, the economy initially allows the fuel supply industry to manage its liquid fuel supply. Modelling of the industry has consistently shown that this provides a robust and flexible approach to liquid fuel security. However, this approach is underpinned by the checks and balances provided by emergency regulatory powers at the state, territory and Commonwealth levels. In addition, NOSEC maintains the NLFERP which is subject to constant revision through the ongoing NOSEC work stream and emergency response exercises.

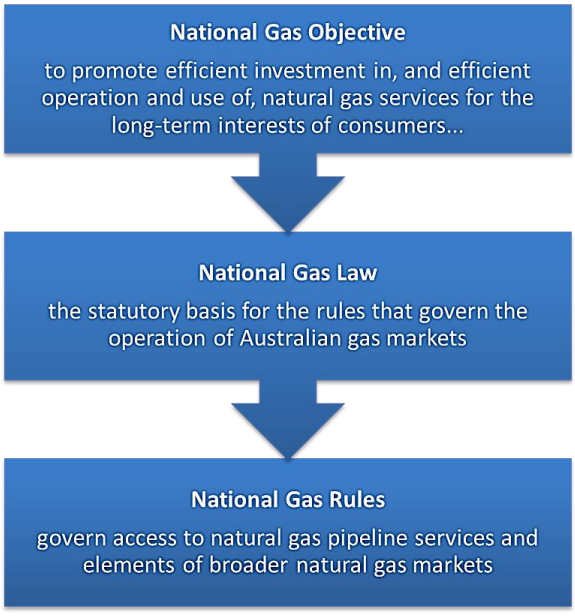
2.9. Australia's Gas Emergency Response Framework

Australian gas markets operate under a clear policy objective, legislation and rules, with oversight from governing bodies – the COAG Energy Council, AEMC, AEMO and AER.

The AEMC oversees market development and rule making under the National Gas Law, while the AER is the national regulator of the national gas rules (Figure 1.8). AEMO has a critical role to play in gas market governance as it operates the Victorian Declared Wholesale Gas Market (DWGM) and the Victorian Declared Transmission System (DTS), Short-term Trading Markets (STTMs) in Sydney, Adelaide, Brisbane, and the retail markets in New South Wales/Australia Capital Territory, Queensland, South Australia, Victoria and Western Australia.

The National Gas Law provides the statutory basis for the rules that govern the operation of Australian gas markets. Under this law is the national gas objective, which sets out the policy goals in promoting efficient investment, operation and use of natural gas services for long-term interests of consumers with respect to price, quality, safety, reliability and security of supply. In addition, there are national gas rules, which are legally enforceable and govern access to natural gas pipeline services and elements of broader natural gas markets. Participating jurisdictions under the National Gas Law are South Australia, the Commonwealth, New South Wales, Victoria, Queensland, Tasmania, the Australian Capital Territory, Northern Territory, and Western Australia, which is included on a modified basis. [14]

Figure 1.8: Gas Market Governance



Source: Department of the Environment and Energy

[14] The National Gas Access (WA) Act 2009 adopts a modified version of the National Gas Law (National Gas Access (Western Australia) Law). The modified legislation is part of the process to transition responsibility for regulating access to Western Power's electricity network and gas pipelines from Western Australia's Economic Regulation Authority (ERA) to the AER, under the National Electricity Law and National Gas Law respectively.

Responses to gas supply disruptions vary slightly in different parts of the market. The National Gas Rules (market rules) contain provisions to deal with gas supply emergencies – AEMO may declare an emergency for the DWGM, and issue directions to market participants, and can also temporary suspend the market operation or implement curtailment/interruption in gas supply to the customers. In the STTMs, AEMO can declare a contingency gas event that sets an abnormal market mechanism to balance supply. AEMO may also conduct offering/bidding for contingency gas (Table 1).

Table 1: Wholesale Gas Market and Short-Term Trading Markets

Declared Wholesale Gas Market	Short-Term Trading Markets
• Emergency situation is when reliability, system security or public safety is threatened • Communication between AEMO, the jurisdiction's safety body and participants • The market may be suspended • AEMO issues directions to participants • Curtailment	Contingency Gas trigger event (examples) • Unacceptable pressure conditions • Inability to meet daily delivery capacity • Upstream event • Insufficient supply Contingency gas process • CG assessment conference • Industry conference • CG gas offer or bid

Source: Department of the Environment and Energy

While the National Gas Rules cover the market rules, the states and territories are responsible for responding to significant gas emergencies in their own jurisdictions. Just like in liquid fuels, each jurisdiction (other than the Commonwealth) has legislation conferring emergency powers, which may also be exercised during a national gas supply emergency, and allow a market response in the first instance. When market responses are insufficient, it is the role of individual states and territories to respond to gas emergencies affecting their jurisdictions, and the role of the Commonwealth to lead a coordinated response in the event of a national or multi-jurisdictional disruption. This takes place through the National Gas Emergency Response Advisory Committee (NGERAC).

National Gas Emergency Response Advisory Committee

NGERAC's membership is comprised of the Commonwealth (as Chair), all jurisdictions, gas stakeholders (producers and users) and AEMO, in recognition of the role of gas power generation in the NEM. NGERAC was established through a Memorandum of Understanding (MOU) in 2005, which also established the National Gas Emergency Response Protocol (NGERP). The MOU was revised in 2016 to take into account the changes in the eastern gas system (since 2005), such as the development of new LNG facilities, and the creation of short-term trading markets and bi-directional pipelines.

The NGERAC and NGERP were designed to address multi-jurisdictional gas supply interruptions, although can also apply to single-jurisdictional interruptions, if required. Their primary purpose includes: (1) to minimise the impact on the economy and the community from disruptions to gas and electricity supplies; and (2) to provide coordinated and efficient management of multi-jurisdictional natural gas supply shortages.

The role of NGERAC is to advise jurisdictions on efficient and effective management responses (including the use of emergency powers by jurisdictions) in the event of a multi-jurisdictional natural gas supply shortage. It operates as a means of sharing information, and learning from experience of the Commonwealth, state and territory governments and natural gas industry in relation to natural gas supply interruptions. NGERAC also conducts annual exercises to test the processes to follow in the event of a multi-jurisdictional gas supply interruption, including roles and responsibilities, advisable incident levels and communication processes, and the key information that the affected jurisdictions need to share in an activation meeting. The effectiveness of the NGERAC is due to the shared objective and cooperation between members, which serves as an avenue to build relationships between governments, market bodies and industry.

2.10. Reporting and Data/Information

There are a number of gas data reports available to planners and decision makers from across government and industry to assess available resources, and supply and demand data and forecasting. This information is important in formulation and implementation of emergency response policy.

- The National Gas Forecasting Report (NGFR) is AEMO's forecast of annual gas consumption and maximum gas demand for the eastern and south-eastern Australia gas

region for over a 20-year outlook period. AEMO's Gas Statement of Opportunities (GSOO) reports on the adequacy of eastern and south-eastern Australian gas markets to meet and supply the maximum demand and annual consumption of gas from the NGFR.

- The AER's annual State of the Energy Market report draws on its internal monitoring and intelligence, regulatory reviews of energy networks, and external resources. This report highlights trends and key issues across the electricity and gas industries, focusing on activity over the past 12–18 months in those jurisdictions in which the AER has regulatory responsibilities.

- The Office of the Chief Economist produces the Australian Energy Statistics, the authoritative and official source of energy data for Australia and forms the basis of Australia's international reporting obligations. It is updated annually consisting of detailed historical energy consumption, production and trade statistics. The dataset is accompanied by the Australian Energy Update Report, which contains an overview and analysis of the latest trends.

- The Australian Energy Resources Assessment (AERA) produced by Geoscience Australia provides the crucial information and data needed to compare energy commodities and review of resources available in Australia and the world. This information can be used on energy policies while considering resources.

Australia has governance arrangements to minimise supply interruptions and to allow for intervention in gas supply emergencies should the market fail to resolve the disruption. Relationships and cooperation between the government and industry is important, as well as information from credible sources for the implementation of emergency response policy.

2.11. Key Themes and Lessons from Australia's Approach

- Multifaceted approach
  - Bringing together different actors with different skills and expertise
- Energy trilemma
  - Ongoing process of (re)balancing trade-offs
  - Policy frameworks that can adapt to change – 'living' processes and documents
- The value of supply diversity

- Whole supply chain approach
- Multiple and flexible supply chains (domestic and international)

- The importance of relationships – external (industry) and within/between governments
  - Government as a facilitator
  - Clear roles, responsibilities and lines of communication
- Ongoing testing energy security and emergency response settings
  - Ongoing monitoring, review and evaluation
- Managing, risk
  - Whole supply chain approach
  - Utilising market in the first instance and commercial risk management measures
- Role of markets in avoiding physical shortages
  - Domestic and international supply chains
  - Market approach means domestic consumers are exposed to price signals
  - Government steps in as a last resort
- Systems approach
  - Oversight of the interlinkages between sectors and participants
  - Governments, industry, consumers
- The "time dimension" of government policy settings

  Both for short run emergencies (sudden short severe interruption) and for more complex, emerging risks and system changes over the medium to long-term.

2.12. External Presentations from Experts

The Global Oil Market Review

Stephen Wilson, Director of Cape Otway Associates gave a review of global oil market. He mentioned that non-OECD oil consumption is the clear driver of global growth, and both non-OECD oil consumption and global oil share are increasing on a long-term trend. APEC economies are playing an increasingly large role in oil market. He specifically mentioned the resilience of energy system involves many factors, including sufficient spare production capacity, strategic reserves, backup equipment supplies, adequate storage capacity along the supply chain, the stockpiling of critical parts for electric power production and distribution, as well as carefully conceived plans for responding to disruptions that may affect large regions.

Global Liquid Fuel Supply Chain Resilience

Ian Twomey, Director of Hale&Twomey gave an overview about global liquid fuel supply chain. Firstly, he showed an example of petroleum supply chain and its timeframes and disruption response. He took Australia as an example, explaining the aim of Australia's supply chain and its supply strategies to provide resilience. He proposed response to minor and major disruption for both crude and oil products.

Case for Scenario Thinking: Insights from CSIRO Global Megatrends and Australian National Outlook

Chief Research Leader Dr. Steve Hatfield-Dodds of CSIRO presented seven future megatrends. Exploring the implications of uncertain future trends can help decision makers recognise, prepare for, and respond more effectively to change:

(1) More from less: Innovation in meeting human needs by more efficient use of mineral, water, energy and food resources in light of escalating demand and constrained supply;
(2) Planetary pushback: Changes in earth systems from the global to microbial are creating challenges for humanity including climate change and antibiotic resistance;
(3) The silk highway: Rapid growth of emerging economies and the transition from industrialisation into technologically advanced service sectors;
(4) Forever young: The rise on the ageing population, retirement savings gap, lifespans, healthcare expenditure, diet & lifestyle related illness and mental health awareness;
(5) Digital immersion: The exponential growth in computing power, device connectivity, data volumes, internet users, artificial intelligence and technological capabilities;
(6) Porous boundaries: Changes in organisational models, governance systems and employer-employee relations in a more agile, networked and flexible economy which breaks through traditional boundaries;
(7) Great expectations: The rise of the important experience factor as society and consumers have rising expectation for personalised and positive experiences involving social interaction, morals & ethics and the physical world;

(Please refer to Annex IV for full presentations of these three topics)

PART 2

BACKGROUND INFORMATION

This section provides information on oil and gas demand and situation of participating economies – Indonesia, the Philippines and Thailand – including existing institutional arrangements and policies in dealing with supply emergencies.

1. INDONESIA

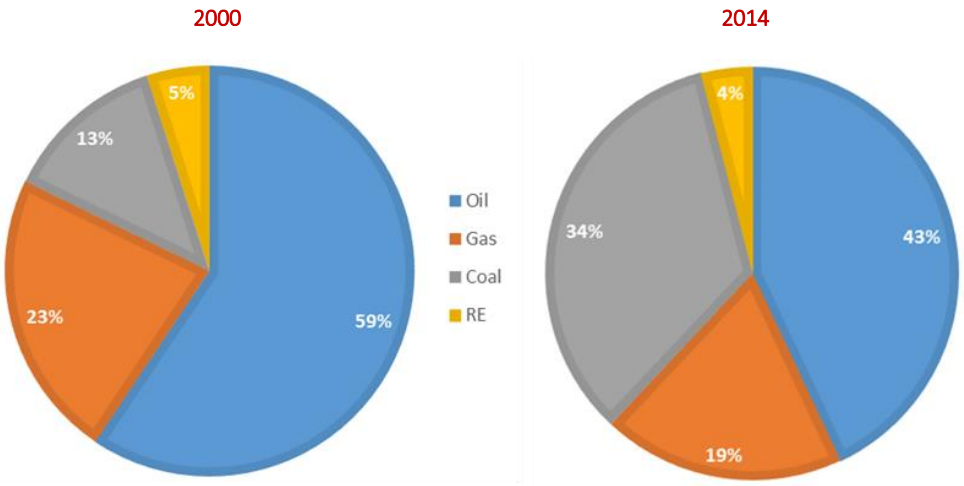
1.1. Background Information

Indonesia is the world's largest archipelagic economy situated in Southeast Asia. The economy has a total land area of 1.9 million km^2, and its exclusive economic zone covers 7.9 million km^2 comprising of 17,504 large and small islands and large bodies of waters.

In 2015, the economy's gross domestic product (GDP) reached USD 2,677 billion (USD 2011 Price and Purchasing Power Parity [PPP]), exhibiting a 5.0% growth rate from previous year's level (WB, 2016). The manufacturing sector accounted for the largest component of GDP (excluding oil and gas), around 20%, followed by agriculture, forestry and fishing with a combined share of about 15% (BPS, 2016). In the same year, the economy's population reached 257.6 million, an increase of 1.2% from a year ago.

Indonesia is a net energy exporter. The economy's total exports of crude oil, petroleum products, natural gas, LNG and coal reached 289 Mtoe in 2014 (IEA, 2016b). Its energy resources (oil, gas and coal) have significant contribution to domestic economy, not only for energy but also as sources for industrial raw materials and foreign exchange earnings. Likewise, tax and non-tax revenue from oil, gas and minerals including coal accounted for 19% of the economy's government budget in the same year (MEMR, 2015).

Figure 2.1: Primary Energy Supply (% Share), 2000 and 2014



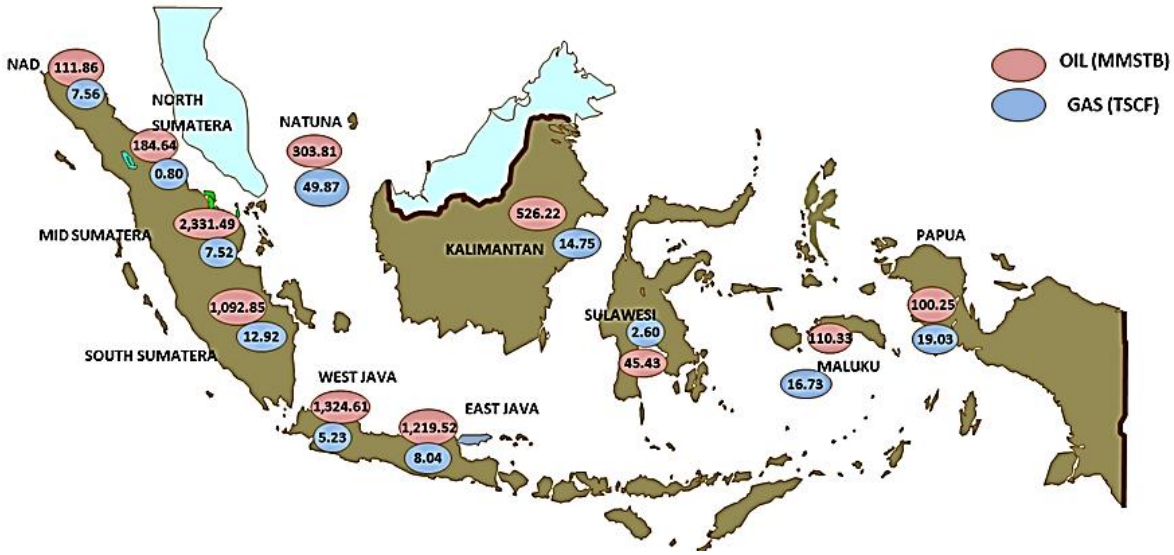
Source: IEA, 2016b
Note: In Indonesia's National Energy Policy, the primary energy mix excludes conventional biomass

The economy's primary energy supply stood at 204 Mtoe in 2014 (1,457 million barrels of oil equivalent [Mboe]), increasing yearly at 5.1% from 2000 level of 102 Mtoe (727 Mboe) in 2000. The economy's coal requirement expanded by five-folds due to increased requirement in power generation, demonstrating the fastest growth among energy resources at 13% a year (from 2000-2014). Meanwhile, oil displayed 2.7% growth rate and gas 3.6% for the same period. Oil share of primary energy supply dropped (59% in 2000 to 43% in 2014) resulting from expanding share of coal. On the other hand, the aggregate share from renewable in 2014 was about 4.0%, geothermal and hydro (Figure 2.1).

1.2. Oil Situation

As of 2015, Indonesia's crude oil proven reserves stood at 3.3 Bbbl with total potential estimated to be around 4.0 Bbbl (total of 7.3 Bbbl) (Figure 2.2). However, the economy crude oil production has been declining because of maturing fields, decreasing at 4.0% annually since 2000, thus decelerating its export volume. Exports of crude oil dropped annually by almost 5.0%, while the share of imports to domestic crude oil requirement gradually increase, about 40% of total in 2015. The economy produced around 786 Kbbl/d of crude oil and condensate in 2015 (788 Kbbl/d in 2014) (MEMR, 2017a).

Figure 2.2: Oil and Gas Reserves, 2015



Source: MEMR, 2017b

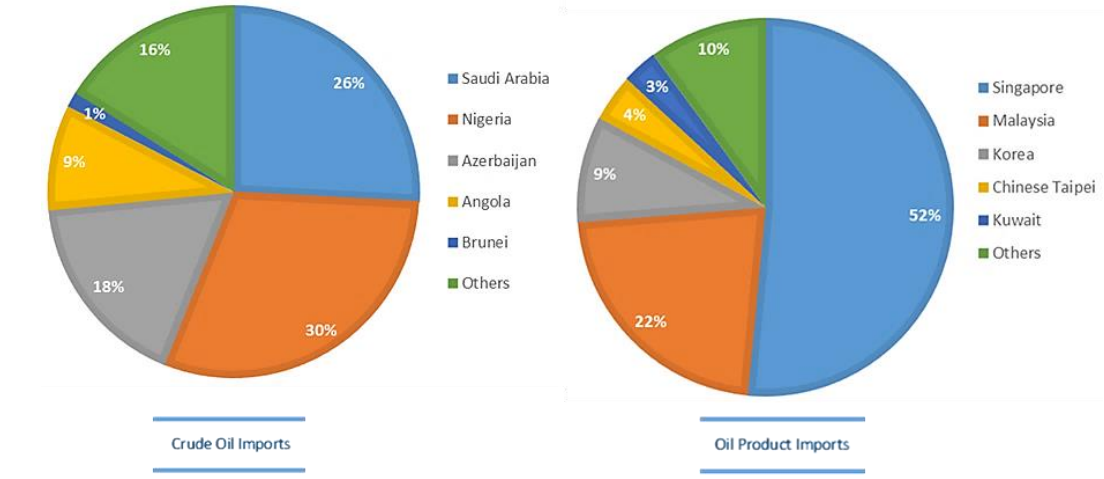
With decreasing domestic crude oil production and rising domestic demand, the economy decided to withdraw its membership from the Organization of the Petroleum Exporting Countries

(OPEC) in 2009. The economy re-joined OPEC in December 2015. The economy has been a member of OPEC since 1969 (EIA, 2015c).

The economy's oil supply requirement has been going down starting 2014 caused by decreased power generation from oil-based plants. In 2015, total oil consumption was about 1.16 Mbbl/day, from 1.22 Mbbl in 2014. The transport sector secured about 60% of total oil consumption of the economy, followed by the industry sector with 10%. Oil requirement for power generation was 8.0% of total, and the remaining shared by the household, commercial and agriculture sectors. When it comes to petroleum product mix, around 70% of oil consumption was gasoline and diesel (each having about 36% share of total), and liquefied petroleum gas accounted for 10%. Jet fuel for aviation demanded 4.0% and fuel oil only 1.0% of total (IEA, 2016b).

The economy's crude oil imports were sourced mostly from five economies. In 2015, total crude oil imports reached 132 Mbbl, 30% of which came from Nigeria, 26% from Saudi Arabia, 18% from Azerbaijan, 9.0% from Angola and 1.0% from Brunei (Figure 2.3). Malaysian crude contributed less than 1.0% of total imports (MEMR, 2017a). Saudi had been the major source of crude oil imports until 2014, providing more than 30% of total imports.

Figure 2.3: Crude Oil (2015) and Oil Product Import (2014) Sources, (% Share)



Source: MEMR, 2017a and UN Comtrade

On the other hand, the economy imported around 175 Mbbl (481 Kbbl/d) of oil products in 2015. About half of total imports came from Singapore, and 22% sourced from Malaysia. Other major exporters were Korea (9.0%), Chinese Taipei (4.0%), and Kuwait (3.0%) (MEMR, 2017a) (Figure 2.3). Bulk of oil product imports was gasoline (65%) and diesel (26%).

The economy also exports both crude oil and petroleum products. Total crude oil exports reached 115 Mbbl in 2015 with almost one-fourth went to Japan. Other major export destinations were Singapore (14%), United States (12%), Korea (7.0%) and Chinese Taipei (5.0%). The exported crude was light crude oil, and a portion of which came from the contractors' crude oil produced abroad. In the same year, total oil product exports stood at 2.0 Mbbl mostly fuel oil (69%) and kerosene (30%) (MEMR, 2017a).

Refining Capacity

Indonesia has 10 refinery units/facilities with a total capacity of 1.2 Mbbl/d – eight owned by Pertamina (state-owned enterprise) and remaining two by private companies. As most of the refineries have been operating for more than 30 years now, performance have deteriorated with production capacity decreased below 70%. In 2015, refinery output was 670 Kbbl/d, providing only 58% of domestic oil supply requirement (MEMR, 2017a).

Pertamina has developed a Refinery Development Master Plan to expand and improve domestic refinery capacity to almost 1.7 Mbbl/d. Pertamina likewise signed several agreements with international oil companies such as Saudi Aramco, Sinopec of China and JX Nippon of Japan. The economy has a plan to put additional four refineries with an aggregate capacity of 300 Kbbl/d through public-private partnership (EIA, 2015c).

1.3. Gas Situation

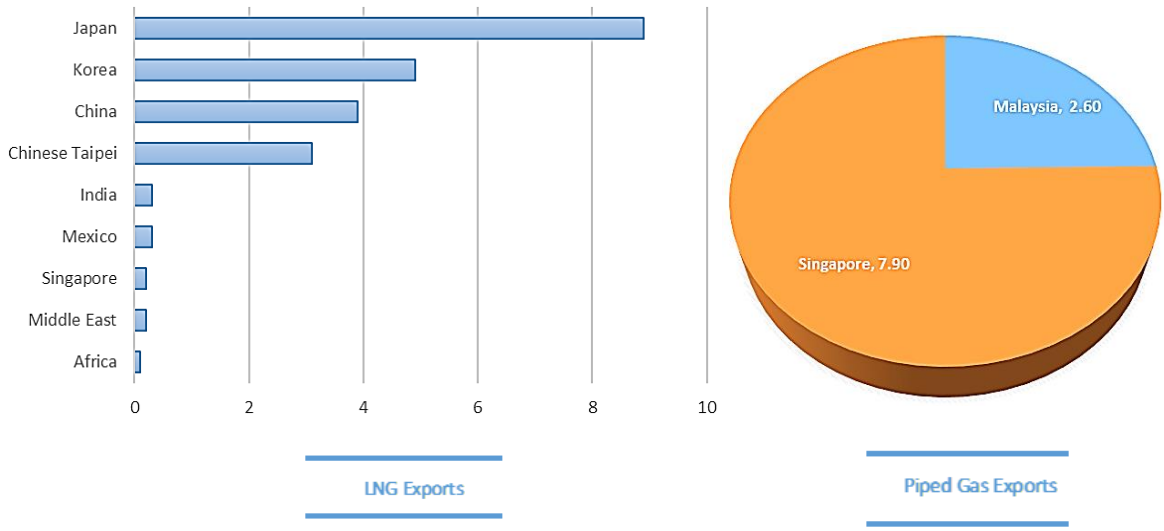
Indonesia is a net gas producer with 2.1% share of global gas production in 2015. The economy has estimated proven and potential gas reserves of 101 trillion cubic feet (Tcf) (2.9 Tcm) and 43 Tcf (1.2 Tcm), respectively (Figure 2.2) (MEMR, 2017b). The economy's proven reserves represent 1.5% of global gas reserves in 2015 with a reserves-production ratio of around 38 years (from 39 years in 2014) (BP, 2016). The large gas reserves are found in Aceh region of South Sumatra and East Kalimantan. The Mahakam block, located in offshore East Kalimantan, accounts for one-fourth of the economy's dry gas production. The government decided to transfer the ownership and management of the Mahakam block from Total Oil Company (in partnership with Inpex of Japan) to Pertamina once the production sharing contract (PSC) expires in 2017. However, the international oil companies can still keep a 30% stake of the block (EIA, 2015c).

The economy's natural gas supply requirement was 35.8 Mtoe (39.8 Bcm) in 2015, exhibiting an annual increase of 2.0% from 26.6 Mtoe (29.5 Bcm) in 2000 (IEA, 2016b and BP, 2016). The economy uses its gas production for various purposes, such as for power generation, industry application and LNG production for exports. The economy's gas supply requirement is forecasted to display a higher growth rate at 5.0% in the future and expanding its share to 21% in 2040 (APERC, 2016).

Of the total gas production in 2015, 2,647 Bcf or 75 Bcm, about 33% was used for LNG production, 22% for industry, 10% for power generation and another 10% for gas pipeline exports. Indonesia was the fifth-largest LNG exporters in the world in 2015, after Qatar, Australia, Malaysia and Nigeria, contributing 6.5% of global LNG exports (BP, 2016). In the 1990s, the economy accounted for more than 30% of global LNG exports (EIA, 2015c).

Japan has been the largest buyer of the economy's LNG with acquiring 40% of total exports in 2015 and 60% in 2014. Other major buyers are Korea, China and Chinese Taipei (Figure 2.4). Currently, the economy has four regasification terminals with an aggregate capacity of 1,322 billion cubic feet per year (Bcf/y) (37.4 Bcm/y), including the newly constructed Sengkang LNG on South Sulawesi coastline, which started its operation in late 2015 (EIA, 2015c).

Figure 2.4: Piped Gas and LNG Exports (Bcm), 2015



Source: BP, 2016

There are also three LNG receiving terminals with total capacity of 412 Bcf/y (11.7 Bcm/y), two of which are Floating Storage Regasification Unit (FSRU) and one land-based. These receiving

terminals receives LNG supply from Tangguh and Bontang LNG regasification terminals and distribute gas to natural gas-fired power plants and industrial customers. Specifically the FSRU in Jakarta Bay is destined only to meet the needs of the natural gas-fired power plants.

The economy likewise exports gas through trans-national gas pipeline to Singapore and Malaysia. About a third of the economy's total gas exports is sent through two pipeline connections to Malaysia and Singapore. In 2015, Singapore received 75% of piped gas exports from Indonesia, and the remaining by Malaysia. Piped gas exports to Singapore are under long-term contracts to expire in 2024.

Over the years, the economy's gas exports have been decelerating annually at a rate of 1.2% with decreasing gas production and increasing domestic demand. The economy has been facing difficulties to improve its gas reserve replacement ratio at the same level as it was before. The ratio fell to 90% in 2014 from a high of 127% in 2012 (EIA, 2015c).

1.4. Institutional Structure and Emergency Policies/Measures

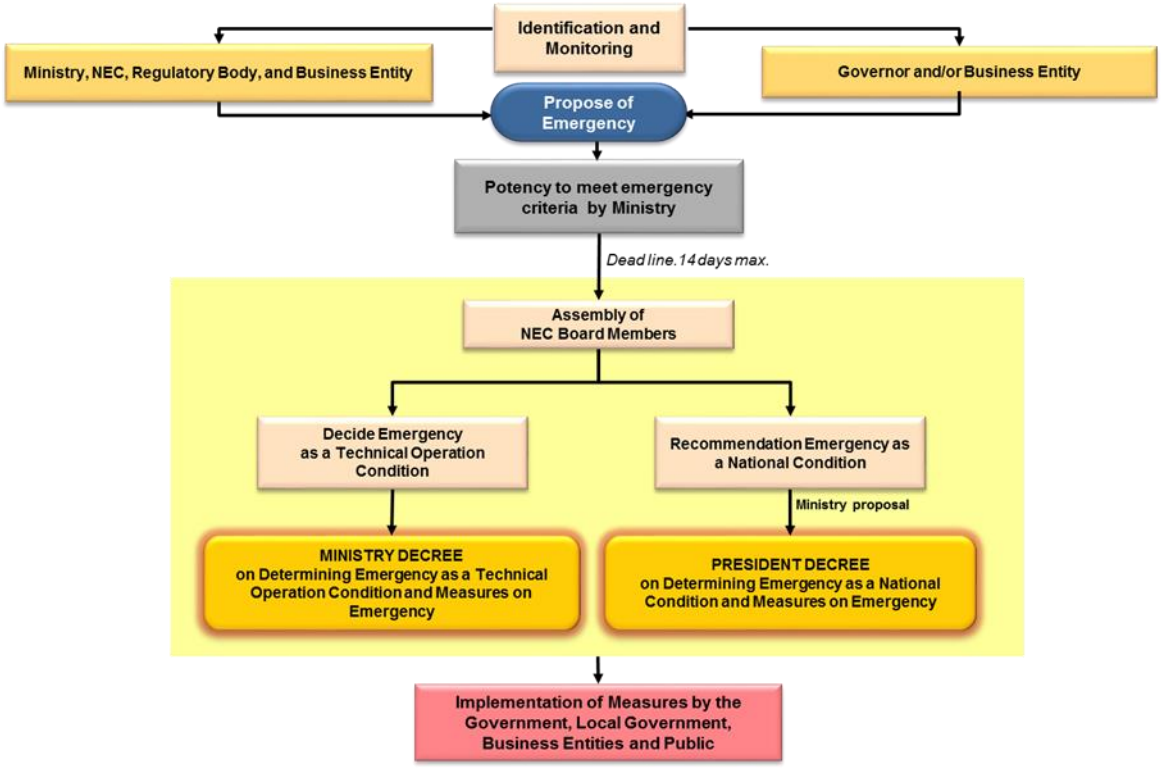
Indonesia revised its National Energy Plan in February 2014 (NEP14), which replaced the 2006 NEP. The NEP14 was signed in 17 October 2014 as Government Regulation No. 79/2014. Under the NEP14, a number of changes in the energy policy planning were introduced. Among the focus of NEP14 is strengthening the economy's energy independence by redirecting energy resources from exports to domestic market aimed at rebalancing the energy mix with priorities given to indigenous energy supplies. This policy calls for minimising oil consumption, increasing the exploitation and consumption of renewables and coal, optimising gas production and consumption, as well as considering nuclear energy as the option of last resort (IEA, 2015).

NEP14 also contains energy emergency policy framework and measures. The framework includes the establishment of an energy emergency management structures, and proposes to build up oil buffer stocks. With the growing concern on import dependency, it recommends to reducing energy subsidies for both fossil fuels and electricity and allows market-based pricing (IEA, 2015).

In 2016, the government enacted Presidential Regulation No. 41 concerning the "Determination and Countermeasures in Energy Crises or Emergencies." Said Regulation sets the policy during energy supply emergencies, such as the provision for the government to buy oil from contractors as part of the production sharing contract (PSC) scheme to augment domestic supply.

Although the economy has no National Emergency Strategy Organisation (NESO), the National Energy Council (NEC), under the Ministry of Energy and Mineral Resources, serves as a special body dealing with energy crises. The NEC is responsible for coordinating responses in the event of energy supply disruptions. Among its tasks are to identify and formulate measures to be implemented by the government to address energy supply crises and mitigate the impacts to the economy (Figure 2.5).

Figure 2.5: Oil and Gas Security Framework and Procedure



Source: MEMR (2017b)

The economy does not hold public oil stockholding except the operational stocks owned by state enterprise (Pertamina) and oil companies. Oil companies (as authorised by the government) and Pertamina are required to maintain 21-23 days operational oil stocks based on domestic oil consumption (APERC, 2015). To improve the economy's resilience to energy supply emergencies, the NEC is drafting the Energy Buffer Reserves (EBR) regulation to include the fuel type, volume location of strategic reserves, management and the institution to handle such reserves. The NEC intends to strengthen the national stockpiling system by introducing a national energy reserve system classified as follows:

- Energy Strategic Reserves consisting of energy resources to be held and regulated by the government to ensure long-term supply security;
- Energy Buffer Reserves are public emergency stocks to be held by the government (based on Energy Law 30/2007), which will be used only for emergency. Under this Law, the government is obliged to establish energy buffer reserves to be withdrawn during energy supply crises. The proposed amount or volume of energy buffer reserves should cover 30 days of net imports; and,
- Operational Reserves as provided by the industry and Pertamina in order to ensure continuity of supply (APERC, 2015).

The draft regulation for EBR proposes a 30-day stock based on domestic consumption for motor gasoline, diesel, LPG and crude oil. In terms of management, the following arrangements are suggested:

- The government may establish or designate institutions/state enterprise to manage the EBR;
- The government provides the investment and operational budget; and,
- Infrastructure development and maintenance can be done by other entities, such as through the public-private partnership scheme.

For gas, the same supply security framework and procedure are followed (Figure 2.14). In addition, the MEMR also issued Regulation 6/2016 on the "Provision and Procedure for Determining Allocations, Utilisation and Price of Natural Gas." Under this Regulation, a specific volume of natural gas produced by the contractors (as part of the PSC) must be first be supplied to fulfil domestic requirement and/or export for a specific period. The Regulation also provides that the contractors may request for the allocation of natural gas they produced and that MEMR shall determine such allocation for natural gas.

In 2009, the MEMR issued Regulation 26/2009 on the "Supply and Distribution of LPG" (produced from gas). This Regulation set the minimum stock obligation for suppliers equivalent to seven days of domestic consumption.

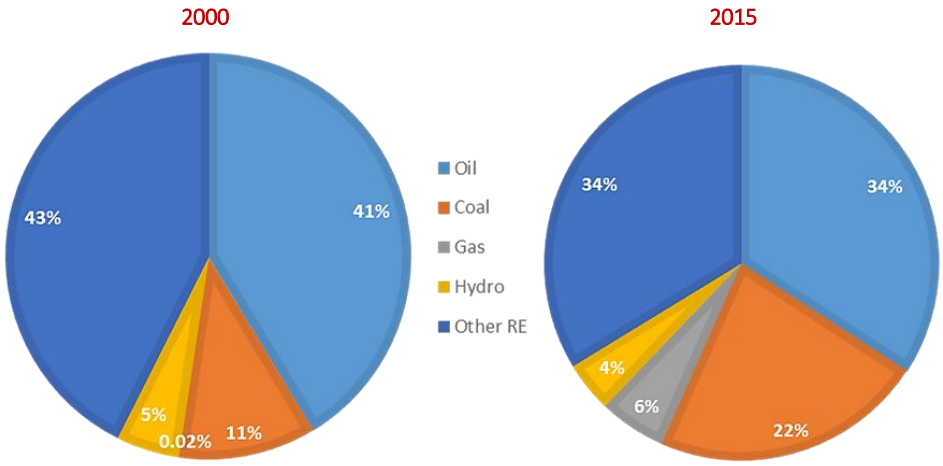
2. The Philippines

2.1. Background Information

The Philippines is an archipelago comprised of 7,107 islands and covering a total land area of 300,000 km² and with coastline of about 36,289 km. The economy is located in the south eastern part of Asia and bordered by the Philippine Sea to the east and west, the Luzon Strait to the north and the Celebes Sea to the south. In 2015, the Philippine economy grew by 6.1%, from USD 659 billion (USD 2011 Price and Purchasing Power Parity [PPP]) in 2014 to USD 699 billion (2011 PPP). The economy's population for the same year was registered at 100.7 million, an increase of 1.0% from previous year' level.

The economy has modest fossil fuel resources with proven crude oil reserves of only 0.14 Bbbl, 834 Bcf of natural gas (24 Bcm), and 440.4 million metric tonnes (Mmt) of coal (Source: DOE-Energy Resources Development Bureau). The government has set as its priority to harness indigenous energy resources by implementing the Philippine Energy Contracting Round (PECR) to reduce reliance on imported energy (fossil fuels) and improve the economy's self-sufficiency level. PECR is a bidding process offering the potential areas for oil, gas and coal exploration and development to prospective investors (both local and foreign energy companies).

Figure 2.6: Primary Energy Supply (% Share), 2000 and 2015



Source: Department of Energy, The Philippines

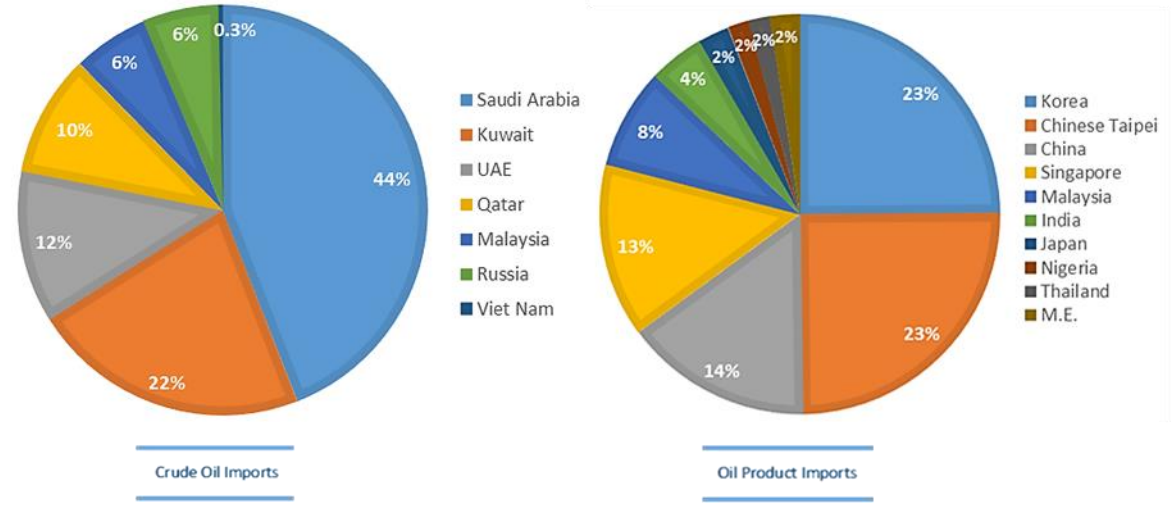
The economy primary energy supply reached 52 Mtoe in 2015, exhibiting a significant growth rate of 8.2% a year from 2000 level of 38 Mtoe (Figure 2.6). More than half (52%) of the

primary energy supply was produced locally largely contributed by renewables and coal. Oil share decelerated to 34% (from 41% in 2000), while gas share expanded to 6.0% from less than 1.0% in 2000 following the discovery and production of gas from the Malampaya gas field beginning 2001.

2.2. Oil Situation

Given the Philippines has limited oil resources, the economy relies heavily on oil imports, nearly 100% dependency on crude oil to meet its refinery requirement. In 2015, crude oil imports reached 78 Mbbl (214 Kbbl/d), an increase of about 20% from previous year's level of 65 Mbbl (178 Kbbl/d). Of the total imports, 86% came from the Middle East and the largest chunk was contributed by KSA with 44% of total imports. UAE, Kuwait and Qatar provided the remaining crude oil imports from the Middle East (Figure 2.7). Meanwhile, almost all of the domestic crude oil production was exported, which stood at 2.4 Mbbl in 2015.

Figure 2.7: Crude Oil and Oil Product Import Sources (% Share), 2015



Source: Department of Energy, The Philippines

As refinery output cannot meet all domestic oil demand, the economy also imports oil products. Imports of oil products went up by 11% in 2015 at 78 Mbbl (214 Kbbl/d) from 70 Mbbl (191 Kbbl/d) in 2000. The higher import volume for naphtha and condensate being used as a raw material for petrochemical production and as a substitute fuel for natural gas, respectively, triggered the increase. At that time, there was a decrease in gas production due to the scheduled maintenance shutdown of the Malampaya gas facility, which resulted in increased importation of condensate (DOE, 2016a). About 35% of total imports was diesel and 20% gasoline. Major import sources

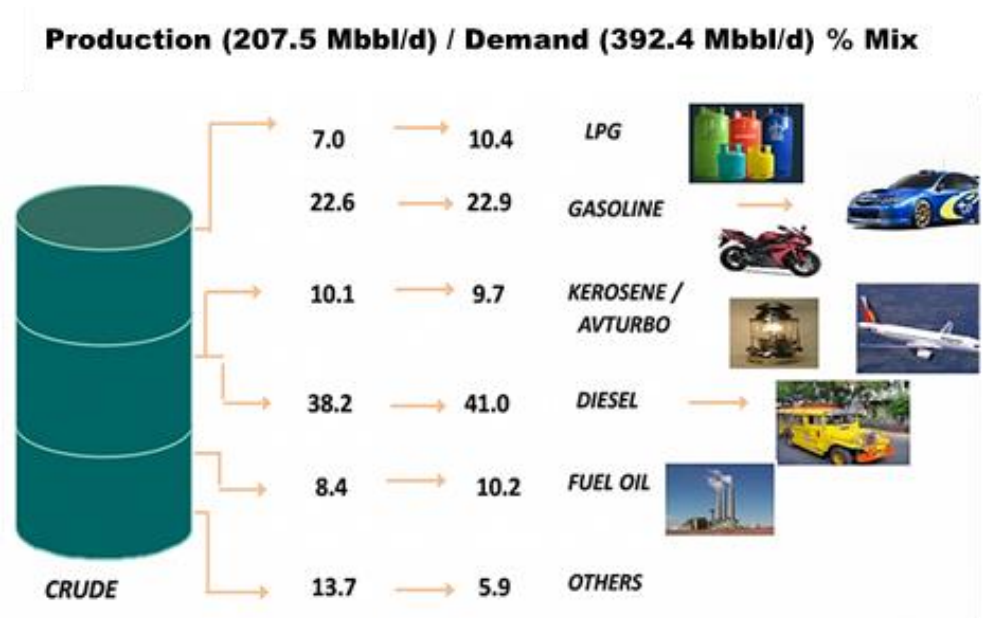
of oil products were Korea with 23% share; Chinese Taipei with 23%, China with 14%[15]; Singapore with 13%; and Malaysia with 8% (Figure 2.7).

The economy also exports oil products (Figure 2.16). In 2015, exports increased by more than 40%, about 14 Mbbl (from 10 Mbbl in 2014). About 37% of total exports was condensate, 29% fuel oil, 18% naphtha, and 16% gasoline.

Refining Capacity

The economy has two refinery facilities owned and operated by Petron (local oil company) and Pilipinas Shell. At present, the working crude distillation capacity stands at 285 Kbbl/d, Petron owns 65%. In 2015, total refinery output rose by around 25% reaching 208 Kbbl/d (from 168 Kbbl/d in 2000). Such production level was able to meet about half (53%) of domestic oil demand of 392 Kbbl/d in 2015 (Figure 2.8). The increase in refinery output resulted in higher utilisation rate, more than 70% compared with 60% in 2014.

Figure 2.8: Refinery Production and Domestic Oil Demand, 2015



Source: Department of Energy, The Philippines

[15] In 2016, China became the major source of oil product imports with almost 30% share of total imports.

2.3. Gas Situation

The Philippines is self-sufficient in gas with its domestic production covering all supply requirement for gas. The economy's main source of natural gas is the Malampaya gas field, which started producing gas in commercial quantity in 2001. The Malampaya gas field provides almost 100% of total domestic production, and is primarily used to fuel three natural gas power plants with an aggregate capacity of 2,861 megawatt (MW) (Figure 2.9). In 2015, total gas production reached 122 Bcf (3.5 Bcm), while total gas consumption was 116 Bcf (3.3 Bcm). The difference (between production and consumption) was attributed to flaring and line pack in the 504 km undersea transmission pipeline going to the gas processing plant. About 98% of gas consumption allocated for natural gas power plants, and the remaining shared by industry (2.0%) and transport (less than 1.0%) sectors. For industry use, the Pilipinas Shell utilises gas for its refinery operation, while the government's program on Natural Gas Vehicle Program for Public Transport (NGVPPT) consumes a small amount of domestic gas supply. Likewise, the Malampaya gas field produces a small volume of condensate, about 4.1 Mbbl in 2015 and most of which is exported. In 2016, two new natural-gas-fired power plant commenced operation bringing the total gas power generating capacity to 3,427 MW, equivalent to 16% of the economy's total installed power generating capacity.

Figure 2.9: Overview of Natural Gas Industry

Source: Department of Energy, The Philippines

As the gas flow from Malampaya field is soon to be depleted (2022-2025), the economy has started to develop its LNG receiving terminal facility to secure gas overseas. The Energy World Corporation (EWC) is constructing the first LNG hub in the economy, which is soon to be completed. This LNG receiving terminal has regasification plant and two storage tanks with an aggregate capacity of 260 cubic metre (cm^3). An anchor load for the project is a 650-MW combined cycle gas turbine (CCGT) composed of two units (with a capacity of 325 MW each). There are several other proposed LNG projects in the economy, which include FSRU.

2.4. Institutional Structure and Emergency Policies/Measures

Except for the 2002 Oil Contingency Plan, the Philippines does not have a written rule to follow in case of emergency in the oil and gas sectors. However, several protocols have been formulated for different emergency scenarios in the oil industry. Most of these only address local emergency like insufficient supply of oil in a particular area devastated by a typhoon or an earthquake. Until now, the Oil Contingency Plan has not been updated. The Contingency Plan contains response measures the government may enforce in event of oil supply emergency with the following principles:

- Priority in the allocation of petroleum products shall be given to vital and strategic activities; and,
- Effects on domestic socio-political stability arising from energy interruptions shall be addressed immediately by the government agencies concerned together with national security and public safety.

The Contingency Plan identifies three levels in attending to oil emergency – Predict Level, Prepare Level and Perform Level. At the initial stage, Predict Level, the government intensifies intelligence collection efforts through coordination with government agencies, monitoring the developments, and issuing up-to-date assessment of the situation. In the Prepare Level, the government undertakes supply diversification, building up of inventories, and securing of energy facilities. Under the Perform Level, the government implements fuel allocation or rationing, conservation measures, price regulation, among others.

Further, the Plan contains four scenarios on crude oil supply disruptions to trigger the implementation of response measures: the 5.0%-10% cut in crude oil supply, 11%-20% cut, 21%-35% cut, and the 50% cut. The fuel allocation and rationing is only introduced in the 50% cut scenario. The fuel allocation and distribution scheme are based on priority sector categories. Likewise, the 50% cut in crude oil supply necessitates the government to strictly regulate prices.

In March 2011, the Office of the President established the Inter-Agency Energy Contingency Committee (IECC) through the issuance of an Administrative Order to ensure that all preparations are in place as precautionary measures to address any event of oil supply disruptions. The Department of Energy (DOE) serves as the chair of the Committee and the other Departments (composed of 11 National Government Agencies) as members, such as the Department of Interior and Local Government, Department of Trade and Industry, Department of Transportation, Department of Agriculture, Department of Budget and Management, Department of Finance, and the National Economic and Development Authority. The primary task of the Committee is to evaluate and improve the existing strategy and contingency plan in handling energy supply disruptions. Each Department has its roles and responsibility in the Committee, which include among others:

- Identifying procedures for utilisation and reallocation of funds;
- Monitoring the effects on prices and socio-economic impact resulting from supply disruptions; and,
- Assessing the impact on national security and energy security (PCOO, 2011).

Even in normal situation, the government, through the DOE, has always been in close coordination with the private oil companies. Although the downstream oil sector is deregulated, the DOE requires the oil companies to submit regular reports on supply, demand, inventory and price adjustments in order for the Department to monitor the oil situation.

As a measure to ensure oil supply availability during emergency situation, the economy enforces the Minimum Inventory Requirement (MIR) to oil companies. The MIR imposes 30 days stocks of crude oil and finished products for refiners, 15 days stocks for bulk marketers, and seven days for LPG. In 2015, closing inventory of crudes and petroleum products stood at 18 Mbbl, or equivalent to 45-day supply equivalent, composed of 33 days stocks for crude oil and oil products, and 12 days in-transit (DOE, 2016a).

On natural gas, the government has not drafted a national contingency plan providing the framework in addressing any gas supply disruptions. The government only relies on the contingency plan of the Malampaya gas field operator, and the three natural gas power plants. The Malampaya undergoes an annual scheduled maintenance shutdown of the platform. However, prior to shutdown, the DOE convenes a meeting with the Malamapaya operator (Shell Philippines Exploration B.V.) and the natural gas power plant operators to discuss and ensure that pending issues are resolved. Among the issues are the availability of alternate fuels

for the operation of the gas power plants and the re-scheduling of maintenance shutdown of other power plants.

3. Thailand

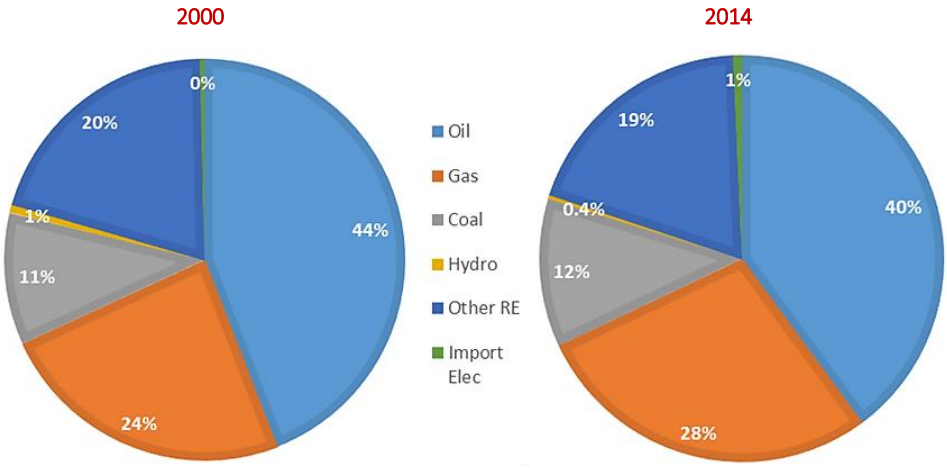
3.1. Background Information

Thailand occupies a total land area of 513,120 km^2, known to be the "window to South East Asia," being surrounded by fast growing economies in this region – Cambodia, Laos and Myanmar to the north and east and shares borders with Malaysia to the south. The economy's gross domestic product (GDP) grew at 2.9% in 2015, registering a total output of USD 1,046 billion (USD 2011 Price and Purchasing Power Parity [PPP]) from USD 1,016 billion (2011 PPP) in 2014 (WB, 2016). Services and industries were the largest contributors to GDP with 53% and 37% shares, respectively (UN, 2016a). In the same year, total population slightly increased, less than 1.0% growth rate, which stood at 68.0 million (67.7 million in 2014) (WB, 2016).

With modest energy resources, Thailand also produces oil and natural gas. However, the economy relies on imports to meet its growing domestic demand for fuel. Crude oil imports provide a significant share in the economy's total refinery demand. On the other hand, despite increasing natural gas production, the economy still imports due to high demand growth and the presence of import facilities, such as pipeline and LNG receiving terminals. Since 2000, the economy has become a net importer of natural gas (EIA, 2017b).

In 2014, the economy's primary energy supply reached 135 Mtoe, which almost doubled from 2000 level of 72 Mtoe and translated to an annual growth rate of 4.5%. Although the share of oil in primary energy supply fell to 40% in 2014 (from 44% in 2000) (Figure 2.10), oil requirement grew at around 4.0% a year. Gas and coal requirements increased by two-folds with growing demand for power generation. The economy also purchased electricity from Lao PDR and Malaysia. The economy sourced more than 50% (57% in 2014) of its primary energy supply requirement through imports (60% of energy requirement was imported in 2015) (EPPO, 2015).

Figure 2.10: Primary Energy Supply (% Share), 2000 and 2014



Source: IEA (2016b)

3.2. Oil Situation

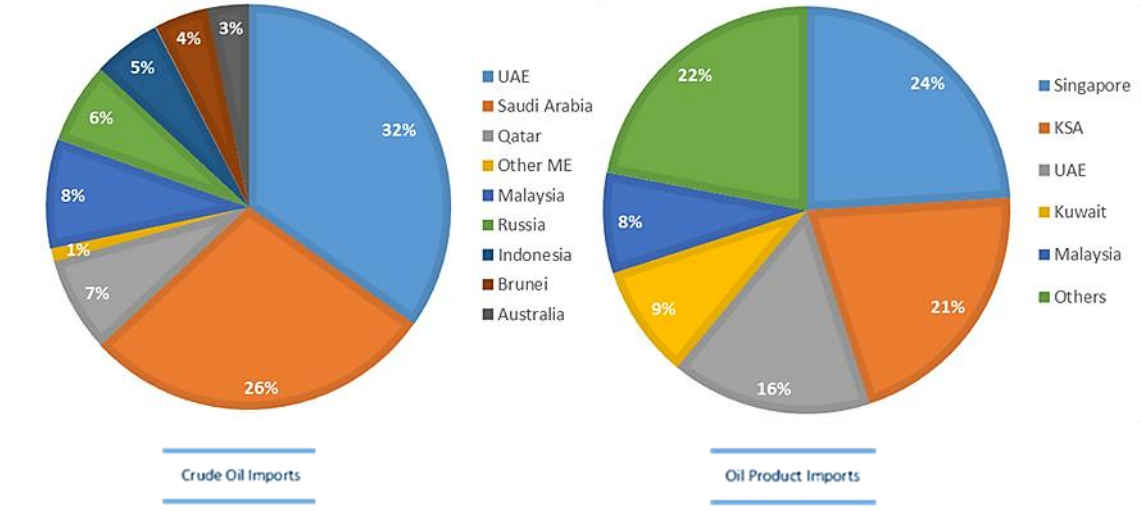
In 2015, Thailand's oil reserves (including condensate) was estimated at 396 Mbbl, slightly lower by 2.1% from 405 Mbbl in 2014 (BP, 2016). About 85% of the economy's reserves is located in offshore. Reserves have been falling due to continued production without new field discoveries. Major crude oil producing fields are the Sirkit, Unocal (Big One Project), Benjamas and Jasmin. Total crude oil production (and condensate) in 2015 stood at 248 Kbbl/d, up by more than 200% from 2000 (105 Kbbl/d) (Figure 2.11). A small portion of domestic crude oil is also being exported (3.0% in 2014). From September 2014 to November 2015, the economy temporary halted its exports as a result of government policy calling for cooperation of oil companies to refrain from exporting crude oil produced domestically (EPPO, 2016).

To meet the domestic refinery demand, the economy imported 85% of its total crude oil supply requirement. Total crude oil imports in 2015 was 875 Kbbl/d, about two-thirds (65%) of which was sourced from the Middle East countries, specifically from UAE, KSA and Qatar (Figure 2.12). On the other hand, imports of oil products in the same year was recorded at 62 Kbbl/d, almost one-fourth came from Singapore, more than 40% from Middle East countries (KSA, UAE and Kuwait) and less than 10% from Malaysia. Bulk of oil product imports was LPG, accounting for 70% of total. With its huge refining capacity, the economy also exports 233 Kbbl/d in 2015. Nearly half of the economy's oil product exports was diesel. Exports volume increased by 19% from previous year's level (2014), while imports were down by 34%.

Figure 2.11: Crude Oil Production and Imports Flow, 2015

Source: EPPO (2016)

Figure 2.12: Crude Oil (2015) and Oil Product Imports (2014) Sources, (% Share)



Sources: EPPO (2016) and UN Comtrade

Refining Capacity

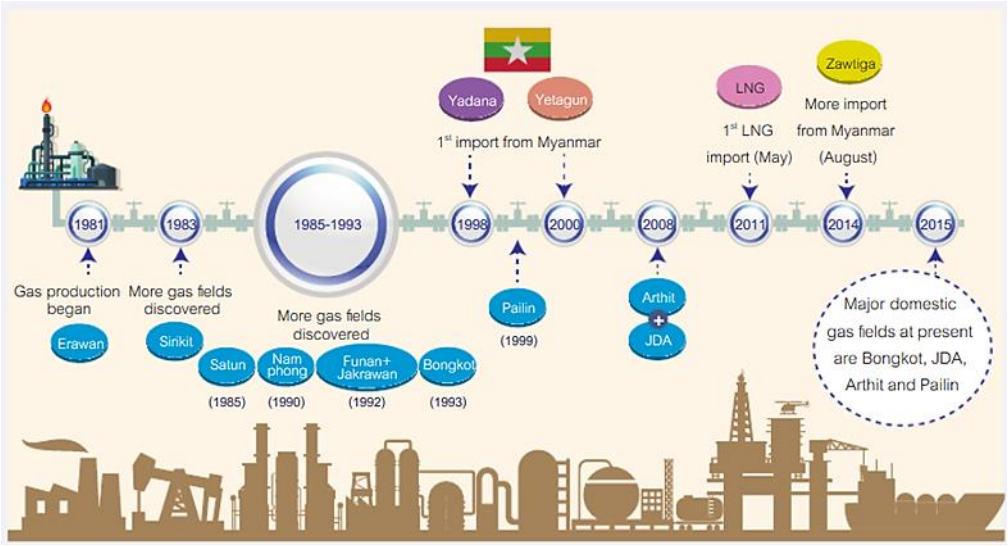
Currently, Thailand has eight refinery facilities with an aggregate capacity of 1.2 Mbbl/d (1,252 Kbbl/d) with 90% utilisation rate based on crude oil intake (1.1 Mbbl/d or 1,132 Kbbl/d). Thai Oil and PTT operate the two largest refineries with combined share of 45% of total capacity. In 2015, total refinery output was 1.1 Mbbl/d, enough to cover domestic demand of 1.0 Mbbl/d. Most of refinery output was diesel (40%), followed by gasoline with 18% and LPG with 16%.

Production of diesel went up by 13% (from 2014) because of increasing demand from the transport sector, while gasoline exhibited a 10% increase in production.

3.3. Gas Situation

Thailand has a proven gas reserves estimated at 7.3 Tcf (207 Bcm) in 2015, more than 95% of which is located in offshore areas. Similar to oil, proven gas reserves have also been decelerating in the absence of additional gas finds. Natural gas development in the economy started in 1981 with the discovery of Erawan gas field (Figure 2.13). Currently, there are major gas discoveries, such as the Bongkot, and the Thailand-Malaysia Joint Development Area (JDA).

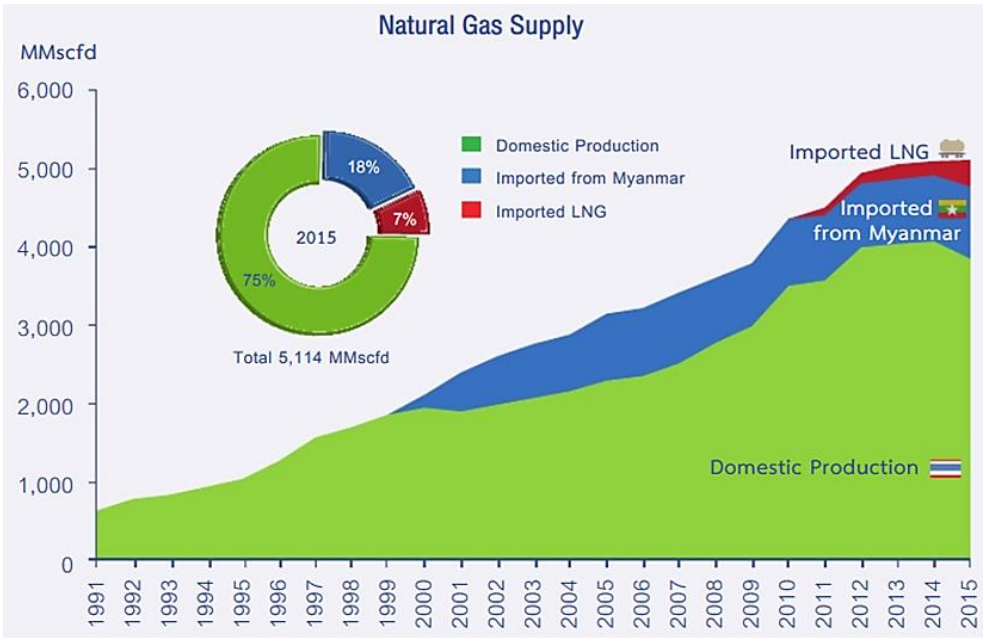
Figure 2.13: Historical Illustration of Natural Gas Development in Thailand

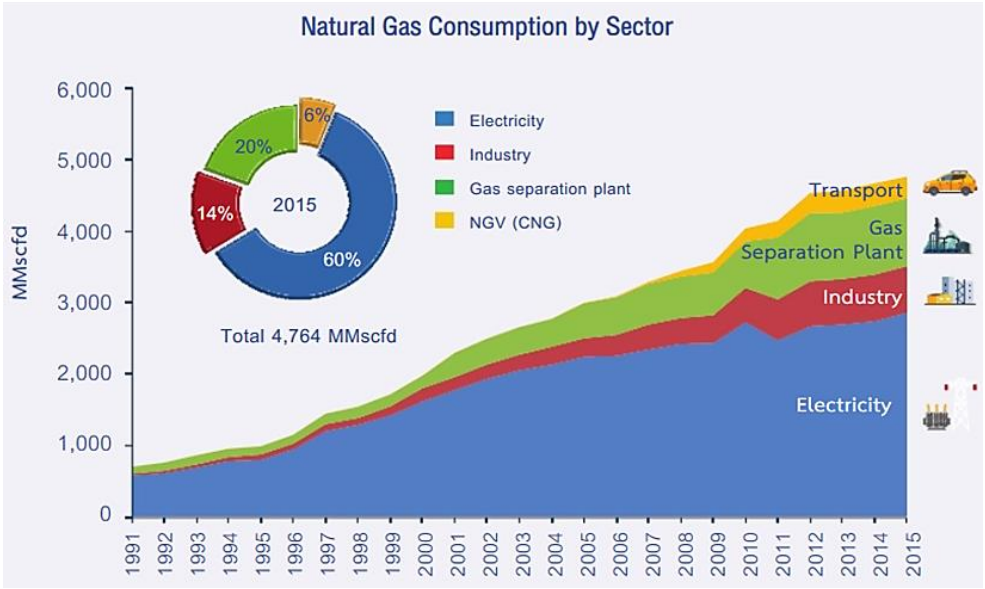


Source: EPPO (2016)

In the past decade, the economy's gas production increased significantly, it peaked out in 2014 at 4.1 Bcf/d (115 Mcm/d) and started to decline (EIA, 2017b). In 2015, domestic gas production was 3.8 Bcf/d (109 Mcm/d), providing 75% of domestic gas supply requirement, and the remaining 25% was sourced overseas. The economy's gas supply was at 5.1 Bcf/d (145 Mcm/d) in the same year, mostly used for power generation (EPPO, 2016). The industrial sector and the natural gas processing plants also consumed a significant portion of the gas supply (EIA, 2017b). Since 2000, gas supply requirement increased at a rate of 5.7% a year.

Figure 2.14: Historical Natural Gas Supply and Consumption, 1991-2015





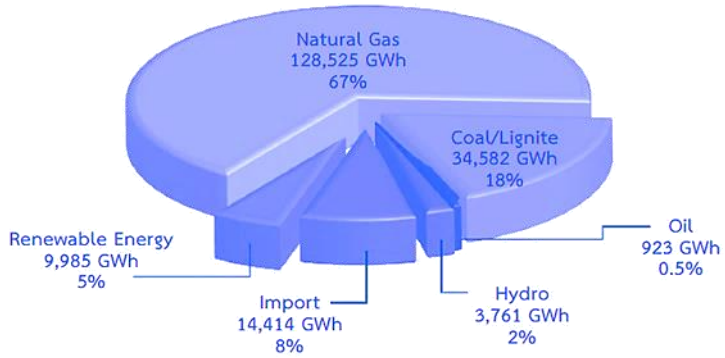
Source: EPPO (2016)

The economy's gas consumption exceeded its domestic gas production in 1999 at a time when it can import piped gas from Myanmar. First piped gas import from Myanmar was received in 1998 from Yanada gas field and in 2000 from Yetagun gas field. In 2014, the Zawtiga gas field

(also in Myanmar) has begun sending piped gas to the economy. Total imports from Myanmar in 2015 reached 923 Mcf/d (26 Bcm/d) (Figure 2.14).

On the other hand, the first LNG imports arrived in 2011 through the economy's regasification terminal – the Map Ta Phut LNG (near Bangkok). Total volume of LNG imports in 2015 stood at 339 Mcf/d (9.6 Mcm/d), about 80% of which came from Qatar. The government executed a long-term contract in 2015 with Qatar Liquefied Gas Company Limited to deliver an annual LNG volume of 2.0 million tonnes.

Figure 2.15: Power Generation Mix, 2015



Source: EPPO (2016)

Of the total gas consumption in 2015, 60% was used for power generation with a demand of 2.9 Bcf/d (81 Mcm/d). Natural gas contributed about two-thirds of the economy's total power generation in 2015 (Figure 2.15). The next largest user of gas in the economy was the gas processing plant, which consumed 20% of total or equivalent to 950 Mcf/d (27 Mcm/d). Meanwhile, industry and transport (for NGV) required 14% and 6.0% of total, respectively.

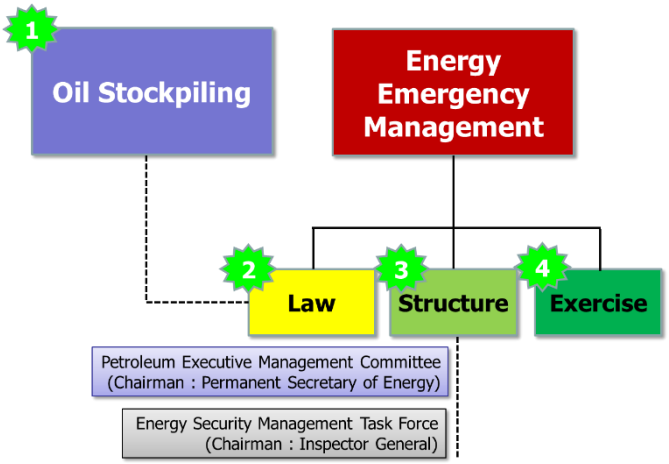
If the new discoveries cannot bring significant amount of additional gas reserves and unless the government can attract more investments in the upstream sector to replace reserves at a faster rate, the economy will increasingly rely on imports.

The economy's gas supply requirement is projected to further increase at 2.4% annually until 2040 (APERC, 2016).

3.4. Institutional Structure and Emergency Policies/Measures

Thailand considers energy security as one of the most important strategies to sustain and drive economic growth. In order to ensure the national energy security, the government has formulated an "Energy Emergency Management Framework" comprising of four factors as shown in Figure 2.16.

Figure 2.16: Energy Emergency Management Framework



Source: Ministry of Energy, Thailand

Oil Stockpiling

The Fuel Trade Act of 2000 mandates the oil stockholding obligations on all refiners, retailers and importers in the private sector. The Act was amended in 2013 requiring refineries to have 6.0% oil stocks of their annual sales of crude and oil products, while retailers and importers should hold 6.0% of crude and 10% of oil products. Overall oil stockholding should be at least 43 days of domestic consumption (IEA, 2014). Such provision on oil stockholding was modified in 2015 with lower stock level obligation, 1.0% of petroleum products for refineries and 7.0% for retailers and importers, while 10% for kerosene/jet for refineries, retailers and importers. The following is the oil stockholding rate by fuel type:

Table 2: Oil Stockholding Rate by Fuel Type

Type of Fuel	Production	Import
Crude	6.0%	6.0%
Gasoline	1.0%	7.0%
Kerosene/Jet	10%	10%
Diesel	1.0%	7.0%
Fuel Oil	1.0%	7.0%

Source: Ministry of Energy, Thailand

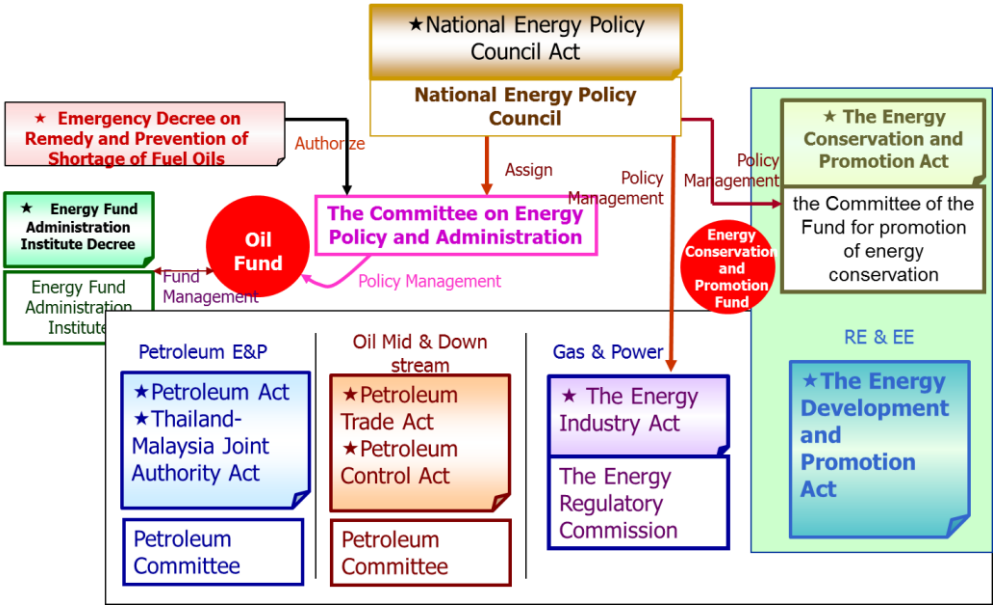
The current legal stock could cover 26 days of domestic consumption. The private sector is also required to have five to seven days of working stocks. Thus, the total oil stock of the economy is 33 days of domestic consumption.

Laws and Regulations

The economy has established several laws related to energy security (Figure 2.17). The most important one is the Emergency Decree on Remedy and Prevention of Shortage of Fuel Oil. This law allows the government to take control of available oil supply by implementing oil allocation during an emergency situation. The Petroleum Control Act and the Energy Industry Act likewise allow the government to have control over emergency caused by oil, gas and electricity disruptions. The Petroleum Control Act (also includes natural gas) covers exploration, production, storage, transport, sale, or disposal of petroleum in the economy. On the other hand, the Energy Industry Act regulates the management of electricity and natural gas businesses, and the energy system network. One of the primary objectives of the Act is to have adequate and secure energy services provision.

The economy has also established an oil fund to provide subsidy and absorb the increases in global oil prices. The oil fund collects levy from the motorist as a buffer fund to subsidise any incremental increase in oil price. However, there is proposal to have a new oil fund law with disbursement rules, which would limit the funding spending and to cut down losses from subsidy (Bangkok Post, 2016).

Figure 2.17: Laws and Regulations on Energy Security



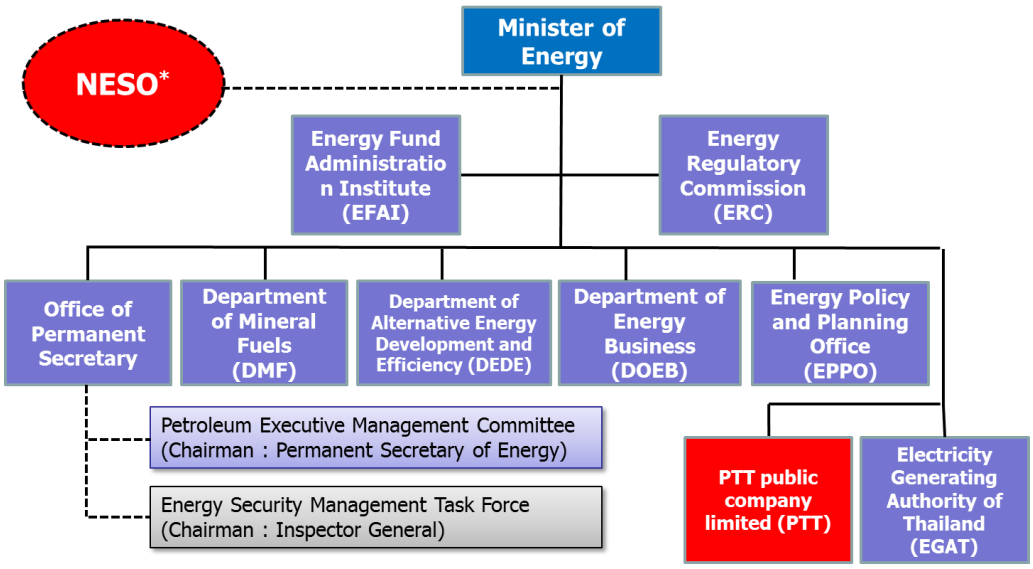
Source: Ministry of Energy, Thailand

Implementing Mechanism

On a regular basis, the Petroleum Executive Management Committee, chaired by the Permanent Secretary of Energy, is responsible for monitoring energy situation. In case of supply emergency, the Working Group on Energy Emergency Response, chaired by Inspector General, will be convened to assess and manage the situation. The Working Group reports regularly to the Ministry of Energy to provide updates and developments in addressing the emergency.

In case of high impact emergency, the **National Emergency Strategy Organisation (NESO)** will be setup, and to be chaired by the Ministry of Energy, to prepare and manage the supply emergency. NESO is a working group consists of representatives from different departments under the Ministry of Energy, including the Office of Permanent Secretary and other concerned organizations, such as the Petroleum Authority of Thailand–Public Company Limited (PTT) and the Electricity Generating Authority of Thailand (EGAT). The Office of Permanent Secretary serves as the secretariat of NESO (Figure 2.18).

Figure 2.18: National Emergency Strategy Organisation



Source: Ministry of Energy, Thailand

Emergency Response Exercise

The Ministry of Energy holds an emergency response exercise annually (oil and gas). Since 2010, the Ministry already conducted eight exercises. The exercise intends to ensure that all concerned agencies are aware of their respective roles during supply crisis or emergency, as well as to test the effectiveness of response measures in addressing supply disruptions. All agencies under th Ministry of Energy and the private sector are invited to participate in the exercise. The recent exercise was held in April 2017.

PART 3

OIL AND GAS SECURITY EXERCISE

This part presents the prepared oil and gas emergency scenarios, the responses of Indonesia, the Philippines and Thailand to emergency scenarios, and the recommendations from the experts based on the responses.

1. THE OIL SUPPLY EMERGENCY SCENARIO

The "Strait of Hormuz" has been closed due to collision of oil tankers, which prevented Middle East Crude, specifically from Saudi Arabia, United Arab Emirates, Kuwait, Qatar, Iran, and Iraq, to be transported. Clearing operation could take about two weeks to a month, which includes addressing the oil spills resulting from leaks in oil tankers (Figure 3.1).

Figure 3.1: Oil Scenario – Collision of Oil Tankers

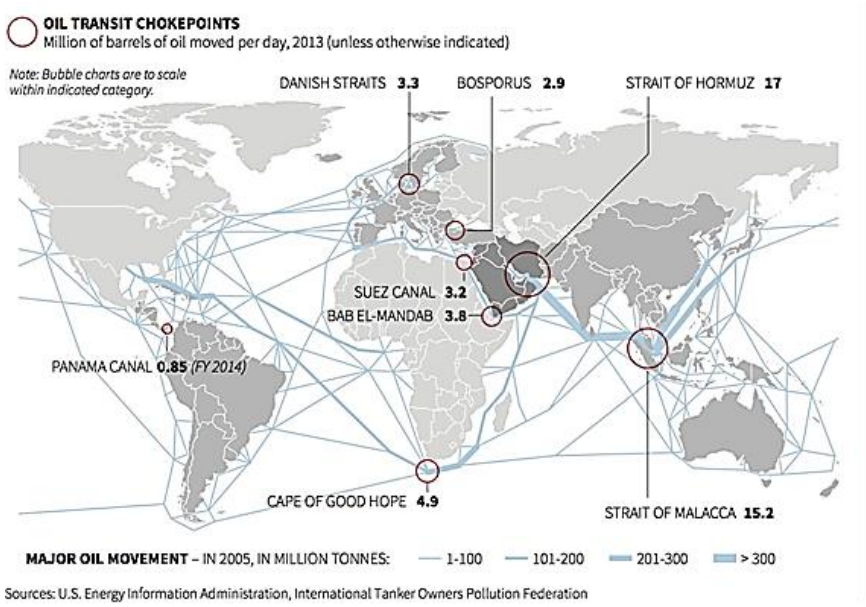
Source: Perry-Castañeda Library Map Collection, University of Texas

Source: Ship Management International

The Strait of Hormuz is the world's most important chokepoint with an oil flow of 17 million barrels per day (Mbbl/d) in 2013, equivalent to 30% of all seaborne-traded oil (Figure 3.2). The Strait is situated between Oman and Iran, which connects the Persian Gulf with the Gulf of Oman and the Arabian Sea. The Strait is the world's most important oil chokepoint with its daily oil flow. About 85% of the crude oil exports moving through this Strait goes to Asian markets – China, Japan, India and Korea are the largest consumers of crude oil coming from this Strait (EIA, 2014b).

The Middle East affected countries contribute an aggregate share of around 30% of global oil production in 2014. In the same year, total Middle East share to global oil production was about 32% (BP, 2016). Only KSA, UAE and Iraq have pipelines to bypass the Strait.

Figure 3.2: Oil Transit Chokepoints



Source: Business Insider (2015)

a) Saudi Arabia

In 2014, Saudi Arabia produced an average of 11.5 Mbbl/d of total petroleum liquids, equivalent to 13% of global production. Of the total, around 9.7 Mbbl/d was crude oil. Total crude oil exports stood at 7.1 Mbbl/d in 2014. KSA has existing pipeline, the 746-mile Petroline known as the East-West Pipeline, to bypass the Strait of Hormuz with total capacity of 4.8 Mbbl/d. The pipeline runs across Saudi Arabia from its Abqaiq complex to the Red Sea (EIA, 2014a).

If KSA decided that 70% of the pipeline capacity (3.4 Mbbl/d) will be utilised to transport crude oil for exports, **this means that around 50% of its total exports can bypass the Strait.**

b) United Arab Emirates

The United Arab Emirates' production of petroleum liquids reached 3.5 million Mbbl/d in 2014, 2.7 Mbbl/d of which was crude oil. More than 90% of crude production was exported, around 2.5 Mbbl/d. UAE opened its new pipeline in 2012, a 230 mile with an initial capacity of 1.5 Mbbl/d. The pipeline runs from Habshan, a collection point for Abu Dhabi's onshore oil fields, to the port of Fujairah on the Gulf of Oman. Through this pipeline, UAE has direct access to the Indian Ocean. UAE has a plan to increase the capacity to 1.8 Mbbl/d in the near future (EIA, 2015a and BBC, 2012).

If the pipeline can be utilised at 90% operating capacity, **about half of the UAE's total exports can be diverted to the Gulf of Oman.**

c) Iraq

Iraq's crude oil production in 2014 was recorded at 3.1 Mbbl/d, and 2.5 Mbbl/d was exported (OPEC, 2015). Although Iraq has also existing pipeline (Kirkuk-Ceyhan or Iraq-Turkey) to bypass the Strait, it could not send additional volume unless more oil will be coming from southern part (through a pipeline connecting north and south). The Iraq-Turkey pipeline has a total capacity of 1.5 Mbbl/d (EIA, 2016). This pipeline brought around 0.45 Mbbl/d of crude oil from Iraq to Turkey (source: IEA).

For this scenario, it is assumed that Iraq could still manage to send **20% of its total exports to the Asia and Pacific region.**

d) Iran, Kuwait and Qatar

In 2014, Iran's crude oil production reached 2.8 Mbbl/d, of which 1.1 Mbbl/d was exported (EIA, 2015b and OPEC, 2015). In the same year, Kuwait's crude oil production was 2.9 Mbbl/d (2014), almost 70% (2.0 Mbbl/d) of which was exported (OPEC, 2015). On the other hand, Qatar produces small amount of crude production compared with other Middle East countries, only 0.71 Mbbl/d in 2014. About 85% of its production was exported (0.60 Mbbl/d) (OPEC, 2015).

Overall Impact

The closing of the Strait of Hormuz will result in 50% reduction in KSA and UAE exports, and 80% in Iraq's exports. Meanwhile, no exports will be expected from Iran, Kuwait and Qatar. Overall, the supply shortfall is estimated to be around **10 Mbbl/d, equivalent to about 26% of global crude oil exports**. **Such shortfall will result in 100% increase in global crude oil price, reaching around USD 100 per barrel (USD/bbl).** Table 3 shows the World Crude Oil Exports by Country.

Table 3: World Crude Oil Exports by Country, 2010-2014, Kbbl/d

	2010	2011	2012	2013	2014	% change 14/13
North America	1,520	1,745	1,872	2,181	2,611	19.7
Canada	1,478	1,698	1,804	2,058	2,266	10.1
United States	42	47	68	123	345	179.8
Latin America	4,624	4,531	4,605	4,409	5,001	13.4
Columbia	484	561	555	703	765	8.7
Ecuador	340	334	358	388	422	8.8
Mexico	1,460	1,421	1,336	1,272	1,220	-4.0
Trinidad & Tobago	75	40	31	38	31	-18.3
Venezuela	1,562	1,553	1,725	1,528	1,965	28.6
Others	703	623	601	480	598	24.5
Eastern Europe	7,273	7,011	6,968	6,964	6,798	-2.4
Russia	4,978	4,786	4,757	4,710	4,487	-4.7
Others	2,295	2,225	2,211	2,254	2,311	2.5
Western Europe	2,555	2,222	2,062	1,968	1,885	-4.2
Norway	1,602	1,455	1,318	1,199	1,203	0.4
United Kingdom	747	571	578	613	563	-8.2
Others	206	196	167	156	119	-23.5
Middle East	15,988	17,772	18,077	17,497	16,793	-4.0
IR Iran	2,248	2,537	2,102	1,215	1,109	-8.7
Iraq	1,890	2,166	2,423	2,390	2,516	5.2
Kuwait	1,430	1,816	2,070	2,058	1,995	-3.1
Oman	749	742	768	838	805	-4.0
Qatar	587	588	588	599	595	-0.5
Saudi Arabia	6,644	7,218	7,557	7,571	7,153	-5.5
United Arab Emirates	2,104	2,457	2,445	2,701	2,497	-7.6
Others	336	248	123	124	123	-0.5
Africa	7,635	6,635	6,997	6,526	5,774	-11.5
Algeria	709	843	809	744	623	-16.3
Angola	1,711	1,546	1,663	1,669	1,608	-3.7
Congo	288	264	252	241	261	8.4
Egypt	85	83	91	97	117	21.2
Gabon	225	235	227	211	225	6.7
Libya	1,118	300	962	589	41	-93.0
Nigeria	2,464	2,377	2,368	2,193	2,120	-3.3
Sudans	389	363	60	133	148	11.6
Others	647	625	565	649	630	-2.9
Asia and Pacific	1,565	1,364	1,313	1,251	1,221	-2.4
Australia	314	299	263	237	261	9.9
Brunei	162	154	139	115	108	-5.7
China	61	50	49	32	12	-62.3
Indonesia	356	302	300	317	257	-19.0
Malaysia	370	280	268	263	282	7.1
Vietnam	161	165	185	170	173	1.8
Others	141	113	109	117	128	9.5
Total world	41,159	41,282	41,894	40,796	40,084	-1.7
of which						
OPEC	22,806	23,734	25,070	23,647	22,644	-4.2
OPEC percentage	*55.4*	*57.5*	*59.8*	*58.0*	*56.5*	
OECD	5,901	5,739	5,572	5,701	6,022	5.6
FSU	7,257	6,991	6,944	6,928	6,760	-2.4

Notes:
Data may include lease condensates, re-exports, petroleum products from gas plants and changes in the quantity of oil and petroleum products in

Source: OPEC Annual Statistics Bulletin, 2015

1.1. Indonesia

1.1.1 Oil Supply Impact

Indonesia crude oil reserves in 2015 was 3.3 Bbbl. In the same year, the economy produced 786 Kbbl/d. Crude oil production has continued to decline over the years due to maturing oil fields (EIA, 2015c).

The economy imported around 362 Kbbl/d of crude oil in 2015, 26% of which came from KSA. Likewise, Indonesia imports oil products, providing 42% of domestic oil demand in 2015, which came from Singapore (51%); Malaysia (22%); Korea (9%); Kuwait (3%); and Chinese Taipei (4%)[16]. Total oil product imports was about 481 Kbbl/d (MEMR, 2017a).

In 2015, the economy's total oil demand reached 1.2 Mbbl/d (1.16 Mbbl/d in 2015). Refinery output provided around 58% of total oil demand (or equivalent to 670 Kbbl/d).

Potential Supply Shortfall[17]

Given these circumstances for Indonesia, the closure of the Strait will result in estimated supply shortfall, as follow:

- A reduction of 47 Kbbl/d in refinery output (from 50% decreased in KSA crude oil imports – with an estimated import of 94 Kbbl/d based on the share to total crude oil imports). This is on the assumption of 1:1 ratio of crude intake and refinery output.

- A decline of 36% in oil product imports (including imports from Kuwait), or equivalent to 171 Kbbl/d. The decrease is based on the share of exporters to total oil product imports. The amount of exports is affected by the share of Middle East crude in their total crude imports (Tables 4 and 5).

Overall supply shortfall is about 218 Kbbl/d, equivalent to 19% of domestic oil demand.

[16] Using 2014 data from UN Comtrade. It is assumed that the same shares of exporters (oil products) to total oil product imports of the economy in 2015.
[17] In this report, the shortfall was revised based on 2015 data.

Table 4: Dependency on Middle East Crudes of Major Exporters of Oil Products

	KSA	UAE	Kuwait	Qatar	Iran	Iraq	Total Dependency
Korea	34%	12%	16%	9%	0%	10%	**81%**
Singapore	20%	31%	8%	0%	0%	8%	**85%**
Japan	32%	22%	8%	12%	0%	0%	**74%**
India	20%	8%	0%	0%	6%	17%	**51%**
China	19%	0%	0%	0%	0%	0%	**19%**
Malaysia	13%	20%	0%	0%	0%	0%	**33%**
Chinese Taipei	36%	6%	22%	0%	2%	0%	**66%**

Source: UN Comtrade Database

Table 5: Estimated Reduction in Oil Product Imports for Indonesia

	Share to Total Oil Product Imports	Total Imports (Kbbl/d)	Dependency on M.E. crude*	Potential Reduction (Kbbl/d)
Singapore	52%	250	85%	**120**
Malaysia	22%	106	32%	**6**
Korea	9%	45	81%	**20**
Chinese Taipei	4%	20	66%	**6**
Kuwait	3%	16		**16**
Others	10%	44		
Total		481		**171**

*Affected Middle East Countries
Source: UN Comtrade Database (share of exporters to total imports)

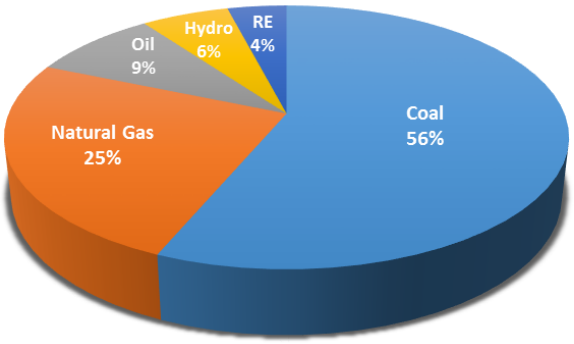
1.1.2 Emergency Responses

The transport will be the most affected sector from the supply shortage considering its large oil requirement, about 60% of total oil consumption, compared with other sectors. Of the total

consumption of the sector, around 66% is used for passenger cars (individual and public), 8.0% for public bus, and 26% for transporting goods. As the global crude oil supply shortage triggers a 100% increase in international crude price, such rises the transportation cost (both passengers and goods). This pushes up the prices of essential goods (foods and agricultural products) that could lead to economy-wide inflation.

In 2013, the government issued a policy to reduce the use of oil in power generation sector in order to cut down the oil consumption of the economy. Although the share of oil in power generation is small, only 9.0% of total, compared with other fuels (coal and natural gas) (Figure 3.3), it is an important fuel in providing electricity for isolated system, specifically in small and far-flung areas (island areas).

Figure 3.3: Power Generation Mix of Indonesia (% Share), 2015



Source: MEMR, 2017b

The oil supply disruption may also impair the transportation of other fuels/energy resources, such as coal, that could cause delays or shortages in primary fuels for power generation. For example, Suralaya is the largest coal-fired power plant in the Java-Bali Interconnection System with total generating capacity of 3.4 gigawatt (GW). Coal supply of the power plant comes from South Sumatra, and transported by trains and ships. The power plant has coal stockpile equivalent for 7-10 days, as longer stockpile deems to be unsafe and requires additional environmental costs. In the event of power shortages, the Perusahaan Listrik Negara (PLN), a state-owned enterprise and sole authority in distributing electricity in the economy already, has a Load Shedding System to control electricity consumption in order to avoid a total blackout.

The Presidential Regulation No. 41 issued in 2016 contains the assessment and declaration of energy crisis or energy emergency, including the procedures to follow and countermeasures for

implementation. Once an oil supply disruption occurs, the first step of the government is to require most oil and gas companies, especially the state-owned enterprises, to conduct an assessment if they can manage and address the supply emergency. Results of assessment should be reported to the MEMR. If such assessment reveals the need to declare a crisis, the MEMR, as the Executive Director of NEC, immediately convenes the Assembly of Council Members to assess the severity of the impact, as well as to formulate response measures. The NEC recommends to the President (as Chairman of NEC) to declare a National Energy Crisis. The government implements the proposed measures formulated under the crisis response of the NEC Member Assembly.

Supply Side Measures

Currently, Indonesia has no energy buffer stocks (publicly held oil stocks), only operational stocks (industry oil stocks) by the state-owned enterprise as part of inventory. Total operational stocks for refinery products are 21-23 days, while 14 days for crude oil.

To augment the available supply, the following actions will be undertaken:

- Delay and/or suspend exports of crude and oil products. The government has the first priority right to buy crude oil from upstream oil enterprise as part of the PSC. Potential additional supply from this is around 315 Kbbl/d (2015).

- Obtain additional imports from oil fields abroad belonging to Pertamina with a total production of 87 Kbbl/d from Algeria (60%), Irag (30%) and Malaysia (10%). Among the three sources, additional supply from Malaysia could be received within five to seven days, while the other two sources would take 25 to 30 days shipping time. Likewise, with the closing of the Strait of Hormuz, crude oil from Iraq could not be shipped out (or only on very limited volume due to the existence of pipeline going to Turkey).

  However, as domestic refinery capacity cannot accommodate additional processing of crude oil, the supply coming from abroad (specifically from Malaysia) will have to be tailored in Singapore refinery or Korean refinery. Processing and shipping the refinery products to the economy will take three to five days.

Demand Side Measures

The government has a list of demand restraint measures, which include:

- Restrict volume of fuel purchase for individual vehicle. There will be a priority allocation of

fuel for strategic purpose (such as, military, medical and public transport). No fuel restriction for industry as it may affect productivity and reduced output that may lead to termination of employment.

- Reduce power generation from oil-based power plants (and natural gas-based power plant) in interconnected grid system with various types of power plants and maximise the generation from hydropower to offset the shortfalls. During rainy season, the potential to utilise water from the reservoir could be around 60-80%.

- Implement load shedding whenever reducing power generation (from oil and natural gas) leads to a system deficit. This is to control electricity consumption in order to avoid a total blackout of the system.

International Cooperation

The closing of the Strait of Hormuz has a global impact on oil supply, and thus affecting other ASEAN countries as well. With this, Indonesia cannot invoke activation of the ASEAN Petroleum Security Agreement (APSA) for this emergency scenario. Further, the APSA operationalisation framework has not yet been finalised and agreed upon by members, hence no cooperation framework to activate APSA.

Based on the scenario, the oil supply shortfall could be overcome with available supply and demand measures. Additional oil supply will be sourced out from oil production in fields abroad. However, as shipping takes time, implementation of demand measures should be immediately followed while waiting for additional supply to come. Taking into consideration the above circumstances, the impact of the closing Strait of Hormuz for two weeks to a month could be moderate for Indonesia.

1.2. The Philippines

1.2.1 Oil Supply Impact

The Philippines has modest oil reserves, which allows a small amount of crude oil and condensate production, stood at 2.4 Mbbl and 3.7 Mbbl in 2015, respectively. Almost all of domestic crude oil production is exported to other economies.

The economy is highly dependent on crude imports to meet nearly 100% of its refinery demand. Total crude oil imports reached 214 Kbbl/d in 2015, 44% of which came from KSA, 22%

Kuwait, 12% from UAE and 10% from Qatar. In the same year, the economy imported 214 Kbbl/d of oil products, mostly from Korea (23%), Chinese Taipei (23%), China (14%) and Singapore (13%).

The economy's domestic oil requirement reached 392 Kbbl/d in 2015, about 53% was provided by local refiners (208 Kbbl/d).

Potential Supply Shortfall[18]

Table 6: Estimated Reduction in Oil Product Imports for the Philippines

	Share to Total Oil Product Imports	Total Imports (Kbbl/d)	Dependency on M.E. crude*	Potential Reduction (Kbbl.d)
Korea	23%	49	81%	**22**
Chinese Taipei	23%	49	66%	**22**
China	14%	30	19%	**3**
Singapore	13%	28	85%	**16**
India	4%	9	51%	**3**
Japan	2%	5	75%	**2**
Thailand	1.6%	3	67%	**3**
KSA	1.6%	3		**2**
Kuwait	0.3%	0.3		**0.6**
UAE	0.3%	0.5		**0.6**
Others	17%	36		
Total		214		**74**

*Affected Middle East Countries
Source: UN Comtrade Database (share of exporters to total imports)

As the Philippines is highly dependent on oil imports to meet its domestic oil demand, the estimated shortfall in supply could be:

[18] In this report, the shortfall was revised based on 2015 data.

- A reduction in refinery output by around 60% as a result of a decrease in crude imports. As 86% of crude imports came from affected Middle East countries, around 127 Kbbl/d could be the potential supply shortage in crude oil imports. A decrease of 47 Kbbl/d from 50% reduction in KSA imports with 44% share of total imports, or 94 Kbbl/d; a shortfall of 13 Kbbl/d in UAE imports as a result of 50% reduction (based on the 12% share of total crude oil imports or 26 Kbbl/d); a 47 Kbbl/d decline from 22% share of Kuwait; and 20 Kbbl/d from 10% share of Qatar.

- Reduction of 36% in oil product imports, or 74 Kbbl/d based on the share of exporters to total oil product imports of the Philippines (Table 6). The share of Middle East crudes in exporters' respective total crude imports affects the amount of oil product exports to the Philippines (Table 4).

Total supply shortfall could reach about 201 Kbbl/d, which is 51% of domestic oil demand.

1.2.2 Emergency Responses

Based on the scenario, the shortfall could have a severe impact to the economy since it is equivalent to about half of domestic demand if the industry players are not able to secure supply from other sources to offset the deficit. Considering this is primarily a business interest, the industry players usually entered into a long-term supply contracts with their suppliers to ensure continuous supply of crude oil and oil product imports.

The shortage and the increase in international crude oil price will definitely affect the domestic oil pump price. As the downstream oil industry is already deregulated, oil prices are determined by market forces, where supply and demand adjust to price level. Based on domestic experience in 2008 when international crude oil price hit USD 100/bbl, the market was able to adapt as it resulted in reduced oil demand even without intervention and direction from the government. However, the government ensures that oil companies do not take advantage of the situation by unreasonably increasing their prices.

The impact of supply disruption could be softened as the oil industry maintains a healthy level of inventory of around 45-50 days. Such level is above the required 30 days minimum inventory requirement by the government. The government will suspend the implementation of the minimum inventory requirement so that inventories will be available in the market to augment domestic supply.

As an initial response to the emergency, the government (through the DOE) will closely coordinate with the oil industry players in order to determine if they will be able to maintain a healthy level of inventories. Likewise, the government will advise the oil companies to look for other alternative sources and to increase their oil imports, if possible. To aid the oil companies to speed up importation of crude oil and oil product, the government will streamline oil import processing and documentation, or even allow post compliance of import requirements. This would expedite importation from different sources. Availability of foreign currency (forex) will be ensured for additional importation (at a much higher price due to global shortfall). In parallel, the government will make regular update to the public through tri-media to avoid or prevent panic and not to further worsen the situation.

If the oil companies cannot respond and secure additional importation from other sources, the government will activate the Oil Contingency Plan, specifically implementing rationing. The rationing shall be based on priority sector categories or sectoral requirements, as follows:

1) Food production and transport;
2) Hospitals and health care facilities;
3) Power generation;
4) Transport (public and cargo land transportation; private land transportation; domestic shipping; domestic aviation);
5) Industry;
6) Government, Armed Forces and Police;
7) International shipping and aviation;
8) Residential; and
9) Diplomatic.

Other demand measures for implementation include:

- Encourage mass transport and intensify implementation of car pooling;
- Limit use of private vehicles may be imposed by strictly enforcing and expanding the transport "volume reduction scheme;"
- Ban vehicles on roads for a specific time, such as from 12:00 midnight to 4:00 a.m;
- Prioritise use of government vehicles; and,
- Shorten the operating hours of gas stations, shopping malls, stores and other entertainment places.

The economy is also a member state of ASEAN and thus a party to APSA. However, APSA is not yet operational as there are still issues that need to be resolved. Although, other ASEAN member states are affected by this global oil disruption scenario, members can actually borrow/buy oil from each other (from those with higher oil inventory or stock level) since the oil product quality in ASEAN is being harmonised.

1.3. Thailand

1.3.1 Oil Supply Impact

With modest crude oil reserves, Thailand was only able to produce 396 Mbbl of crude oil and other liquids in 2015. As such, economy imports crude oil to meet its refinery demand, which stood at 875 Kbbl/d in 2015, about 66% of which originated from Middle East – 32% from UAE, 26% from KSA, and 7.0% from Qatar. The economy likewise imports oil products (62 Kbbl/d in 2015) mostly coming from Singapore (24%), KSA (21%), UAE (16%), Kuwait (9.0%), and Malaysia (8.0%)[19].

Thailand holds a large refining capacity (next to Singapore in Southeast Asia) providing almost all of its oil demand requirements, with a capacity of 1.2 Mbbl/d in 2015 (1,252 Kbbl/d). In the same year, refinery output was estimated at 1.1 Mbbl/d.

Potential Supply Shortfall[20]

Based on the oil supply and demand situation of Thailand, the potential supply shortage could be:

- A decrease of 315 Kbbl/d in crude oil imports as a result of 66% share of affected Middle East countries to total crude oil imports. The 32% share of UAE leads to a reduction of 140 Kbbl/d (50% decreased from UAE's imports of 280 Kbbl/d); the 26% share of KSA results in 114 Kbbl/d supply cut (50% declined from KSA's imports of 228 Kbbl/d); and, the 7.0% share of Qatar has a 61 Kbbl/d shortfall in total crude oil imports.

- A Reduction of 40% in petroleum product imports (including imports from KSA, UAE and Kuwait), or equivalent to 25 Kbbl/d (Table 7). The decrease is based on the share of exporters

[19] Using 2014 data from UN Comtrade. It is assumed that the same shares of exporters (oil products) to total oil product imports of the economy in 2015.

[20] In this report, the shortfall was revised based on 2015 data.

to total oil product imports of the economy, which the volume of oil product exports is affected by the share of Middle East crude in their respective total crude imports (Table 4).

Total supply shortfall is about 340 Kbbl/d, representing around 30% of domestic oil demand.

Table 7: Estimated Reduction in Oil Product Imports for Thailand

	Share to Total Oil Product Imports	Total Imports (Kbbl/d)	Dependency on M.E. crude*	Potential Reduction (Kbbl/d)
Singapore	24%	15	85%	**7**
Malaysia	8%	5	32%	**0.2**
KSA	21%	13		**7**
UAE	16%	10		**5**
Kuwait	9%	6		**6**
Others	22%	13		
Total		62		**25**

*Affected Middle East Countries
Source: UN Comtrade Database (share of exporters to total imports)

1.3.2 Emergency Responses

The oil disruption scenario may have moderate impact to the economy given its supply surplus compared with consumption. The excess supply is exported to neighboring economies. However, with an increase in global oil price, pricing mechanism will automatically apply using the oil fund to reduce the impact to the economy. The following are the emergency response measures in priority order:

- Implement demand-side management

  Demand-side management will be strictly implemented to control the level of domestic demand by encouraging consumers who have dual system vehicle to switch from fuel oil to LPG and NGV; and, promoting energy saving campaign such as car pool and public transportation.

- Reduce refinery crude intake

All refineries may be encouraged to run at minimum capacity in order to reduce crude oil intake and thus imports. However, this will affect the volume oil product exports.

- Release of oil stock and allocation of oil use

  These measures will only applied when there seems to have tighter crude supply. The 33 days oil stockholding holding (both crude oil and oil products) may be released to augment domestic supply of oil. Allocation of oil to end consumers could be considered to free up some amount of oil supply. Such allocation will be set based on order of priority among users of oil.

As a long-term measure, the economy will consider improving the diversity of its crude oil imports sources from the Middle East to other exporting regions. On international cooperation, the APSA should be operationalise to play an important role during supply disruption.

2. GAS SUPPLY EMERGENCY SCENARIO

2.1. Indonesia

In 2015, Indonesia's proven gas reserves stood at 2.9 Tcm with largest natural gas fields found in South Sumatra (in Aceh Region) and East Kalimatan (Figure 2.2 in Part 2). The Mahakam block, located offshore of East Kalimantan and operated by Total Oil Company, accounts for about 25% of total gas production and the main supplier to the Bontang LNG Plant.

A computer virus was uploaded in the main control system of the platform of Total Oil Company that paralysed the whole gas production system in the Mahakam block. With this, the platform operation was totally shutdown until all ICT systems are fixed and cleaned, which could take two to three weeks.

However, a day after, the computer virus was also uploaded to the other gas production platforms:

- The Tangguh gas field (British Petroleum) with 15% share of total production;
- The Grissk and Natuna of Conoco Phillips with 14% and 5.0% shares, respectively; and,
- The Arun of Exxon Mobil with 3.0% share.

2.2.1 Gas Supply Impact

In 2015, gas production reached 75 Bcm (200 Mcm/d), while domestic demand was recorded at 39.8 Bcm (109 Mcm/d). With five of the gas fields are out of operation, there will be a 58% shortfall (equivalent to 43.5 Bcm or 119 Mcm/d) in Indonesia's gas production.

Potential Supply Shortfall

- The remaining producing gas fields can only meet 80% of domestic demand (a shortfall of 8.0 Bcm (22 Mcm/d).

- Indonesia's gas export obligations are also affected by the incident. In 2015, the economy exported a total of 32.4 Bcm (89 Mcm/d) of gas composed of 10.5 Bcm of piped gas and 21.9 Bcm of LNG.

2.2.2 Emergency Responses

The role of natural gas in the economy is significant considering its share in the primary energy supply, and as one of the major sources of fuel for power generation. However, the industry sector will suffer the most from domestic gas shortage. About one-fourth of gas supply requirement of the economy is utilised by the industry sector as a feedstock or raw material. The use of gas even on specific industry, such as in ceramic, glass and tire industries, cannot be replaced by other energy resources. Thus, gas supply shortage threatens the survival of industry operations. As industry contributes so much to domestic economy in terms of revenue and employment generation, and in promoting economic growth, the government is ardent to maintaining the continuity of its operation.

As an agricultural economy, agriculture's role is crucial in supporting the domestic food requirement. Therefore, the use of gas (as a raw material) for the fertiliser industry is also prioritised, after power generation and for lifting of oil. Gas supply shortage greatly affects the production of fertilisers, and so its supply.

In electricity, gas supply shortage reduces power plant production capacity. It is somewhat alleviate as gas power plants are generally used for peak load and not as a baseload. In addition for dual fuel power plants, fuel switching can be done, gas substituted by fuel oil.

The transport sector is less affected as compressed natural gas (CNG) vehicle has not yet fully developed, consuming less than 1.0% of gas production.

Supply Side Measures

Gas supply shortage could be overcome by increased imports of LPG (from gas) and LNG. Currently, the economy has a regasification unit with a capacity of up to 405 million cubic feet per day (Mcf/d) (or 11.2 million cubic metre per day [Mcm/d]), and a land-based storage tank in Arun with a capacity of 500,000 cubic metre (Cm). The terminal is connected to the pipeline with total length of 325 km to deliver the gas to the industrial area around the city of Medan (North Sumatra). In addition, there are several other FSRU, such as in the Bay of Jakarta (regasification capacity of 250 Mcf/d or 7.1 Mcm/d and storage capacity of 126,356 Cm), and Labuhan Maringgai Lampung (regasification 240 Mcf/d or 6.8 Mcm/d, and storage capacity of 170,271 Cm). However, the two FSRUs are not equipped with land-based tank, so it is not capable of storing LNG longer.

Demand Side Measures

In terms of demand, reduce gas utilisation in power sector through fuel switching (fuel oil) and maximise coal and hydropower generation. If maximum power generation from other fuels is not enough and still results in system deficit, load shedding will be implemented, specifically for household customers. Shutting down the gas power plants in the Java-Bali system (providing only 6.0% to total power generation) can reduce the need for gas up to 10.4%.

Cutting down production of fertilisers decreases the need for gas up to 8.3% of domestic requirement. However, reduction in fertiliser production should take into consideration amount of fertiliser stocks in the warehouse, as well as the time of planting. During the period of rice planting, demand for fertiliser is high, but in harvest period requirement for fertiliser is low.

Although gas utilisation in household and transport is small, a decrease in demand from these sectors could still help in lowering domestic gas requirement. Limiting the allocation of LPG for household use could be considered, and even reducing gas demand in industry could be an option, if necessary, to address the shortfall.

Based on the conditions of this gas emergency, the impact to the economy of such gas supply shortage is very severe.

2.2. The Philippines

Currently, the Philippines is self-sufficient in natural gas. However, almost 100% of its production is only coming from one source, the Malamapaya gas field and reserves are expected to deplete soon (2022-2025). In 2015, production level was 122 Bcf or 3.5 Bcm (9.6 Mcm/d). Specifically, about 98% of gas production from Malampaya is used for natural gas-fired power plants with an aggregate capacity of 2,861 MW, and the rest for industry (Shell Philippines refinery facility) and for CNG bus program of the Philippine government.

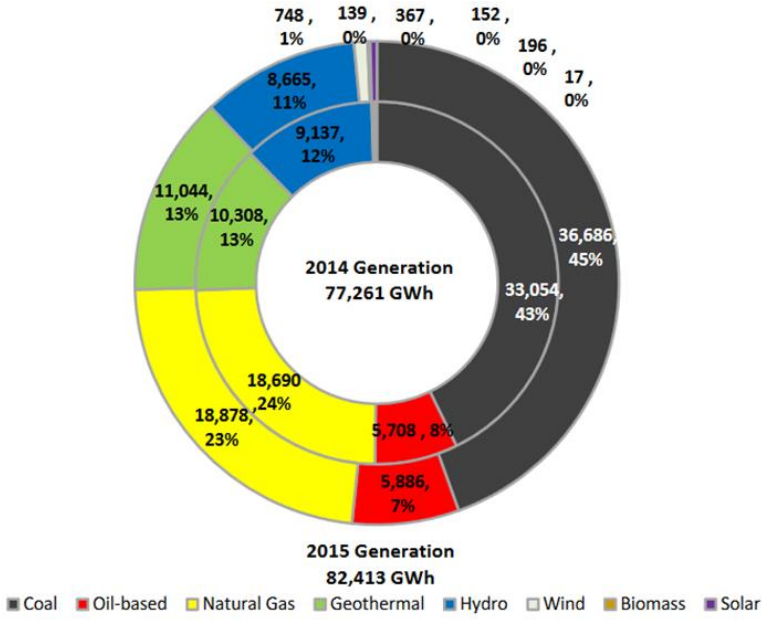
An incident happened in the Malamapaya gas platform. A fire broke out in the control room, which eventually paralysed the whole operation of the platform. The incident happened just few days after the Malampaya gas field annual maintenance shutdown. Repair of the control room will take 2 to 3 weeks. As this incident occurred right after the maintenance shutdown, the three natural gas-fired power plants have not yet replenished theirs stocks of alternative fuels (diesel and condensate).

2.2.1 Gas Supply Impact

The total shutdown will result in a loss of around 9.6 Mcm/d of gas supply to fuel the three natural gas-fired power plants. These power plants provides an aggregate share of around 23% of total power generation mix in the Philippines in 2015 (82 terawatt-hour [TWh]) (Figure 3.4), and around 30% in Luzon grid. The Philippines has three major power grids – Luzon, Visayas and Mindanao grids. The gas power plants produced a total of 19 TWh in 2015.

If these power plants can run using diesel fuel (or condensate), an equivalent of 63 Kbbl/d of diesel fuel is required. However, this requires additional diesel supply requirement.

Figure 3.4. Total Power Generation (% Share), 2014 and 2015



Source: DOE, 2016c

2.2.2 Emergency Responses

The impact to the economy of the total shutdown of Malampaya is too severe considering the contribution of gas to total power generation. As the Philippine economy is heavily dependent on industry and services sectors, particularly the Business Processing Outsourcing (BPO). BPOs contribute around USD 22 billion to the local economy. BPO's operation requires a stable and reliable electricity to power its information technology and telecommunications infrastructure, while

the same is true for the manufacturing of semiconductors. Without the 2,861 MW (or the 3,430 MW in 2016) total natural gas capacity, such impacts on the supply integrity, specifically in the Luzon grid.

As an immediate response, the government (through the Department Energy) will convene a meeting with the operators of Malampayas gas field and power plants including other stakeholders to assess the situation and discuss alternative measures. After such meeting, the DOE to issue official press release about the situation and the measures to be undertaken to address the Malampaya incident, and to get support and cooperation from the stakeholders and the public.

The DOE will implement and monitor compliance to the Department Circular for all natural gas-fired power plants to maintain a minimum inventory good for 15-day supply of diesel/condensate as alternate fuels. Two natural gas power plants (San Lorenzo and Sta. Rita) can take 20 days of diesel/condensate with its existing storage facilities, while the other one (Ilijan) can only operate one block, about 420 MW (instead of 600 MW of the total 1,271 MW), and only for five days based on its storage capacity for diesel. The new power plant San Gabriel is only designed for natural gas firing, while Avion is operated as peaking load (and can use diesel as an alternate fuel). Avion is the first power plant in the Philippines to run on aircraft engines for land-based power generation application. It uses two units of the LM6000 PC Sprint aero-derivative gas turbines from General Electric. In order for the power plants to procure their alternate fuels (diesel and condensate), the DOE should issue a certificate for the Malampaya shutdown. Diesel supply is procured locally, while condensate is sourced overseas. However, condensate produced locally (from Malampaya) can also be used if not yet exported.

During the shutdown only 1,949 MW (420 MW Ilijan, 1000 MW Sta. Rita, and 500 MW Sta San Lorenzo operate as baseload, and 97 MW Avion for peaking (only if the emergency happens in 2016) by switching to alternate fuels. There is a shortfall in dependable capacity from natural gas plants of about 1,335 MW. The baseload plants can be offset by ensuring that coal (700 MW), geothermal (200 MW) and hydro (216 MW) supplement the shortfall in dependable capacity during the emergency period, and Avion plant to operate at 60% plant capacity factor to offset the shortfall for peaking requirement.

The DOE and the National Grid Corporation of the Philippines (NGCP) will immediately conduct an inventory by requiring all power plants in the Luzon grid to submit its respective capacity commitment to determine the dependable capacity profile within the two-three week timeframe. In addition, the DOE will direct the NGCP to also have an inventory of schedule for maintenance

shutdown of other power plants and to require the operators to reset the date of maintenance shutdown after the emergency situation is resolved (if it falls within the same period).

To hasten the procurement of spare parts for the repair, the DOE will facilitate the importation of the necessary equipment/spare parts to meet the target schedule on the repair of the control room through close coordination with the Department of Finance and Bureau of Customs.

Other option of the government is to implement the Interruptible Load Program (ILP) to reduce demand during peak hours. Under the ILP, the customers of the distribution utilities will be encouraged to voluntarily de-load themselves from the grid by operating their own generation facilities during peak demand hours. The distribution utilities will then compensate the ILP customers from the charges to be collected from customers within the franchise area on the corresponding electricity freed up (kilowatt-hours/KWh).

The DOE, in coordination with other agencies, will intensify the promotion and implementation of energy conservation measures to reduce electricity consumption, especially in the household sector to reduce pressure on demand levels for the service and industrial sectors. Household sector consumes 28% of electricity generated, and a target 10% reduction in electricity demand could translate to 240 MW of capacity savings. Other measure is to mandate all government agencies, shopping malls and commercial establishments to enforce energy conservation measures like set the air conditioner units to 25 degrees Celsius. Government offices may shorten the operating hours of air conditioning unit. Demand-side management may be implemented such as shifting of operating hours of manufacturing plants to off-peak hours. As a last resort, load shedding and scheduling of rotating black out with priority to sectoral requirement will also be considered, if required.

To diversify the sources of natural gas and encourage the entry of LNG, the DOE is expediting the passage of a Department Circular that would provide a clear policy framework for the development of LNG and increase use of natural gas in the energy mix. The LNG import receiving terminal is soon to be available in the economy with the completion of the Energy World Corporation (EWC) LNG project, which will kick off the importation of LNG. The fastest source of LNG will come from Australia; Malaysia; and Russia with delivery time of two to five days.

Given the nature of supply disruption scenario, it may not warrant a regional action or international cooperation as the economy is not yet importing LNG. Nonetheless, regional

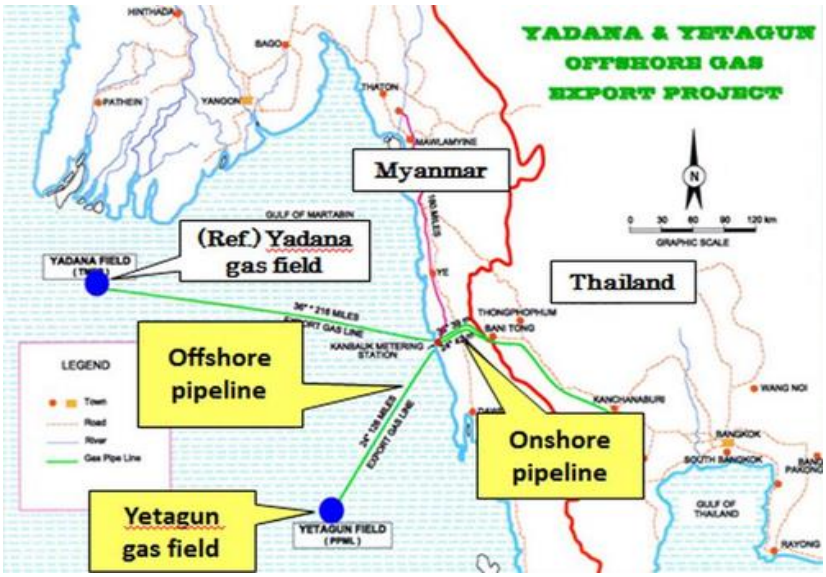
cooperation is important when the necessary infrastructures are in place, such as sharing or diversion of LNG cargoes among economies APEC (or ASEAN) economies during emergency.

2.3. Thailand

As the "Strait of Hormuz" has been closed, LNG exports from Qatar is also affected. Qatar gas production in 2015 was about 5.1% of global gas production, equivalent to 17.3 Bcf/y (489 Mcm/y). Qatar also is the largest LNG exporter in the world, providing around 30% of global LNG exports (BP, 2016). The economy received its first LNG imports (specifically from Qatar) through its first regasification terminal, the Map Ta Phut LNG, near Bangkok in 2011, with a capacity of 237 Bcf/y (6.7 Bcm/y).

Aside from the supply cut as a result of the closure of the Strait, an unexpected mechanical failure happened in the connecting point (compressor station) linking the offshore pipeline from Myanmar and the onshore pipeline that runs to the Thailand border (Figure 3.5). The repair of the pipeline would take two to three weeks. About 75% of the economy's gas imports is through this pipeline.

Figure 3.5. Pipeline Network between Thailand and Myanmar



Source: offshoreenergytoday.com

2.3.1 Gas Supply Impact

Thailand's total gas production was recorded at 3.8 Bcf/d (109 Mcm/d) in 2015, which could meet 75% of its domestic demand (5.1 Bcf/d or 145 Mcm/d) (EPPO, 2016). In the same year, the economy's gas imports reached 1.3 Bcf/d or 35.7 Mcm/d, of which 923 Mcf/d (26 Mcm/d) was piped gas from Myanmar and rest in LNG form. The economy sourced 80% of its LNG imports from Qatar, or 21% of total gas imports. Other sources of LNG imports were Australia, Malaysia and Nigeria. In previous year, the economy also imported LNG from Oman, Russia, Trinidad and Tobago, and Yemen.

Potential Supply Shortfall

- A reduction of 95% in total gas imports – 74% from piped gas and 21% from the closure of the Strait preventing Qatar's LNG to be shipped out.

- A shortfall of 24% in gas supply requirement, or equivalent to 1.2 Bcf/d (35 Mcm/d).

2.3.2 Emergency Responses

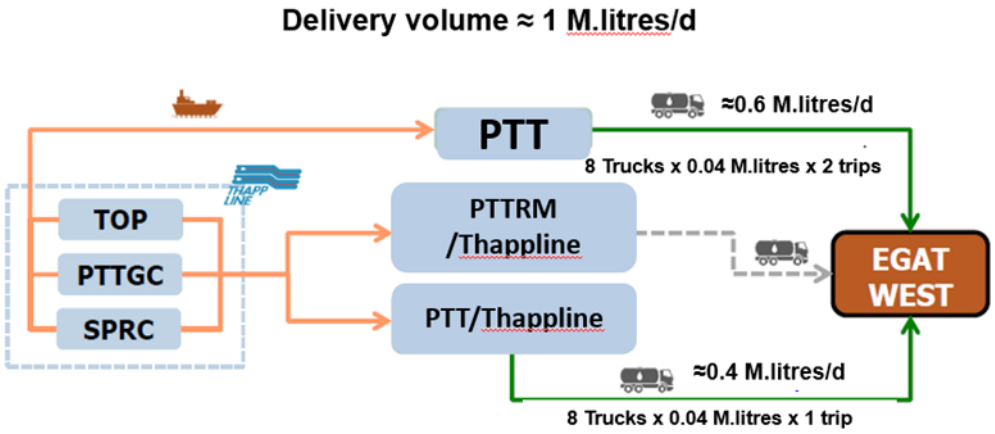
The magnitude of emergency supply is severe considering that the shortfall in domestic supply due to cut in LNG imports is about one-fourth of supply requirement. In particular, the Western part of Thailand will suffer the most from the stoppage of imports from Myanmar, specifically affecting the power plants using gas with an aggregate capacity of 3,394 MW. Although most of the power plants have their own oil stocks and can switch to using fuel oil and diesel to produce electricity, the supply is only good for 14 days. Oil delivery to power plants in the West could reach around one million litres per day (Figure 3.6).

Other users of gas in the West can use the supply from the line pack. About 300 Mcf (8.5 Mcm) could be made available and support some gas users (industries) for 9-12 days. Other measure is to send gas from the East via the East-West pipeline connection.

On the other hand, the shortage from Qatar LNG (not able to ship out natural gas) due to the closure of the Strait of Hormuz may not have much impact on the gas users in the East. The government may call for more gas production from the concessionaires in the Thai Gulf, may be around 15% above the daily contract quantity (DCQ).

The economy may secure LNG from other sources (or from previous sources) or increase the volume of imports from Australia and Malaysia (as among the exporters of LNG). The economy may also consider imports from Indonesia and from traders with LNG portfolios.

Figure 3.6. Oil Delivery to Power Plants in the West



Source: Ministry of Energy, Thailand

If the incident last longer than expected, some large power plants in the East have to switch to fuel oil and diesel. Likewise, gas consumption of the gas processing plant may be reduced.

For both the West and the East, demand-side management will be carried out, particularly for electricity consumption. Power savings will be promoted in households and industries. If the supply emergency last for more than two weeks, load shedding will be implemented to reduce gas consumption in power generation.

3. EXPERTS' OBSERVATIONS AND RECOMMENDATIONS

The invited experts assessed the responses of participating economies based on the emergency scenarios presented in this report on oil and gas. From the discussions and clarifications made by the experts with the participating economies during the exercise on emergency policy, institutional structure and strategic and response measures to deal with the oil and gas supply shortfall, a set of observations and recommendations were formulated as shown below.

3.1. Oil Supply Emergency

3.1.1 Indonesia

- The institutional arrangements are well established in the economy. However, the economy should make sure that there is clear delineation of roles between the government and the industry. The functions and responsibilities of the National Emergency Committee should be strictly defined including its rights during emergency situation.

- The economy should consider the global impact of its actions like withholding exports. Such action may not make the most in terms of economic sense, both globally and domestically. Clearly assess if limiting exports brings a net positive effect to the economy and the region. The economy might be better off to allow exports to flow and earn large revenue or return, and use such to purchase oil supplies from elsewhere.

- In communicating to the public, the government is encouraged to consider the public perception of any actions they might take.

- The government should ensure that the implementation of priority allocation or redirecting supplies to particular sectors is not causing unintended consequences to the market. Such measure should only be undertaken as a last resort.

- The economy highlights the need to control oil prices even in times of crises. By excluding demand side adjustment resulting from price increases, the economy does not really have much policy instruments at hand to affect demand. While socially and politically understandable, from an economic point of view, the economy could not be capable of maintaining subsidies for oil prices through an extended oil crisis. The high importance of price management is also a critical dimension as to how economy would handle emergency stocks – true emergency stocks or as an instrument aimed at price manipulation.

- The economy considers APSA, as a regional cooperation, as an option to help address the crisis through supply sharing. As regional cooperation is deemed important for the economy, severely limiting its exports could also have an impact on regional partners in the event of supply emergency.

3.1.2 The Philippines

- It is creative that the economy, rather than assisting in locating supplies from elsewhere, considers the role of government to streamline import processing and documentation being required from oil companies/players for the importation of oil.

- Allowing the industry the freedom to try resolving the supply crisis is a good strategy. However, it is not clear when the government attempts to prevent any "unreasonable" increases in oil prices (by oil companies), which may be interpreted as price gouging action. Any attempt to cap prices below market level would likely divert the needed supplies elsewhere.

- The economy has an oil contingency plan mainly focused on supply rationing. However, there is a room for refinement on the institutional response with regard to data collection and reporting, as well as the hierarchy of measures to be undertaken during an emergency. More work needs to be done to develop short- and long-term emergency response measures.

- The economy has a detailed list of possible measures to curb demand. However, the impact of each individual measure was not quantified, neither was the order of priority of the measures. A quantification would be very useful to allow the government a more detailed assessment of the sufficiency of their demand-side management policies.

- Any limit on the use of oil by the government should be the last resort of action. Limiting the use of private vehicles and shortening the operating hours of establishments may make sense, but only under the most severe circumstances, as doing so will send a message to the public that grave measures are necessary, which may create panic if not manage properly.

- Although the economy underscores the importance of informing the public as a key element of government's role, a fledged out media strategy must be formulated to manage the communication effective and calm the public.

- The economy stresses the depth of the Asian market and shows confidence that market players will be able to buy the needed crude and oil product regionally. This might be an over optimistic assessment in the given scenario and due perhaps to a misreading of the extent of the shortage of oil supply in the region.

- The economy favours voluntary regional oil stockpiling, but points out that all economies must have stocks (commercial and/or strategic) and make them operational for this purpose. Firstly, APSA needs to be operationalised to address concerns on reciprocity of regional cooperation and the question of commercial versus strategic stocks and how this influence the ability to cooperate regionally.

- The economy understands the need for regional cooperation, and participating in emergency exercises highlights the understanding of its importance. Whether working under the APEC or ASEAN, regional cooperation is critical in responding to a major emergency affecting the entire region.

3.1.3 Thailand

- The economy has well developed legal and regulatory framework. This reflects that the economy has been concerned about energy supply emergencies for a long time and even absorbed international best practices in dealing with emergencies.

- It is very positive to note that the economy undertakes emergency response exercise on an annual basis, which also invites media personnel to participate in the activity. However, it would be interesting to learn more how the feedback from media is considered in improving the policies and institutional arrangements for emergencies.

- The economy has good experiences on price signals to manage periods of peak demand, which could provide insightful lessons for managing emergencies. The response to price signals was tested when LPG subsidies were removed, and subsequently reduced demand for the said fuel.

- The use of the "Oil Fund" to subsidise partially the prices could become a costly policy, should the disruption last a long time. On the other hand, setting a price cap below the market price sends a wrong signal and encourages potential sources of supply to be

diverted to other economies. The implementation of Oil Fund likewise appears to be in slight contradiction to letting price signals deal with demand measures.

- A very remarkable learning was that the economy has provisions to cut off exports of oil products to neighbouring economies. This of course passes the problem of supply shortages on to other actors. It would be interesting within the context of ASEAN/APSA to have a more detailed assessment on the specific provisions with Laos and Cambodia on this matter.

- On the view for longer term, the economy has established a cut-off price at which switch from oil to LPG or natural gas vehicle (NGV) makes economic sense. However, it is not clear how a policy will be developed for this purpose. It is important to highlight that today the transport sector has high flexibility to switch to LPG and NGV. It would be interesting to analyse this in more detail for possible lessons learned for other ASEAN economies.

- Drawing down inventories to augment supply will not just contribute to addressing the emergency domestically, but the entire region, as it may free up other supplies to go elsewhere.

- The same with other participating economies, in communicating with the public, the economy must take into consideration the public perception on every action/measure the government intends to implement.

- The government considers that regional cooperation is critical in responding to a major emergency affecting the entire region.

3.2. Gas Supply Emergency

3.2.1 Indonesia

- Despite the huge loss in domestic production based on the scenario, the economy can still meet 80% of its gas demand. The economy is optimistic that it could increase imports from overseas fields in which it holds shares. However, the issue on shipping and timing of execution of priority rights as part of PSC should be further threshed out for the economy to have a clearer picture on how better to use this option during supply emergency.

- Fuel switching from gas to coal in fertiliser and petrochemical is possible but the policy and institutional framework is not adequately developed. The existing procedure in coal production and utilisation might need to be refined as well.

- The industry would be one of the affected sectors from natural gas shortage, specifically the requirements for petrochemical and fertiliser production, and both are highly prioritised industries in the economy. The economy would consider reducing exports for augment domestic supply, but this alone is not sufficient to avert the shortfall. The economy should consider developing alternatives to reliance on gas supply in the production of fertiliser for food security.

3.2.2 The Philippines

- The institutional arrangements in the economy are clearly thought through and effective. However, in the short-term the economy is increasingly aware about the cybersecurity risks and general IT security of its gas field. This area needs to be given more attention at the policy level. Institutional arrangements are not clearly visible now to for this type of supply threat.

- There is a recognition on the pending government order should be expedited to provide a legal and regulatory framework for the introduction of LNG. Such framework should encourage investment on LNG from the private sector. The government is also exploring technical models for gas storage, but there is no clear cost-benefit analysis seems to have been undertaken. However, a legislated policy is encouraged to support the entry of new gas supply as the Malampaya gas field near its depletion.

- The economy is looking at fuel switching as a longer-term solution with a view towards the expected end of domestic gas production in the early 2020s. However, there are also plans to consider new sources of supply via LNG import terminals.

- The economy should consider the impact of requiring natural gas-fired plants maintain a 15-day supply stock of alternate fuels. While this is a good strategy on the surface, the government should make sure that stockholding of alternative fuels makes economic sense.

3.2.3 Thailand

- The economy indicates that it could increase natural gas domestic production as a first response to supply shortages. In the case of a gas emergency, the question of the different qualities of gas arises. Gas is not interchangeable, which limits the possible replacement in intra-economy. Hence, the existing East-West gas pipeline is not a suitable emergency infrastructure. The economy has recognised this limitation and is working towards a technical solution that would allow more fuel switching between the different gas qualities.

- Thailand's encouragement for gas-fired power plants to use alternate fuels may make sense as long as the price of the alternate fuels are economically feasible.

3.3. General Observations and Recommendations

3.3.1 Policies

- All economies emphasise to securing supplies from unaffected economies. However, obtaining additional supplies might not be so easy, given the magnitude of the disruption and that many economies and industry participants would be attempting the same thing.

- All economies have well set out policies on how to handle oil and gas emergencies. Some may have benefitted from work undertaken under APEC and ASEAN to raise awareness and expose them to the instruments and policies available to manage emergencies.

- Economies may consider a policy on floating oil price mechanism for "business-as-usual" and during a supply emergency to support faster market response and resolution of supply shortage.

- Economies should consider a staged response to a severe oil supply emergency, as an alternative to implementing all emergency response measures at once.

- Economies may undertake studies on maritime oil supply routes and shipping arrangements during a liquid fuel emergency.

- Each of the participating economies develops a better data collection system. Even though there are provisions for data to be collected from the industry during a liquid fuel emergency, the specifics of data collection systems, for example, which data to collect and how often, is not well developed.

- Map out related policies that have impact on oil and gas disruptions, such as on energy, environment, agriculture, health and safety, and emergency management.

- Need to keep emergency policies as "living policies" and to update regularly, including instruments and institutional set-up, with changing circumstances and lessons learned domestically, regionally and globally. Availability of resources for emergency preparedness, strategic stocks and adequate staffing vary between economies depending on their respective economic development status and competing requests on public resources.

- Develop better-integrated domestic and international gas markets through government policies that support market transparency and supply flexibility. For example, place policy emphasis on enhancing regional gas markets.

- Consider mitigating the impact of the oil and gas scenarios in the long-term by diversifying the energy mix, including low emission energy sources.

3.3.2 Communication Strategy

- Communication strategy was the least discussed by all economies though all economies have communication strategies. Perhaps one learning from the exercise is to have a special session on communication strategy in future OGSEs.

- Invite representatives from media and oil traders to participate in emergency exercise, as this would be helpful to show the different expectations toward communication and the different ways in interpreting the information provided by authorities. This could likewise aid APEC economies shape their emergency communication strategies.

- Monitor company announcements during an emergency and where appropriate, align government messaging to reinforce industry actions. The government must make consistent statements that do not add to public alarm. Further, regular monitoring of commercial downstream oil and gas market is necessary to have a better communication messaging about the emergency and its resolution.

- Engage new market participants and regularly update phone and email emergency contact details.

3.3.3 Institutional Arrangement

- All economies have institutional arrangements that reflect their system and legal frameworks that serve as a guide in dealing and responding to supply emergency.

- Identify all government agencies responsible for policy, monitoring or providing intervention in addressing oil and gas supply disruptions, e.g. energy, treasury, attorney general, environment, health and safety, police and emergency services. If not yet established, set up a national standing group(s) and rehearse the role of each institution and how they work together more effectively. Agree ahead how reliable information is prepared during an emergency and used to support shared recommendations to the government.

- Build capacities of all the agencies involved by sharing and reviewing actual fuel and gas supply-related emergency responses.

- For future OGSEs, it might be good to include electricity security more explicitly to emphasise the importance of cross-sectoral work between institutions and authorities.

3.3.4 Supply Measures

- All economies showed a higher degree of fuel substitution for oil than for gas. Conversely, economies placed more emphasis on domestic solution in gas emergency than for oil.

- Rather than targeting imports from a particular country or region, economies should encourage industry to look for supplies from wherever makes the most economic sense. This is an area where industry has a clear advantage over government intervention.

- Infrastructure limitations were mentioned by all economies for both oil and gas scenarios. As such, the next OSGE might consider initiating some work on critical infrastructure (and funding) as a background analysis for the exercise.

- Any fuel switching away from gas needs to consider the impact on emissions and should consider if any waiver is needed from a legal standpoint.

- Develop a more accurate modelling on gas infrastructure and surge capability since disruption in gas market has an impact on electricity supply.

- Considering the importance of gas in electricity generation, integrate more backup systems into the electrical power grids, to mitigate the impacts of gas disruptions.

- Use of line pack in a natural gas emergency has a positive, but limited impact providing only few days of gas supply. However, gas supply from line pack could buy some time in securing supply from other possible options.

- For the next OGSE, the participating economies must quantify each of the supply response measures to determine the amount or volume of supply that could be generated from these measures, and to see if other measures (demand measures) are still necessary to offset the supply shortfall from disruption.

3.3.5 Demand Measures

- Demand measures constitute a challenge in all economies, as they require painful decisions and rely largely on cooperation from the public. Governments need to be careful in instituting mandatory demand restraint measures to prevent public panic. Once governments activate rationing of oil demand, it is a signal to consumers of how grave the situation is. Creating awareness is one important step and preparing comprehensive communication strategies is advisable for all economies.

  The economies displayed varying assessments about urgent/non-negotiable demand that must be met, reflecting the differences in economic structure and income level. Hence, measures that work in one economy are not necessarily adaptable to another economy. Likewise, consumption patterns for oil and gas vary between economies, thus having an impact on the possible instruments available to deal with a crisis (beyond strategic stocks) also differs.

- Oil demand elasticity is extremely low. Without government intervention, it is difficult to see an economy-wide demand reduction of around 20%, which some of the economies assumed to rebalance the supply impact of the oil disruption scenario. As observed, disruptions in the gas market have an impact on electricity supply, for which it is more difficult to obtain demand restraint. In each economy, assess the volume by which an economy could reduce short-term demand with and without government intervention.

- Demand restraints measures for the private transport sector are particular sensitive and depend on the degree of public transport infrastructure available. Fuel and mode switching is a medium

to long-term option and does require substantial investments. However, certain transport options do allow for switching between oil and gas. From an economic point, market pricing, taxation and the abolition of subsidies might be good starting points to asses demand elasticity, as well as the economic and financial cost of an emergency.

3.3.6 Regional Cooperation

- All economies identified regional cooperation as an important instrument pointed towards APSA and the need to make it operational first before going beyond ASEAN towards an APEC solution. However, APSA may not work as almost all member states will also affected by the global supply disruption scenario.

- Regional cooperation is critical in a global event. Should one economy try to act in opposition of a regional partner, it could lead to a worse situation for both countries.

- Recommend future OGSE gas exercise scenarios consider LNG and natural gas in a global market context, and include seasonal factors.

- Suggest continue to invite a mix of net energy importing/exporting participating economies to test and understand regional energy market dynamics, relationships, and interdependencies.

ANNEX I: AGENDA

Day 1

29 March 2017, Australia Room 1, Novotel Melbourne on Collins

Time	Program
08:30-09:00	**Registration**
09:00-09:10	**Welcome Remarks** Helen Bennett, Assistant Secretary, Energy Security Office
09:10-09:20	**Opening Remarks** Ojimi Takato, President, Asia Pacific Energy Research Centre
09:20-09:50	**Australian Energy Policy** Helen Bennett, Assistant Secretary, Energy Security Office
09:50-10:35	**Oil and Gas Markets: Part 1 Global Market historical Overview** Steven Wilson, Cape Otway Associates
10:35-10:50	**Coffee Break**
10:50-11:35	**Oil and Gas Markets: Part 2 Supply Chain Resilience in the APEC Region** Ian Twomey, Hale and Twomey
11:35-12:00	**Q&A**
12:00-13:00	**Lunch**
13:00-13:30	**Megatrends and the Australian National Outlook and Q&A** Dr. Steven Hatfield-Dodds, CSIRO
13:30-14:15	**Australia's Oil Emergency Response Framework** ▪ **Legislative Structures** ▪ **Operational Context: planning, decision making process, communication protocols** Penny Maher, A/g Assistant Director, Liquid Transport Fuels
14:15:15:00	**Australia's Gas Emergency Response Framework** Chris Marsden, Assistant Manager, Australian Energy Security
15:00-15:30	**Q&A**
15:30-15:45	**Coffee Break**
15:45-16:15	**Key Themes and Lessons from Australia's Approach** Led by Helen Bennett, Assistant Secretary, Energy Security Office
16:15-16:45	**Learnings for APEC Economies** Led by Helen Bennett, Assistant Secretary, Energy Security Office

Day 2
30 March 2017, Australia Room 1, Novotel Melbourne on Collins

Time	Program
08:45-09:00	**Presentation of Oil Supply Emergency Scenario** Michael Ochoada Sinocruz, Senior Researcher, Asia Pacific Energy Research Centre
09:00-09:50	**Presentation of Responses by Participating Economies** Australia and Indonesia (15mins/economy & 10 mins Q&A after each presentation)
09:50-10:05	**Coffee Break**
10:05-10:55	**Continuation of Presentation of Responses by Participating Economies** The Philippines and Thailand (15mins/economy & 10 mins Q&A after each presentation)
10:55-12:15	**Experts Review Team comments and recommendations on emergency responses of participating economies** (10 mins for each expert)
12:15-13:15	**Lunch**
13:15-13:30	**Presentation of Gas Supply Scenario** Fang-Chia Lee, Researcher, Asia Pacific Energy Research Centre
13:30-15:10	**Presentation of Responses by Participating Economies and Comments from Experts** Australia, Indonesia, the Philippines and Thailand (15mins/economy & 10 mins Q&A after each presentation)
15:10-15:25	**Coffee Break**
15:25-16:35	**Experts Review Team comments and recommendations on emergency responses of participating economies** (10 mins for each expert)
16:35-16:50	**Wrap-up Session** Adam Ritchie, AR Oil Consulting
16:50-17:00	**Way Forward** Irie Kazutomo, General Manager, Asia Pacific Energy Research Centre
17:00-17:10	**Closing Statements** Ojimi Takato, President, Asia Pacific Energy Research Centre

Day 3
31 March 2017

Time	Program
08:45-15:00	**Site Visit - Dandenong LNG gas storage facility:** https://goo.gl/4bygX9

ANNEX II: LIST OF PARTICIPANTS

Name	Designation	Organization
Indonesia Delegates		
Mr. Budi Cahyono	Head of Energy Crisis Mitigation Sub Division	Secretariat General of National Energy Council
Mr. Dwi Kusumantoro	Head of Energy Policy Supervision Facilitation Division	Secretariat General of National Energy Council
Mr. Hermawan	Directorate General of Oil and Gas	Ministry of Energy and Mineral Resources
Philippines Delegates		
Ms. Melita Carmen V. Obillo	OIC-Director	Oil Industry Management Bureau, Department of Energy
Ms. Ma. Laura L. Saguin	Chief Science Research Specialist	Natural Gas Management Division, Department of Energy
Thailand Delegates		
Dr. Veerapat Kiatfuengfoo	Director	Petroleum Business Group, Energy Policy and Planning Office, Thailand
Ms. Jomkwan Polak	Plan and Policy Analyst, Professional Level	Office of the Permanent Secretary, Ministry of Energy, Thailand
Australia Delegates		
Ms. Helen Bennett	Assistant Secretary	Energy Security Policy Branch, Energy Security Office, Department of the Environment and Energy
Mr. Chris Marsden	Assistant Director and NGERAC Chair, Australian Energy Security	Energy Security Policy Branch, Energy Security Office, Department of the Environment and Energy
Ms. Penny Maher	A/g Assistant Director, Transport Fuels Security	Energy Security Policy Branch, Energy Security Office, Department of the Environment and Energy
Ms. Victoria Carpenter	Assistant Director, International Energy Security Engagement	Energy Security Policy Branch, Energy Security Office, Department of the Environment and Energy
Mr. Rodrigo Rodrigues	Policy Officer, Transport Fuels Security	Energy Security Policy Branch, Energy Security Office, Department of the Environment and Energy

Name	Designation	Organization
Australia Delegates		
Mr. Adam Ritchie	Founder	AR Oil Consulting
Mr. Stephen Wilson	Director	Cape Otway Associates
Mr. Ian Twomey	Director	Hale And Twomey
Mr. Paul Martin		Resources and Energy Section, Investment and Economic Division, Department of Foreign Affairs and Trade

ANNEX III: LIST OF EXPERTS

Names	Designation	Organization
Ms. Dagmar Graczyk	Senior Energy Analyst, International Energy Agency	International Energy Agency (IEA)
Dr. Phoumin Han	Energy Economist	Economic Research Institute for ASEAN and East Asia (ERIA)
Mr. Christopher Zamora	Manager of ASEAN Plan of Action for Energy Cooperation (APAEC)	ASEAN Centre for Energy (ACE)
Mr. Jun Okunishi	Deputy Director, Petroleum Refining and Reserve Division, Agency for Natural Resources and Energy	Ministry of Economy, Trade and Industry (METI)
Mr. Douglas MacIntyre	Associate Deputy Assistant Secretary for the Office of Petroleum Reserves in the Office of Fossil Energy	Department of Energy (DOE), United States
Dr. Ken Koyama	Chief Economist and Managing Director	Institute of Energy Economics, Japan (IEEJ)
Ms. Robyn Casey	A/g Assistant Secretary Australian Representative to the IEA Standing Committee on Technical Questions (SEQ)	International Energy Implementation Branch, Energy Security Office, Department of the Environment and Energy

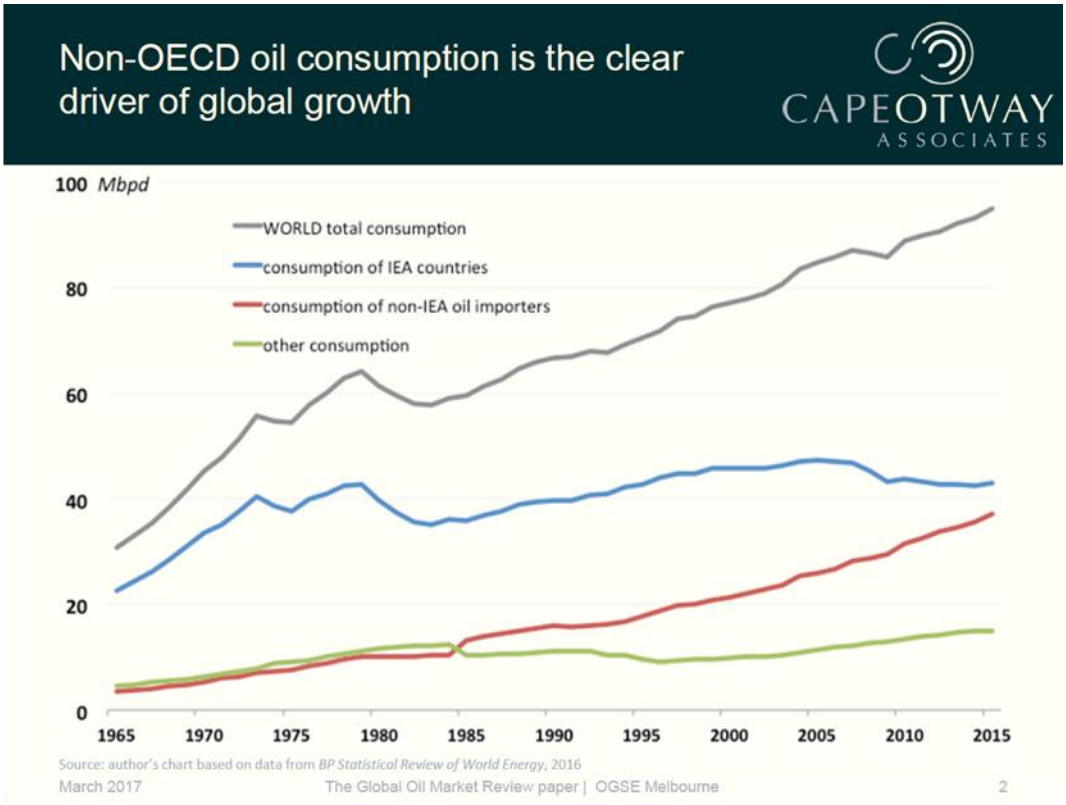
ANNEX IV: PRESENTATIONS OF CONSULTANTS

Global Market historical Overview by: Steven Wilson, Cape Otway Associates

CAPEOTWAY
ASSOCIATES

Oil markets have changed enormously since the first oil shock of 1973-74.

—International Energy Agency, 2014


Non-OECD oil consumption is the clear driver of global growth
CAPEOTWAY ASSOCIATES
100 Mbpd
80
60
40
20
0
WORLD total consumption
consumption of IEA countries
consumption of non-IEA oil importers
other consumption
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Source: author's chart based on data from BP Statistical Review of World Energy, 2016
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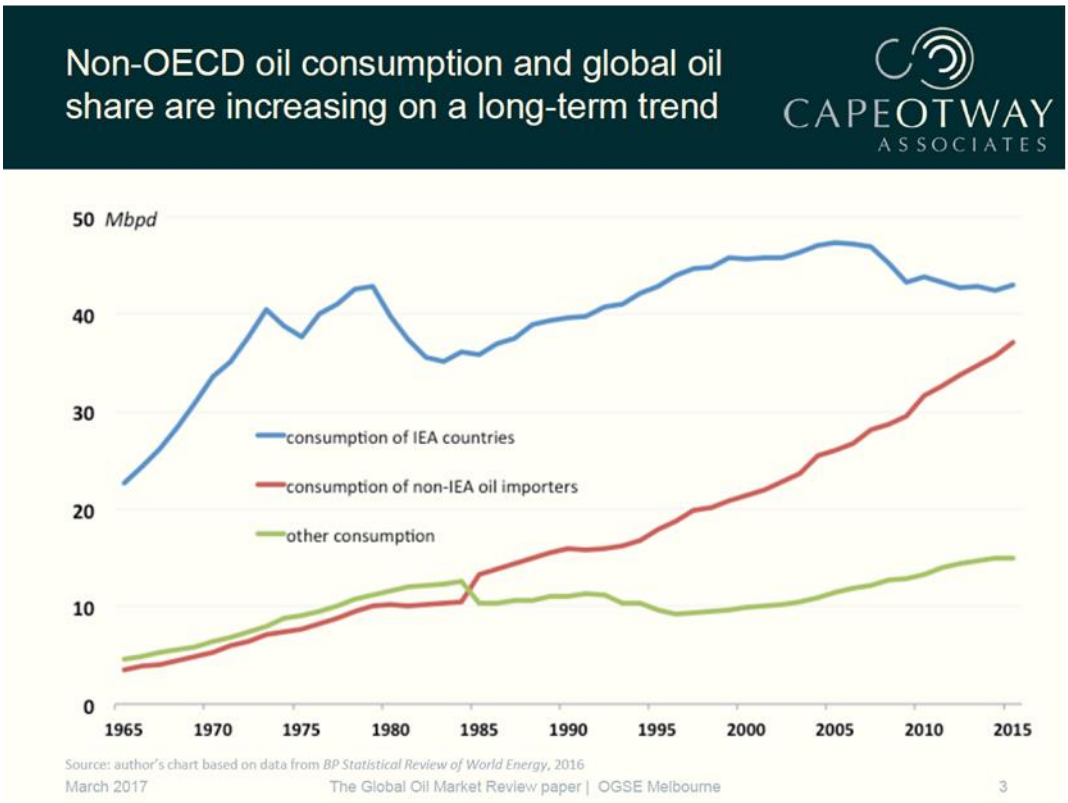
Non-OECD oil consumption and global oil share are increasing on a long-term trend
CAPEOTWAY ASSOCIATES
50 Mbpd
40
30
20
10
0
consumption of IEA countries
consumption of non-IEA oil importers
other consumption
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Source: author's chart based on data from BP Statistical Review of World Energy, 2016
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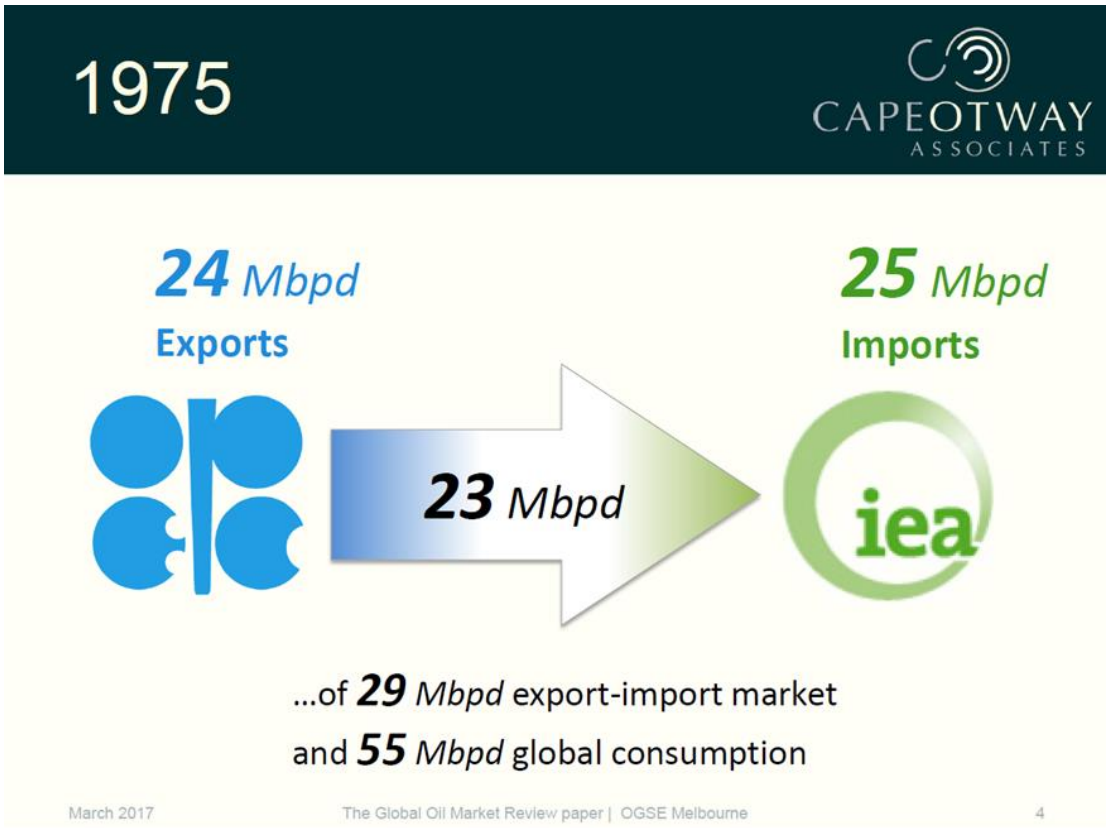
1975
CAPEOTWAY ASSOCIATES
24 Mbpd
Exports
25 Mbpd
Imports
23 Mbpd
iea
...of 29 Mbpd export-import market
and 55 Mbpd global consumption
March 2017
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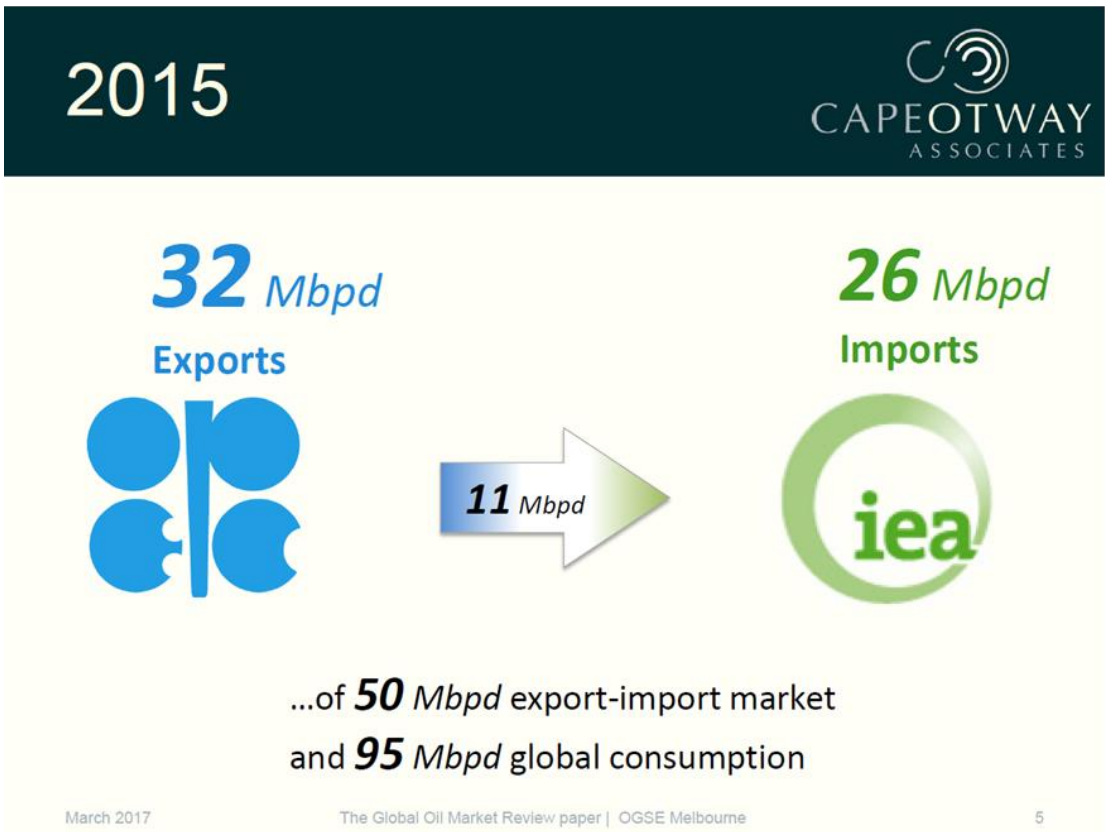
4


2015
CAPEOTWAY ASSOCIATES
32 Mbpd
Exports
26 Mbpd
Imports
11 Mbpd
iea
...of 50 Mbpd export-import market
and 95 Mbpd global consumption
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Crude oil and liquids trade flows, 1975 as a share of global net imports

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Net Exports / Net Imports *Mbpd*	OPEC Saudi+...	Non-OPEC Russia+...	TOTAL
OECD EU, US, Japan	23 *Mbpd* *80%*	2 *Mbpd* *6%*	25 *Mbpd* *86%*
Non-OECD Miscellaneous	1 *Mbpd* *3%*	3 *Mbpd* *11%*	4 *Mbpd* *14%*
TOTAL	24 *Mbpd* *83%*	5 *Mbpd* *17%*	29 *Mbpd* *100%*

Source: Author's estimates using data from the BP *Statistical Review of World Energy*, 2016

Crude oil and liquids trade flows, 2015 as a share of global net imports

CAPEOTWAY ASSOCIATES

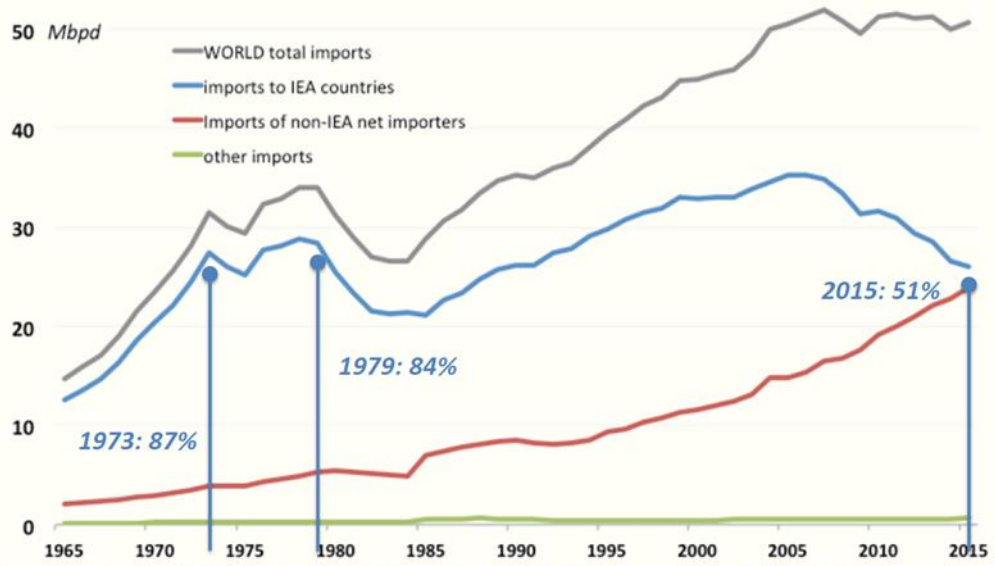
Net Exports / Net Imports *Mbpd*	OPEC Saudi+...	Non-OPEC Russia+...	TOTAL
OECD Japan, EU, US +...	11 *Mbpd* *22%*	15 *Mbpd* *30%*	26 *Mbpd* *52%*
Non-OECD China, India, ASEAN +...	21 *Mbpd* *43%*	3 *Mbpd* *5%*	24 *Mbpd* *48%*
TOTAL	32 *Mbpd* *65%*	18 *Mbpd* *35%*	50 *Mbpd* *100%*

Source: Author's calculations using data from the BP *Statistical Review of World Energy*, 2016

'The world of rich nations is just beginning to realise it no longer dominates energy markets'

CAPEOTWAY ASSOCIATES

OMR Figure 69 Oil imports by OECD and non-OECD countries 1965-2015

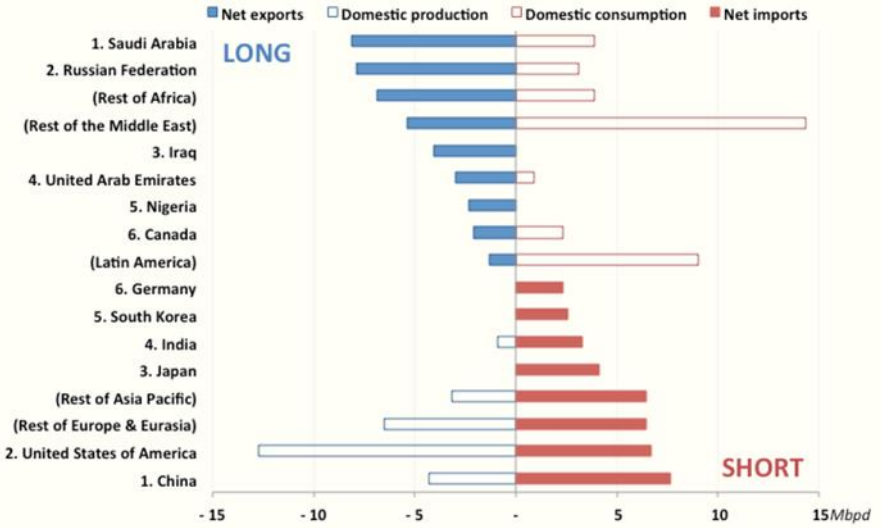


Sources: quote from Pascual C (2015) *The New Geopolitics of Energy*, Columbia University School of International and Public Affairs (SIPA) Center on Global Energy Policy (CGEP), New York, September; author's chart based on data from *BP Statistical Review of World Energy*, 2016

Global oil production-consumption and import-export balance, 2015

CAPEOTWAY ASSOCIATES

OMR Figure 4



Source: Author's calculations using data from the BP Statistical Review of World Energy, 2016

Note: For net exporters, domestic consumption is shown, accounting for the balance of their production. For net importers, domestic production is shown, accounting for the balance of their consumption. Hence the total length of the bar for net exporters represents their total production and the total length of the bar for net importers represents their total consumption.

APEC economies are playing an increasingly large role in oil markets

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Australia's oil production, consumption and imports, 1965-2015

OMR Figure 7

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Sources: Author's calculations using data from the BP *Statistical Review of World Energy*, 2016

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DIVERSIFICATION: Oil has a smaller share of the fuel mix in the global economy than in the 1970s

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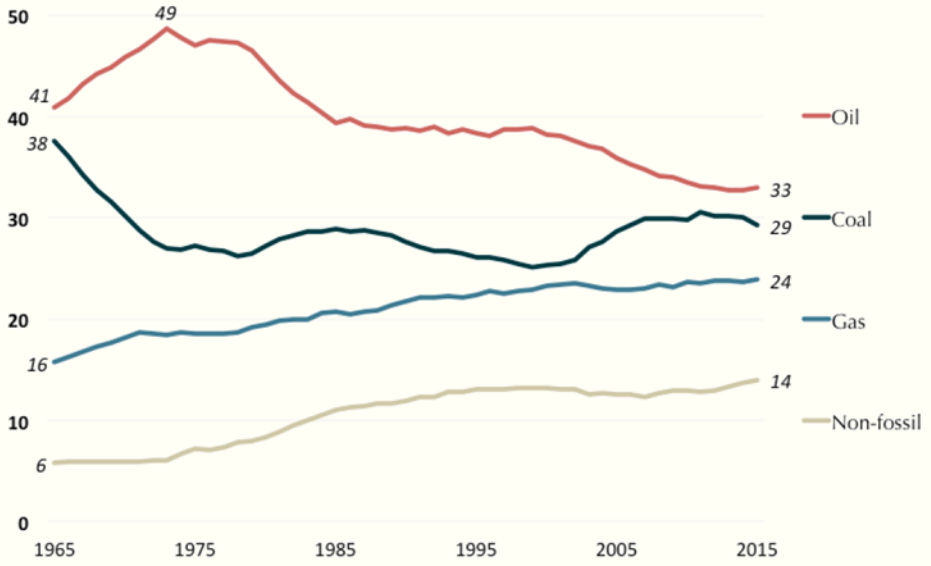
OMR Figure 47 Shares of world primary energy supply, 1965-2015



Source: BP, Statistical Review of World Energy, 2016

Resilience of the energy system

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Resilience can come from many factors, including:

- sufficient spare **production capacity**
- **strategic reserves**
- **backup equipment** supplies
- adequate **storage capacity** along the supply chain
- the stockpiling of **critical parts** for electric power production and distribution
- carefully conceived **plans** for responding to disruptions that may affect large regions

Physical and financial oil markets are now large, deep and liquid

OMR Figure 21

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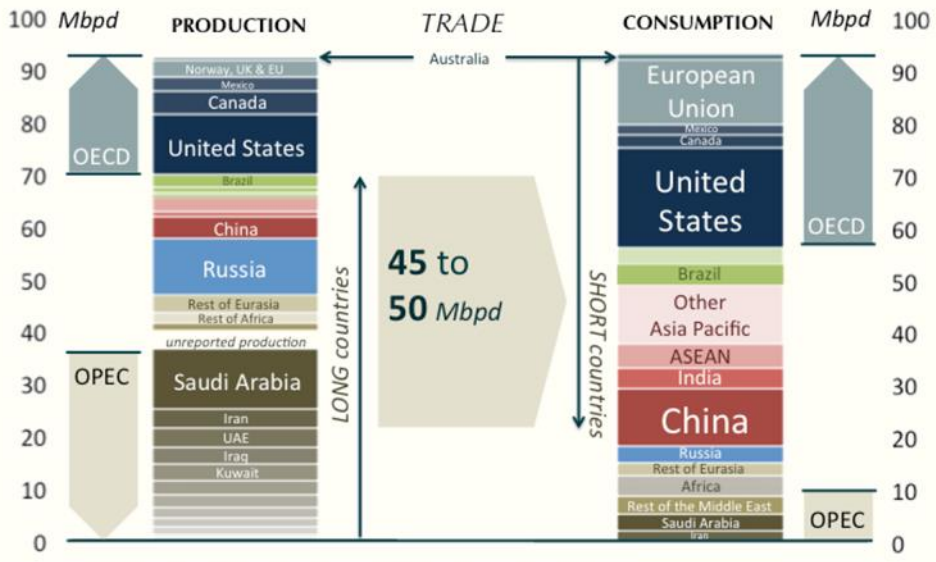
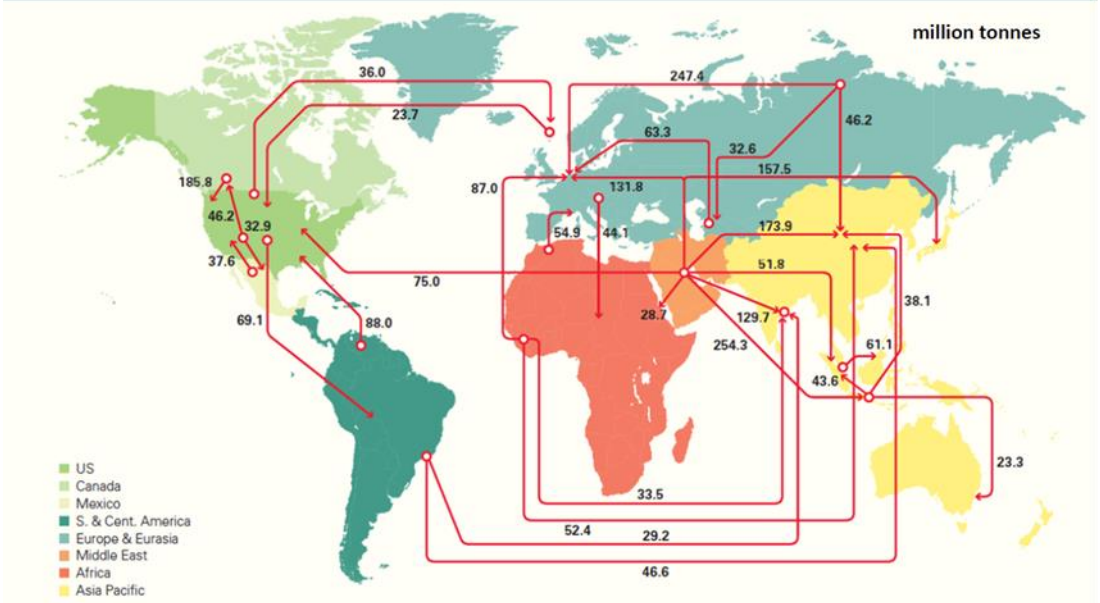


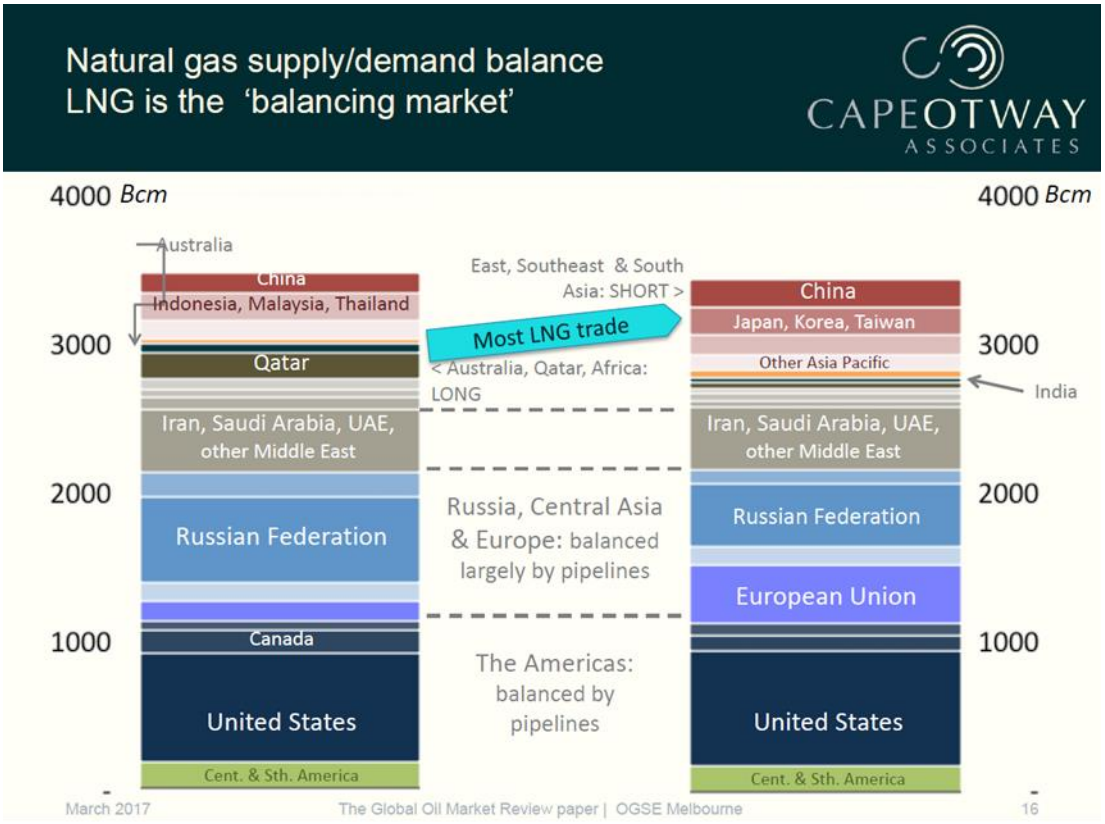
Sources: Author's calculations using data from the BP *Statistical Review of World Energy*, 2016

World OIL Trade Flows
—major pipeline and tanker movements, 2015

CAPEOTWAY ASSOCIATES



Sources: BP *Statistical Review of World Energy*, 2016


Natural gas supply/demand balance
LNG is the 'balancing market'
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4000 Bcm
4000 Bcm
Australia
China
Indonesia, Malaysia, Thailand
Qatar
Iran, Saudi Arabia, UAE, other Middle East
Russian Federation
Canada
United States
Cent. & Sth. America
East, Southeast & South Asia: SHORT >
Most LNG trade
< Australia, Qatar, Africa: LONG
Russia, Central Asia & Europe: balanced largely by pipelines
The Americas: balanced by pipelines
China
Japan, Korea, Taiwan
Other Asia Pacific
India
Iran, Saudi Arabia, UAE, other Middle East
Russian Federation
European Union
United States
Cent. & Sth. America
3000
2000
1000
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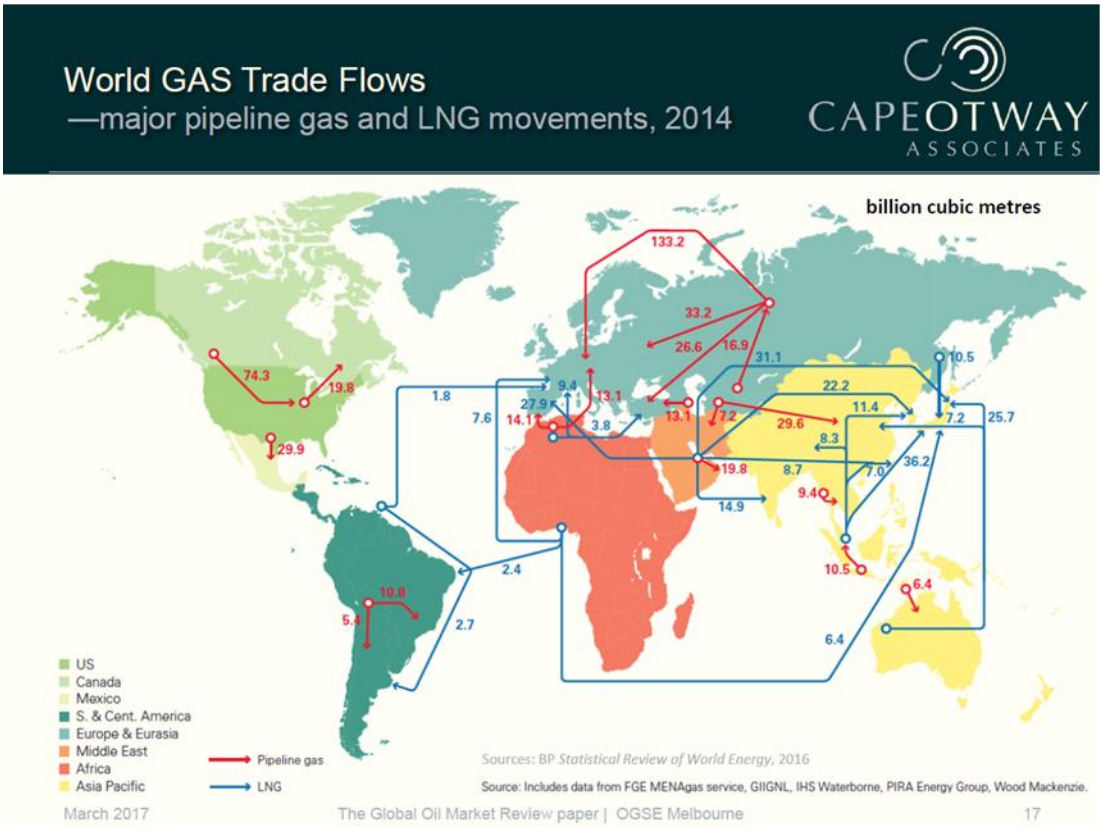
World GAS Trade Flows
—major pipeline gas and LNG movements, 2014
CAPEOTWAY ASSOCIATES
billion cubic metres
133.2
33.2
26.6
16.9
31.1
10.5
74.3
19.8
29.9
1.8
7.6
27.9
14.1
9.4
13.1
3.8
13.1
7.2
22.2
11.4
29.6
8.3
7.2
25.7
19.8
8.7
7.0
36.2
9.4
14.9
10.5
6.4
2.4
10.8
5.4
2.7
6.4
US
Canada
Mexico
S. & Cent. America
Europe & Eurasia
Middle East
Africa
Asia Pacific
Pipeline gas
LNG
Sources: BP Statistical Review of World Energy, 2016
Source: Includes data from FGE MENAgas service, GIIGNL, IHS Waterborne, PIRA Energy Group, Wood Mackenzie.
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The market is far more mature than in 1973 and now includes financial oil risk management tools

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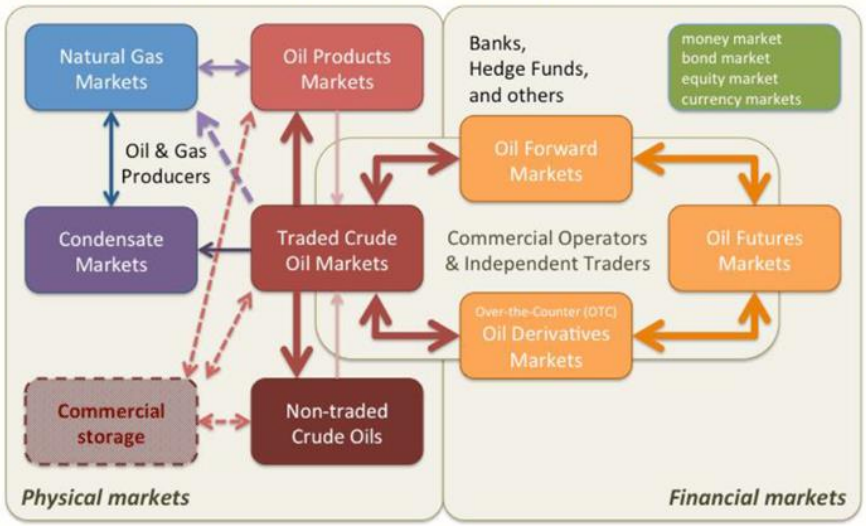
OMR Figure 22

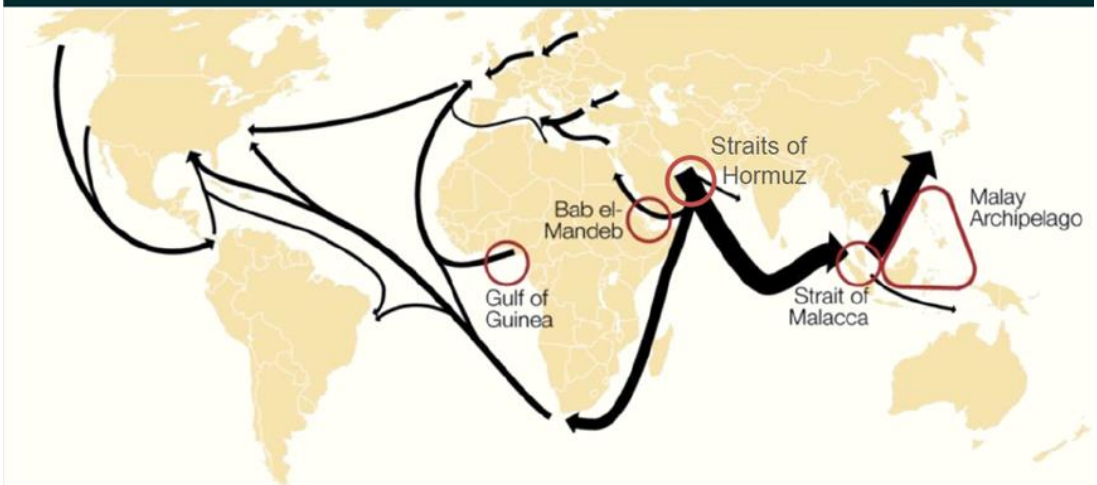
The interconnections between physical and financial markets for oil



Source: Author's chart, adapted from Luciani (2010)

Protection of the oil supply chain
—maritime oil choke points

CAPEOTWAY ASSOCIATES



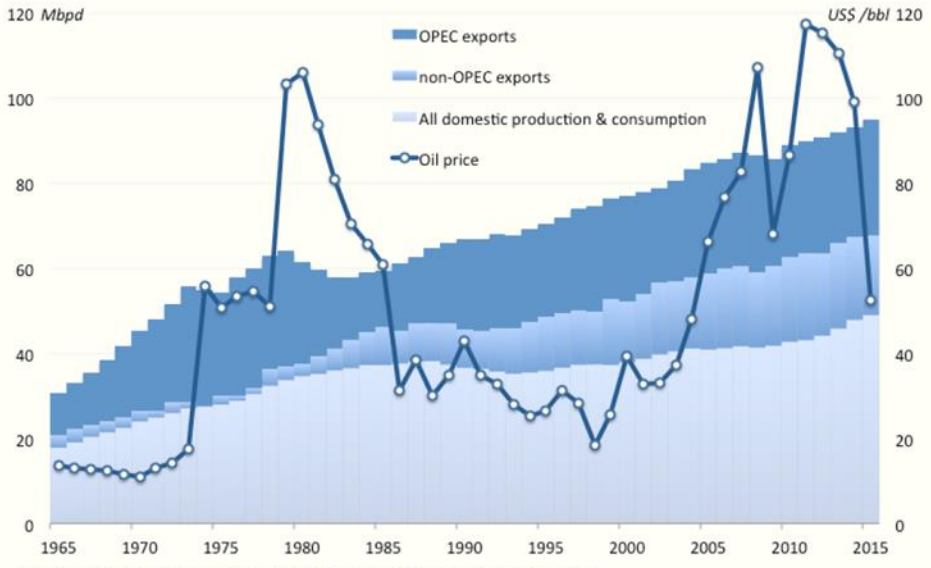
This map shows major oil shipping routes and maritime choke points

For some countries, oil pipelines are equally important

History of oil consumption, imports and prices 1965-2015

OMR Figure 1

CAPEOTWAY ASSOCIATES

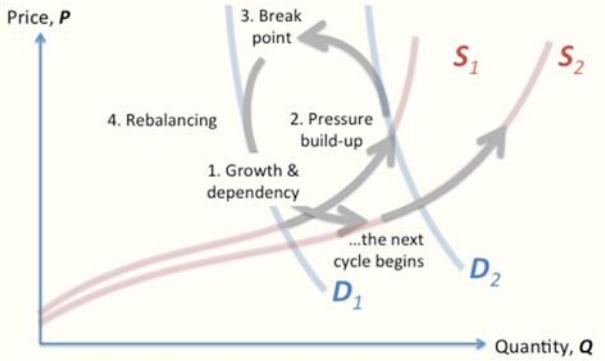


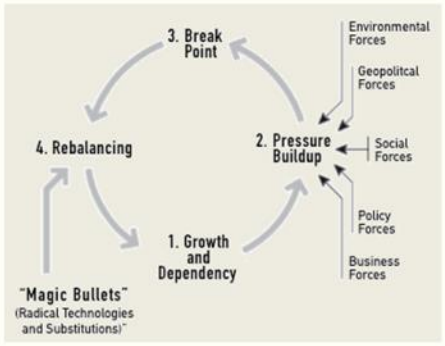
Source: Author's calculations using data from the BP *Statistical Review of World Energy*, 2016

The shale revolution is expected to continue to ease global pressures on new oil supply and prices

OMR Figure 39

CAPEOTWAY ASSOCIATES





	First oil shock	Second oil shock	China Boom-GFC	Quantitative Easing
Growth and dependency	Pre-1970	1976-77	2002-05	2010-11
Pressure build-up	1971-73	1978	2006-08	2012-13
Break-point	1973-74 price shock	1979-80 price shock	2008 price peak	2014 end of rebound
Rebalancing	1975 pause	1981-2001 inflation erosion	2009 price crash	2015-... price collapse...

Source: Adapted by the author from Peter Tertzakian, 2007, *A Thousand Barrels a Second: The Coming Oil Break Point and the Challenges Facing an Energy Dependent World*, McGraw-Hill, Figure 1.1

Learning from the past as we look to the future (1)

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Analysis undertaken for the Oil Market Report found that there were a range of factors that influenced major oil security events in the past.

- Supply shocks are not the main explanation of the price shocks
- A demand surge was important in the 1970s as well as in the 2000s
- The energy evolution cycle is evident in the events of both periods
- The market today has shown its ability to rebalance very effectively

Government efforts to manage the oil market by emergency rationing in the 1970s failed

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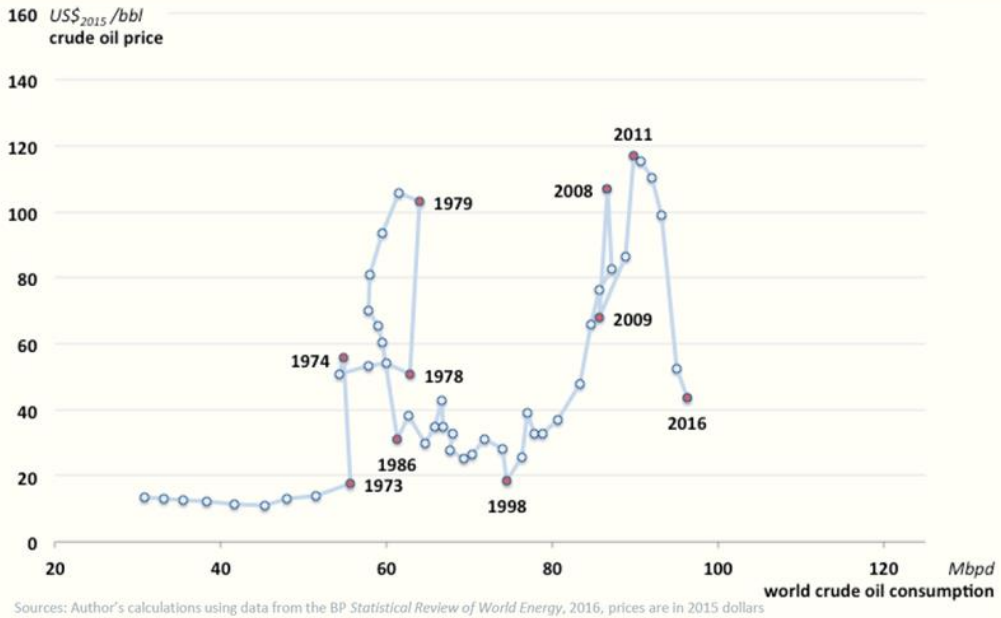
OMR Figure 13, 40 Evolution of world crude oil consumption and prices, 1965-2015



Sources: Author's calculations using data from the BP *Statistical Review of World Energy*, 2016, prices are in 2015 dollars

WEO 2016 scenarios and historical context —oil prices and quantities

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Learning from the past as we look to the future (2)

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The 'first oil shock' was :
smaller than more recent disruptions
but caused **larger** 'ripples'

WHY?

There are many reasons (see the *Oil Market Report*) including:

- Greater economic dependence on oil than today
- A far less developed market: hardly what we mean by a 'market' today
- Lack of data and weaker understanding of oil economics than today
- PANIC (by policy-makers and the public) and poor policy responses
- Misguided ideas, particularly on oil scarcity and Cold War geopolitics

Suggested reading: Roger Stern (2013) *Oil Scarcity Ideology in US National Security Policy, 1909-1980*, Working Paper #105, February, Freeman Spogli Institute for International Studies, Stanford University

The 'first oil shock' was smaller than more recent disruptions but caused larger 'ripples'

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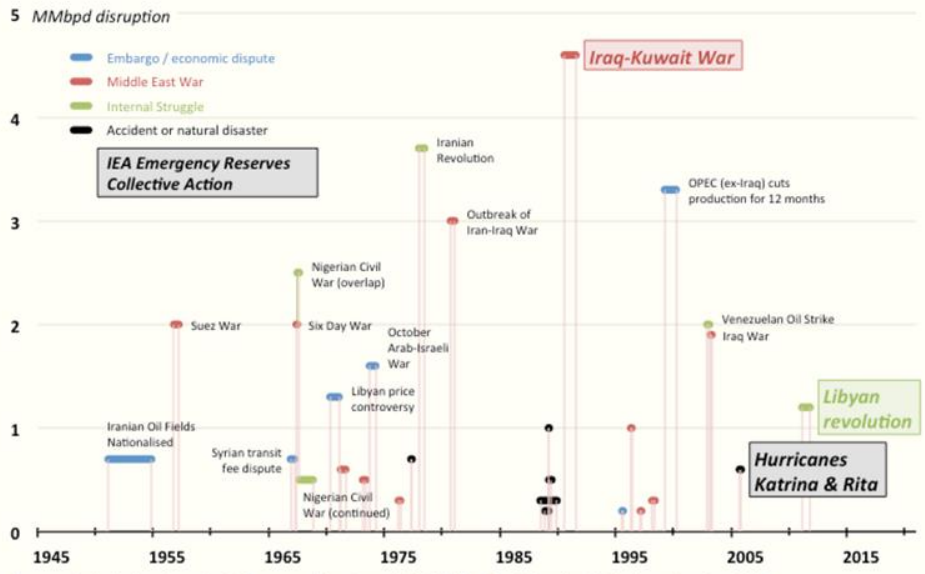
OMR Figure 50a Timeline of oil supply disruptions and IEA collective actions

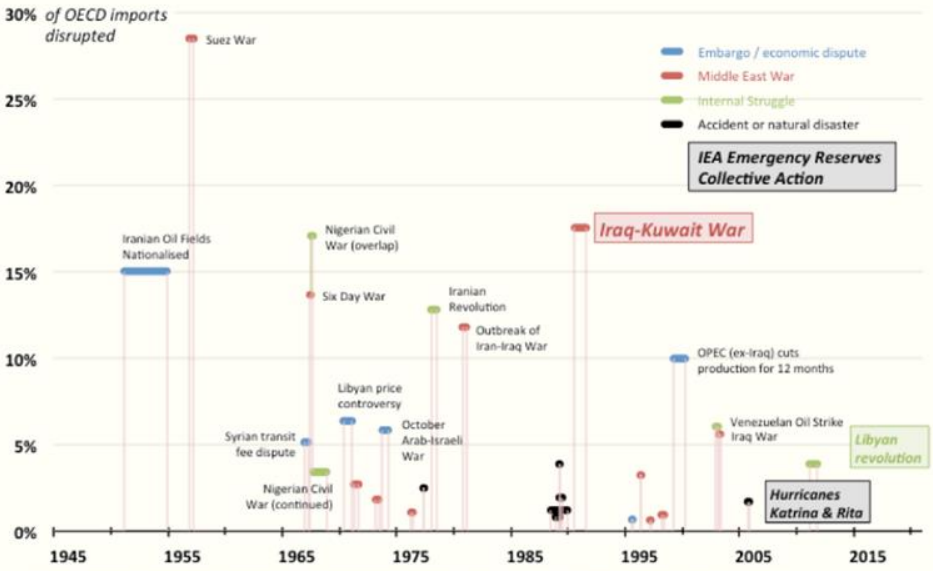


Sources: Author's chart from data in Beccue and Huntington (2005), Table E.1, p.55, updated with disruptions since 2005

The 'first oil shock' was smaller than more recent disruptions but caused larger 'ripples'

CAPEOTWAY ASSOCIATES

OMR Figure 50b Timeline of oil supply disruptions and IEA collective actions



Sources: Author's chart from data in Beccue and Huntington (2005), Table E.1, p.55, updated with disruptions since 2005

In the 1970s there was an oil industry but 'the oil market' as we know it today did not yet exist

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- No financial futures market or options market in the 1970s
- Oil production was regulated
- Prices were fixed in nominal dollar terms for extended periods
- Forward contract prices were 'posted' after agreement between national and international oil companies.
- There was no spot market referenced to benchmark prices
- The Bretton Woods system of dollar-gold exchangeability and fixed currency exchange rates was in place until August 1971
- Today's deep and liquid markets in currencies, commodities and financial derivatives, were developed during the 1970s and 1980s

Oil supply disruptions occur continually and are mostly managed well by the market

OMR Figure 49

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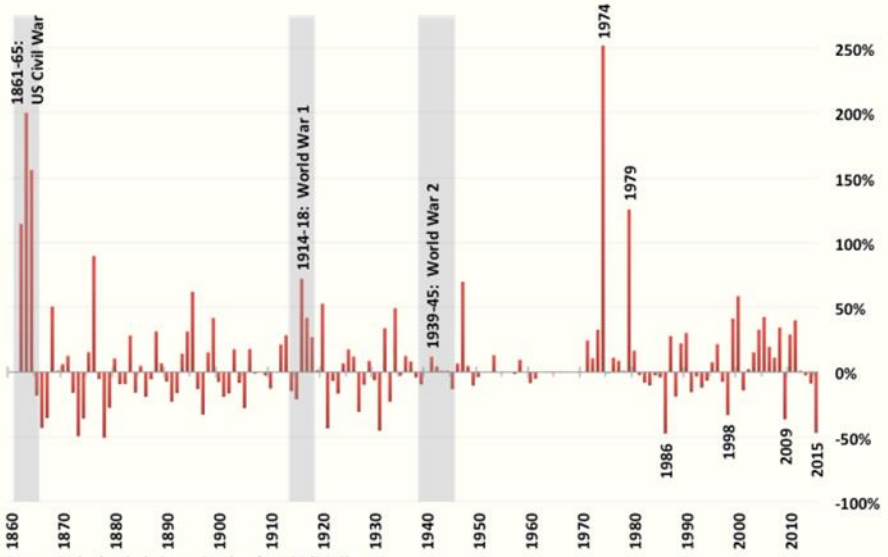
Year-on-year changes in the nominal price of crude oil



Source: Author's calculations using data from BP (2016)

Long history of annual average crude oil prices in nominal and real US dollar terms

OMR Figure 63

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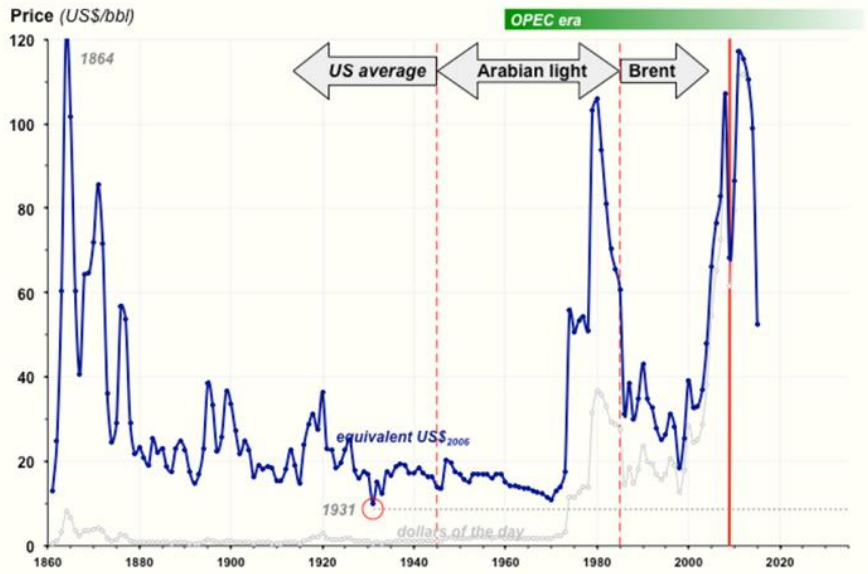
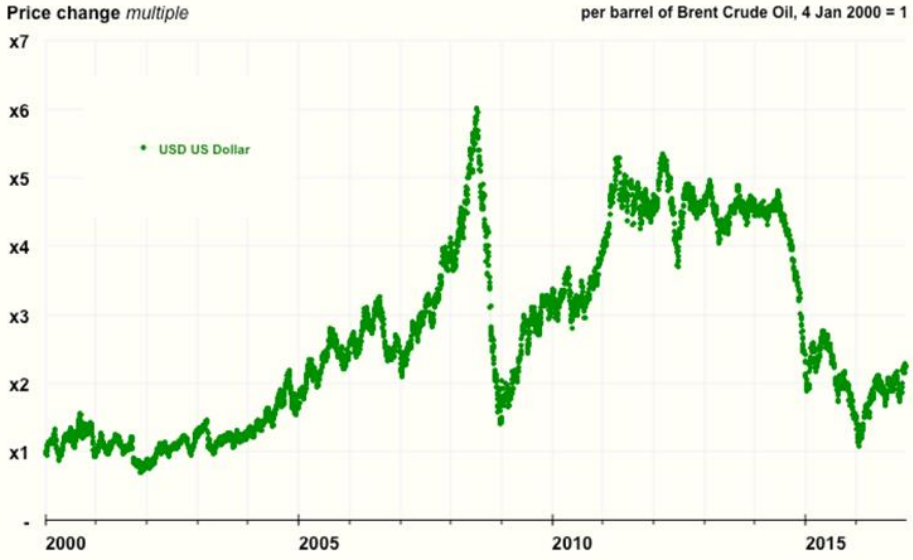


Sources: Author's chart using price data from BP (2016)

Brent crude oil daily nominal prices relative to January 2000 in US dollars

OMR Figure 60, updated

CAPEOTWAY ASSOCIATES

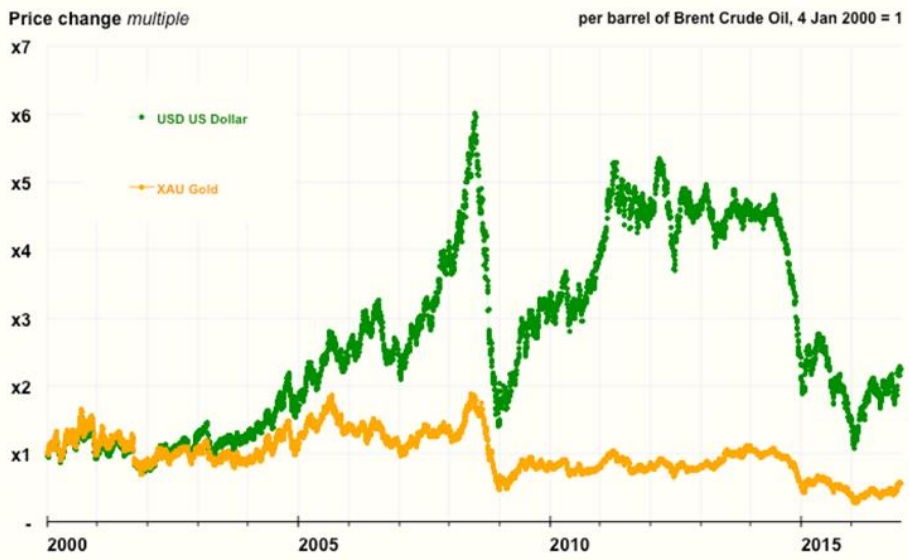


Sources: Author's calculations using oil price data from the United States EIA and currency data from *www.fxtop.com*

Brent crude oil daily nominal prices relative to January 2000 in US dollars and gold

OMR Figure 62, updated and modified

CAPEOTWAY ASSOCIATES



Sources: Author's calculations using oil price data from the United States EIA and currency data from *www.fxtop.com*

OPEC and non-OPEC supply disruptions

OMR Figure 33

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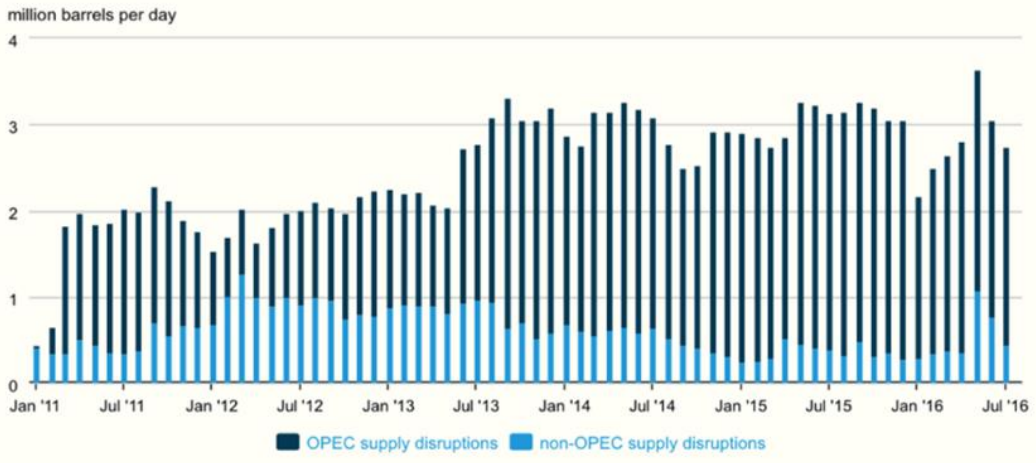
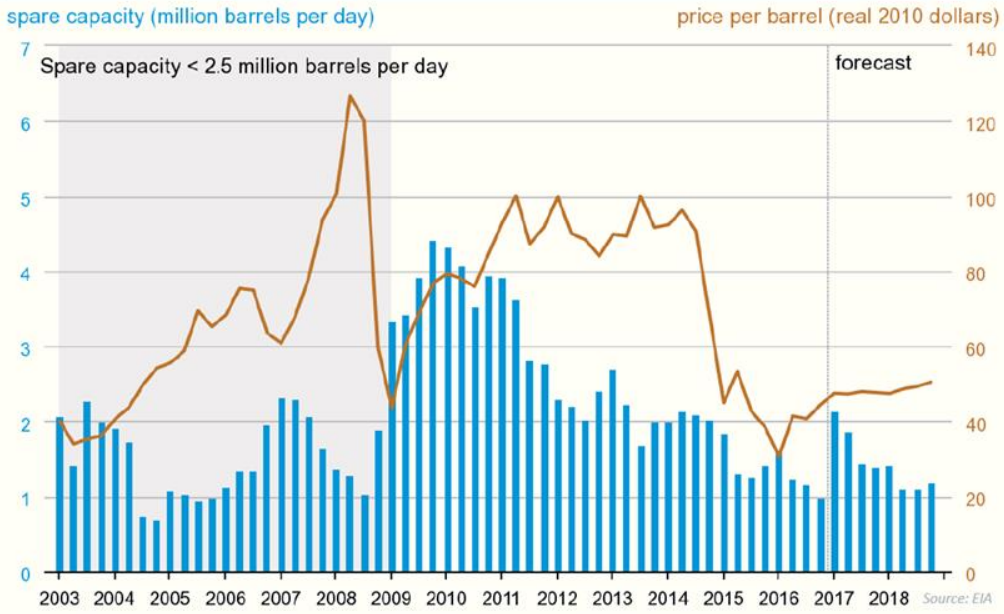


Source: *Published by United States Energy Information Administration | Updated monthly, Last Updated 9 August 2016. EIA (2016), 'Unplanned supply disruptions tighten world oil markets and push prices higher' www.eia.gov/finance/markets/supply-opec.cfm accessed 5 October 2016*

OPEC spare production capacity and WTI crude oil prices

OMR Figure 35, updated

CAPEOTWAY ASSOCIATES



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Financial risk management is now larger and more sophisticated than emergency systems

OMR Figure 23

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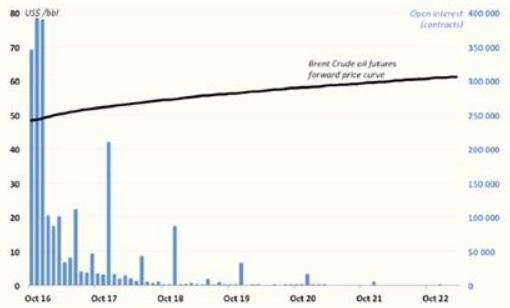

Global crude oil and liquids round numbers:

- **~95** *Mbpd* production & consumption
- **>45** *Mbpd* international trade
- **50** *per cent* in 3-month window
- **80** *per cent* in 12-month window
- **100** *per cent* in 6-year window
- **45** *Mbbl* sample day traded volume

Note: Each contract (the minimum tradable size) is 1000 barrels
Source: Wall Street Journal, online market data, available by subscription at quotes.wsj.com/futures accessed 16 Aug 2016

Daily trade	Futures	Open int.	of Consumption		Physical		of Global	of Imports
Million bbl		*billion bbl*	*= days*		*@ Mbpd*		*= days*	*= days*
15	Brent	**2.20**	**29**	of non-US	**76**	liscus	**23**	**50**

OECD incremental inventories are at record high levels

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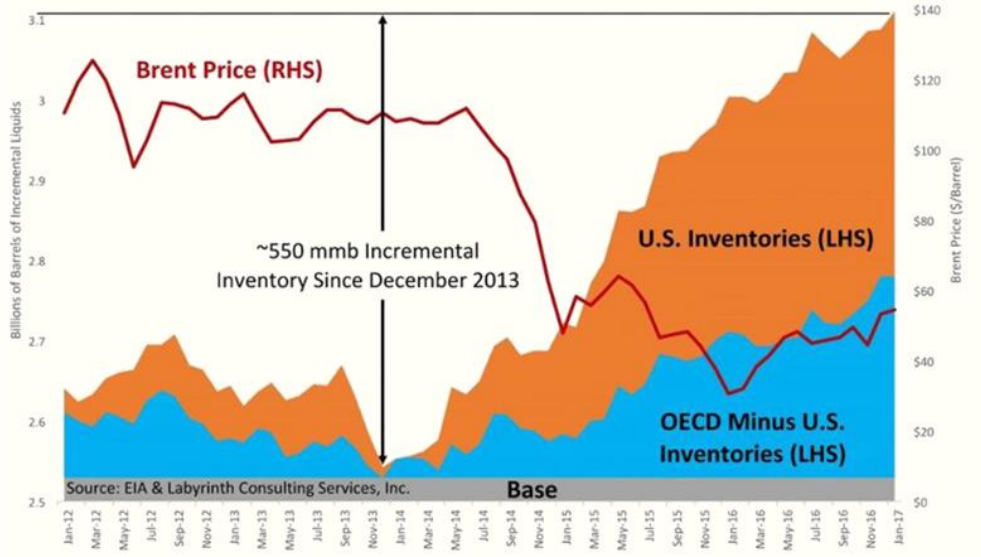

Sources: EIA and Labyrinth Consulting Services, Inc, Art Berman, 'Oil Price Plunge Is An Overreaction, But It May Also Be A Turning Point', *https://www.forbes.com/sites/arthurberman/2017/03/09/oil-prices-plunge-over-reaction-or-turning-point/2/#49d76aff71ce*

Changes in the market have made it far more transparent and supply is better at rebalancing

OMR Figure 58 Comparison of supply side contributors to oil market balancing

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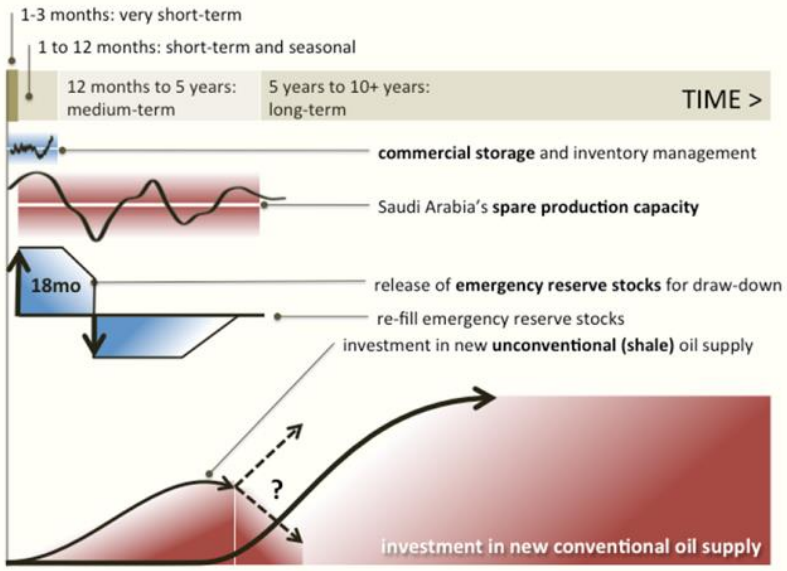

Sources: Author's chart, with examples broadly based on data for the period 2011 to 2015

Phases in the United States light tight oil industry (horizontal drilling and shale oil fracking)

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OMR Table 8

Phase	Dates	Rigs	WTI Price	Response	Correl[n]	Actual Lag
		count	(note a) *US$ /bbl*	*Rigs per $10 price change*	(note b) R^2	(note c) *days (weeks)*
Start of data series	4 Jan 1991…	100	25 (30)	—	—	—
1. Experimentation	…24 Nov 2006	302	60 (77)	**+42**	0.90	133 (19)
2. Persistence	…11 May 2007	372	62 (52)	+20 (b)	0.58	112 (16)
Shale GAS boom:						
3. Price spike	…31 Oct 2008	650	68 (142)	**+33**	0.92	119 (17)
4. GFC collapse	…22 May 2009	375	61 (33)	–26	0.97	154 (22)
Shale OIL boom:						
5. Boom	…24 Oct 2014	1 355	81 (107)	**+145**	0.79	133 (19)
6. Retracement	…27 May 2016	314	49 (29)	–148	0.93	105 (15)
New era:						
7. Recovery	...23 Sep 2016	402	43	**+44**	0.88	—

Source: author's analysis. Notes:
(a) The prices in brackets are the price at the turning point (price peak or price bottom) prior to the rig count turning point.
(b) The lag used for all of the correlations is the WTI price 17 weeks earlier.
(c) The actual lags from each price turning point to the subsequent rig turning point varied from 15 to 22 weeks

The risk of intentional or 'strategic' supply disruption by oil exporting countries is now much lower

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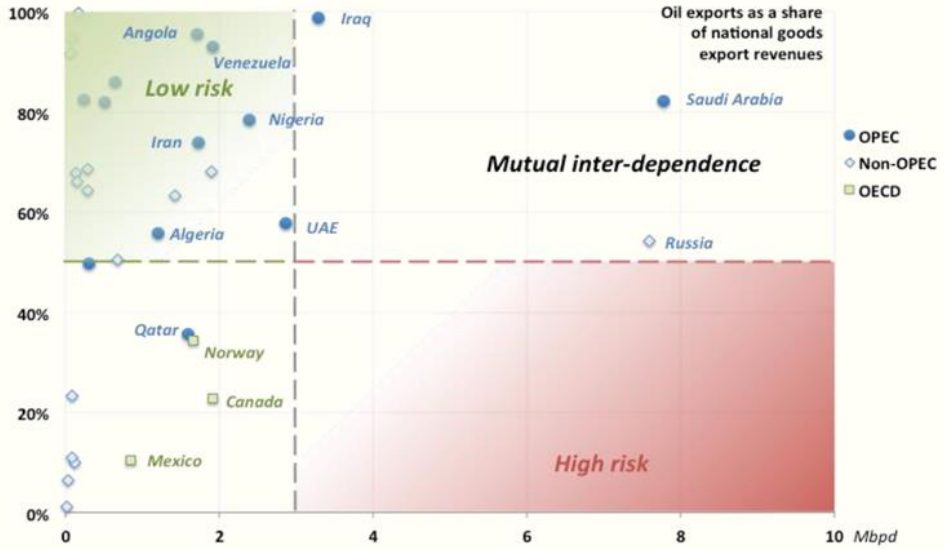
OMR Figure 11 Oil export revenue dependence of selected key countries, 2014



Source:Author's calculations of exports using country oil production and consumption data from BP, Statistical Review of World Energy, 2016; country trade data from MIT, Observatory of Economic Complexity, http://atlas.media.mit.edu/en/

In 2015, oil at the same real price levels as 1975 is more affordable relative to GDP

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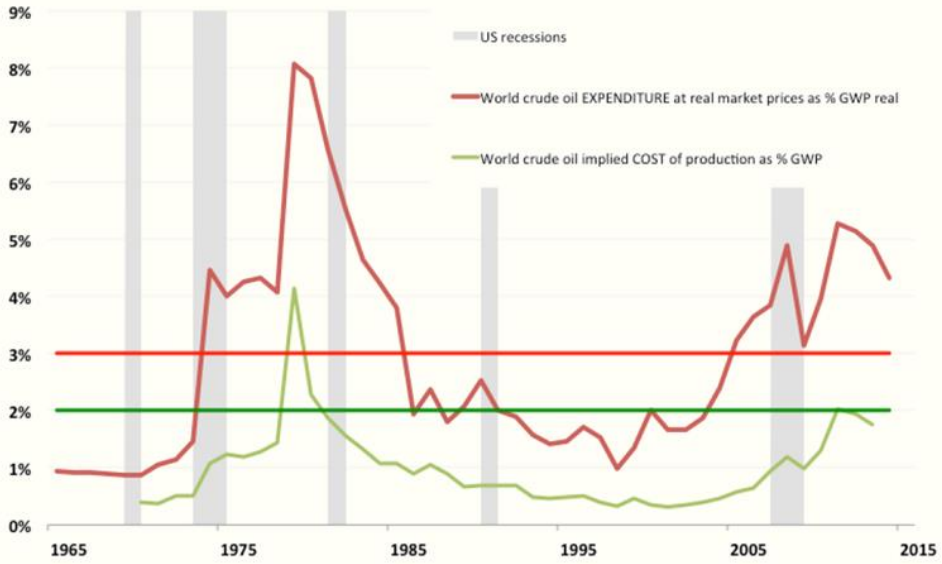
OMR Figure 67 World crude oil expenditure and implied cost of production as share of GWP



Sources: Author's calculations using data from the BP Statistical Review of World Energy, 2016, The World Bank and the Federal Reserve Bank of St Louis (2016)

Shifts in the priority of policy concerns since World War 2

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OMR Table 11

Demand centre:	**America**	**Atlantic basin**	**Transition east**	**Indo-Pacific**
Approximate period	**1945-1973**	**1974-1999**	**2000-2015**	**2016-…**
Dominant policy priorities: this is a highly simplified summary of the major themes of each era	**Price**: low and stable prices played a key role in post-war recovery. Security was a lesser issue.[a] Environment not yet a concern.	**Security** again pre-eminent, followed by price, which was gradually displaced by the environment	**Environment** became a headline concern in the West. In the East, price was increasingly overtaken by supply security concerns	Increasingly complex **3-way tension**: security, environment, and price
Demand dominated by	US, EU + Japan	OECD	Non-OECD	Non-OECD Asia
Imports dominated by	Europe	Europe + US	Europe + US	China (+India)
Exports dominated by	Concessionaires	OPEC	OPEC	OPEC (?)
Supply most *influenced* by	US & OECD	OPEC…NOCs	…US shale…	***key uncertainty***
Oil price set by	'Seven Sisters' posted prices / balanced in Texas with TRC regulation	OPEC posted prices…then benchmarks and futures trading, OPEC balancing	Price discovery in a mature market balanced by OPEC	Market forces with questions about OPEC's role in balancing
Global monetary system	Bretton Woods	Floating USD	…under stress	RMB enters SDR

Sources: Author's analysis

Oil pricing eras and transition periods —a 200-year perspective

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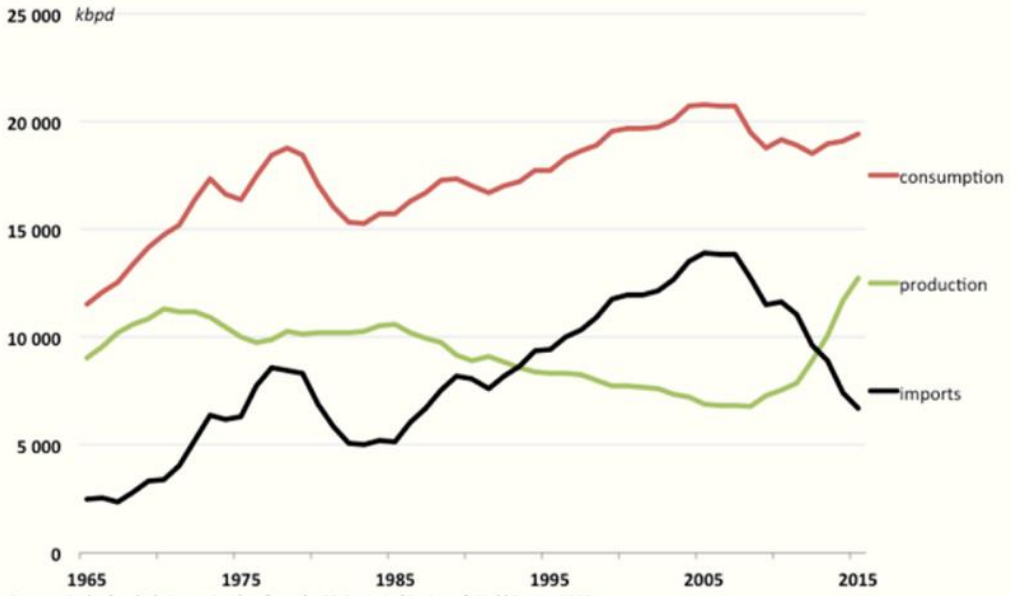
The United States' oil production, consumption and imports, 1965-2015

OMR Figure 10

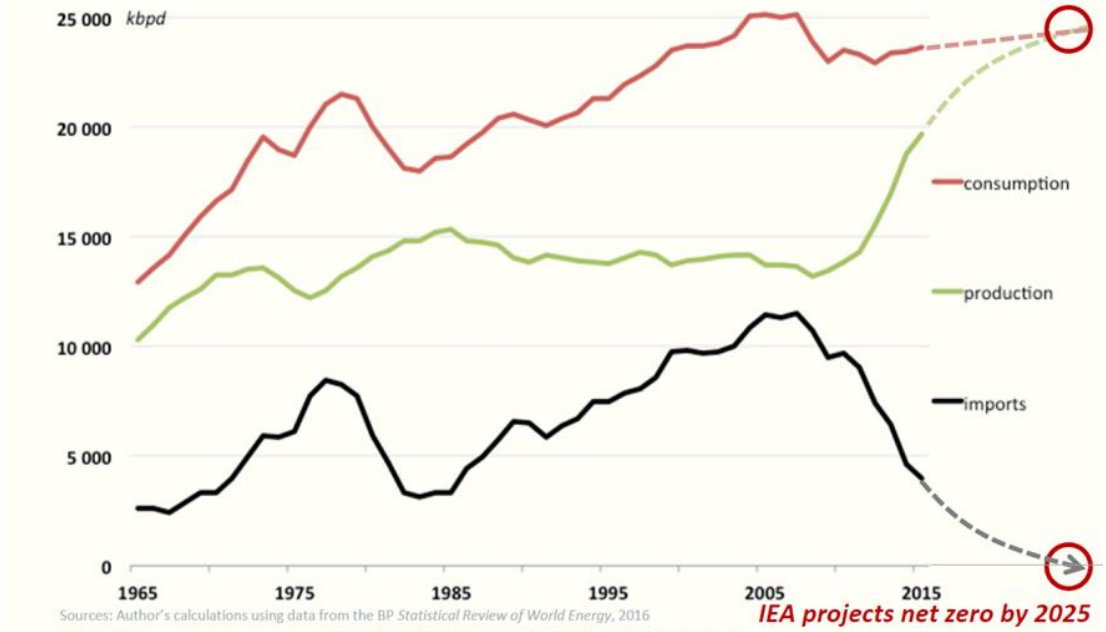
CAPEOTWAY ASSOCIATES



Sources: Author's calculations using data from the BP *Statistical Review of World Energy*, 2016

North American oil production, consumption and imports, 1965-2015

CAPEOTWAY ASSOCIATES



Sources: Author's calculations using data from the BP *Statistical Review of World Energy*, 2016

Existing global energy governance structure

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Coordination mechanisms

iea

oil importers

oil exporters

Legal and protocol mechanisms

UNFCCC
Kyoto Protocol
Paris Agreement

WTO

Energy Charter Treaty

Discussion and cooperation platforms

G20

IEF INTERNATIONAL ENERGY FORUM

CLEAN ENERGY MINISTERIAL
Accelerating the Global Clean Energy Transition

Other regional organisations

APEC Asia-Pacific Economic Cooperation

APERC Asia Pacific Energy Research Centre

TEN PRINCIPLES of energy security

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1. **Diversification** of supply: Churchill's 'variety' principle
2. **Resilience**: a "security margin" (1)
3. **Integration**: the reality of which needs to be recognised
4. **Information**: high quality information underpins well-functioning markets
5. **Globalisation**: engaging China and India
6. **Protection**: of the entire energy supply chain globally (2)
7. **Interdependence**: require continuing producer-consumer collaboration
8. **Co-ordination**: international national, companies and governments
9. **Markets**: need to be recognised as a source of security in themselves
10. **Flexibility**: easing regulatory and environmental constraints in emergencies

(1) "Resilience can come from many factors, including sufficient spare production capacity, strategic reserves, backup supplies of equipment, adequate storage capacity along the supply chain, and the stockpiling of critical parts for electric power production and distribution, as well as carefully conceived plans for responding to disruptions that may affect large regions."
(2) Including monitoring maritime choke-points and pipelines.

Source: drawn from Daniel Yergin, 'Ensuring Energy Security,' *Foreign Affairs*, Vol.85, No.2, Mar/Apr 2006, pp.69-82

Supply Chain Resilience in the APEC Region by Ian Twomey, Hale and Twomey

hale & twomey

Global Liquid Fuel Supply Chain Resilience

Prepared for

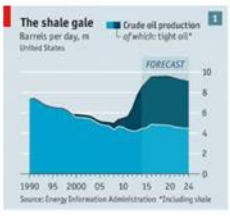
2017 APEC Oil and Gas Security Exercise

Ian Twomey
March 2017

thinking energy. www.haletwomey.co.nz

Dynamic Environment

- Moved from threat of oil shortage (peak oil) to excess supply in the last decade
- Volatile fuel prices
- New technologies unlocking more supply (shale oil/fracking)
- Australian refineries closing
- Majors selling out of refining/marketing
- **Fuel security has become a headline issue**



Sheikhs versus Shale

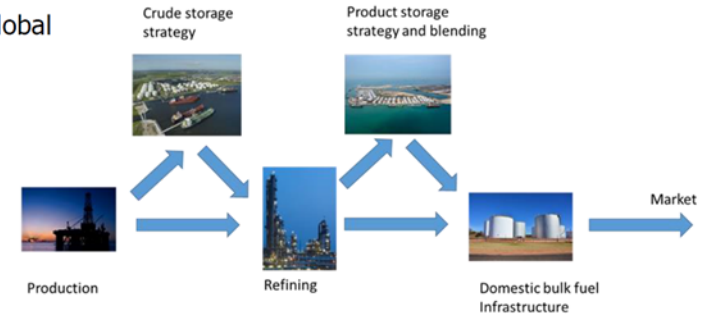

FINANCIAL REVIEW
Peak oil threat becomes harder to ignore

The IEA Says Peak Oil Is Dead.

South Korea to be big winner from Australia refinery closures

Petroleum supply chain

Dynamic, complex and global



Over last 40 years the petroleum market has evolved:

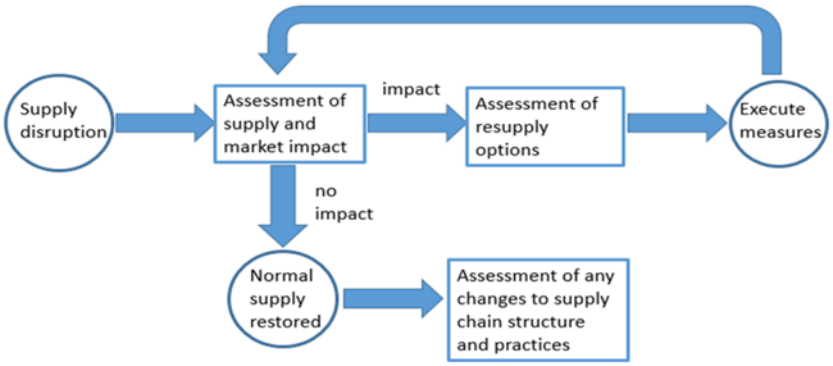
- More transparent
- More global
- More depth and specialisation
- More physical trading and related trading assets (e.g. storage)

Commoditisation of crude and product markets and associated infrastructure (refining/shipping)

Hale & Twomey | Supply Chain Resilience www.haletwomey.co.nz

Disruption response

Industry has a standard response to disruption, reassessing and adjusting supply options within the usual operational timeframes.



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Timeframes

Petroleum supply process works on:

- An annual planning basis to put supply structures in place (e.g. establishing supply deals)
- A continual three monthly planning cycle for purchasing cargoes for crude and product supply
- A continuing operational cycle dealing with physical movement of product and operational variation

Process could be longer for more distant crudes, shorter for those nearby.

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Australia's supply chain

- Aim of supply chain is to deliver quality product to the customer reliably and safely – commercial imperative
- The supply chain is demand driven (always adapting to changes)
- Australia is part of a global supply chain (e.g. crude from West African to Eastern Russia)
- Both crude and products are purchased from global commodity markets
- While product imports are primarily supplied from Asia as the most economic supply point, they can, and have come from further afield as the product markets are also global
- Supply is from a mix of global multinational companies, global commodity trading companies and independent or direct consumer imports

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Supply strategies to provide resilience

Key risk management strategies:

- Diverse supply sources (countries, production locations and counterparties)
- System-owned crude/product (or "term" deals) covering significant portion of demand
- Trading system to manage portfolio with ability to put in place replacement cargoes (or sell excess cargoes) at short notice
- Ability to switch cargoes within system prior to the cargoes loading
- Holding stock at trading centres to provide system support and flexibility
- Vary destination of cargoes to manage disruption event (flexible shipping contracts)
- Holding stock locally to manage normal supply variation and small scale disruption events
- Local product purchases from competitors

Crude supply

- Australia's crude supply is diverse (~ 85% imported)
- Creates options if disruption in a particular region

Response to disruption - crude

Minor disruption:

- Assess impact – mitigation options (delay cargo, part load)
- Seek replacement cargo if more serious
- Consider option of reducing refinery rate and increasing product imports

Major disruption:

- Major disruption will have a price impact that will flow to market – this will reduce demand and enhance supply options
- Price changes result in reallocation of supply (type and location)
- Replacement cargoes secured – may be a time delay to manage
- Short term disruption (timing issues) may be managed through inventories and switching to product imports
- For a major disruption event there may also be a political response (e.g. release of stocks by IEA members)

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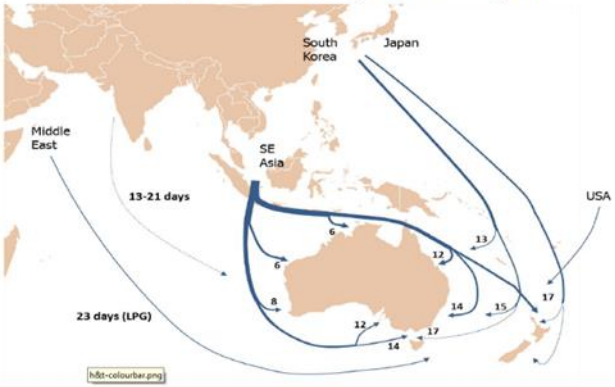
Product supply

- Product imports will meet over 50% of market demand
- Australia's product sources are becoming more diverse
- Options for shipping routes to avoid certain areas if necessary
- Occasional USA sourced product coming into the region



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Response to disruption - product

Minor disruption (e.g. local refinery or product import)

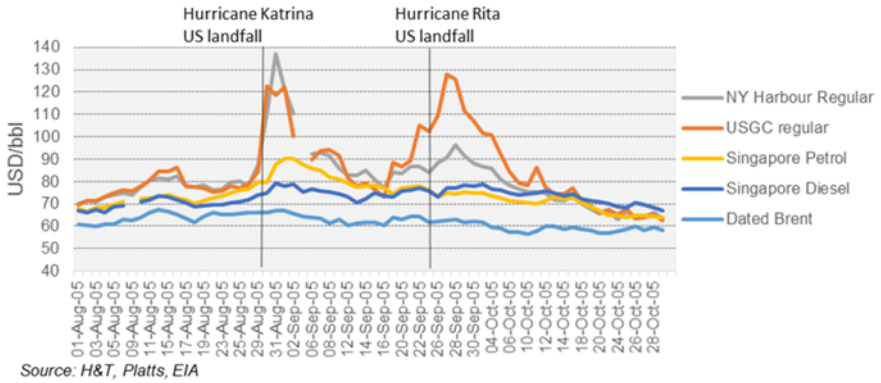
- Assess impact – mitigation options (use of inventories, purchases from competitors)
- Divert import tankers to use available stock from other locations
- Seek replacement cargo(es) if more serious

Major disruption:

- Major disruption will have a price impact that will flow to market – will reduce demand and enhance supply options
- Price movement will see product move between regions to meet shortage (arbitrage opens)
- Replacement cargoes secured – may be a time delay to manage
- Short term disruption (timing issues) may be managed through inventories and adjusting product import destinations
- For a major disruption there may also be a political response (e.g. release of stocks by IEA members)

Disruption example – Hurricane Katrina (2005)

- Hurricane Katrina had major impact on refining availability (>2 million bbls) in one of world's largest product demand locations
- Price spikes saw the flow of product quickly move globally
- Within one week prices started returning to more normal levels



Source: H&T, Platts, EIA

Shipping

- Australia dependent on maritime supply for bulk of its economy (not just fuel supply)
- Not unusual – estimated 65% of global fuel demand is met using seaborne trade
- Shipping typically in control of purchasing company

- Both crude and product tanker markets are global and diverse
- Local delivery flexibility built into shipping contracts
- Substantial stock on the water at any time – fuel suppliers like the flexibility shipping provides

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Other disruption risk

- Financial market risk
  - Flow of oil is dependent on financial system
  - Many companies large enough to manage risk within their own company
  - Credit risk is a key factor already built into oil market transactions
  - Physical nature of assets mean financial failure quickly sees sale of valuable assets to generate funds
- System relies on multilateral cooperation (as does the IEA) – assumes countries continue to act as they have for the past 60 years
- Product quality risk is managed with inspection and audit processes
- Weather and 'Act of God' impacts are generally temporary and affect demand as much as supply
- Industrial action – there is usually time during the build up to any action where some mitigation is possible
- Local infrastructure failure – normally multiple supply options available to cover risk of single failure

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Disruption planning

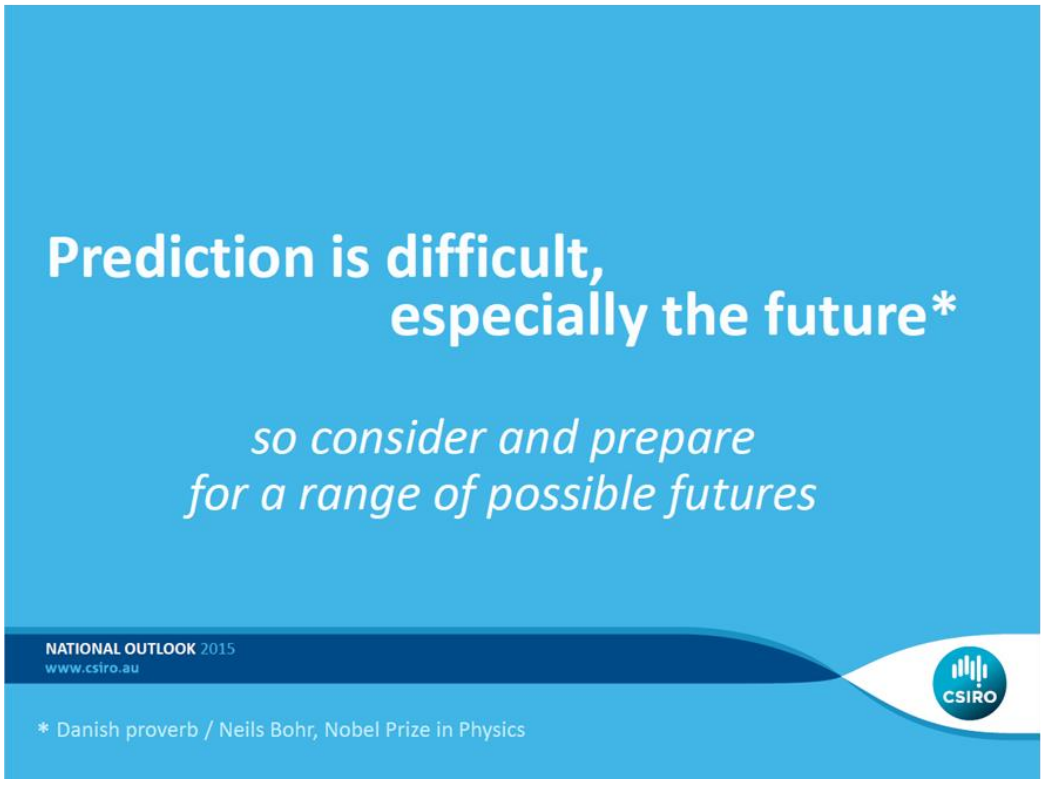
- Global disruption primarily price impact (price rationing)
- Significant domestic disruption harder to manage initially until supply chains adjust
- Supply will not dry up – more likely supplies limited (rationing demand)

- National plans need to assist in ensuring available fuel gets to where it is most needed in a disruption

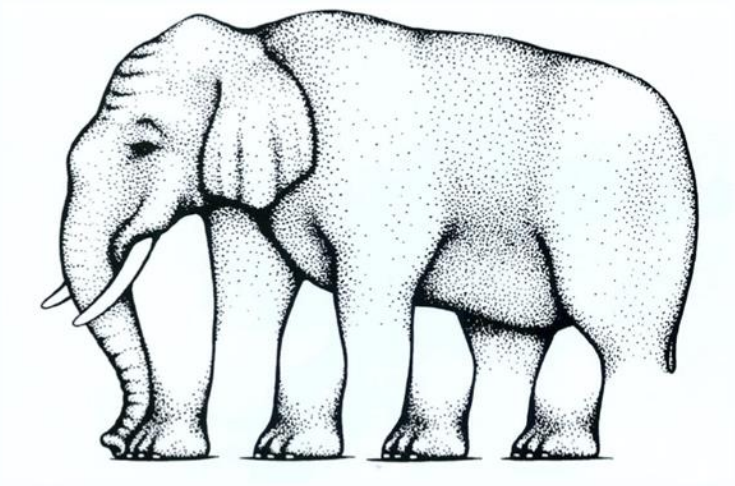
Conclusions

- Fuel supply routes are diverse and likely to remain so, both for the delivery of crude and finished product imports
- Companies build resilience into their supply chains to manage disruption – commercial imperative to be reliable
- Secure supply relies on the resilience of global supply chains and increased depth in the options for supply/ trading
- For Australia, shipping and the sheer number of product imports on the water is a key part of the supply resilience (20 to 30 product tankers at any one time)
- Difficult to conclude that the shift to an increased dependence on product imports is changing risk from the earlier dependence on crude imports
- Global system relies on multilateral cooperation and free movement of goods

Case for Scenario Thinking: Insights from CSIRO Global Megatrends and Australian National Outlook by Dr. Steven Hatfield-Dodds, CSIRO



The case for scenario thinking



It can be difficult to see an elephant

The case for scenario thinking

"Scenarios represent plausible, possible futures."

"The purpose of using scenarios is to break the common habit of planning for what we perceive as the 'most likely' future, or a future that looks much like the present."

"Exploring the implications of uncertain future trends can help decision makers recognise, prepare for, and respond more effectively to change"

- plausible not probable
- balance relevant and challenging
- tell disposable stories
- add numbers to narrative
- manage disagreement as an asset

Done well: "Scenarios provide the right framework for appreciating fundamental long-term choice, which is not the same as next year's annual plan"

Peter Voser, Shell CEO

Source: Wilkinson and Kupers (2013) Living in the Futures, Harvard Business Review

Megatrends: a structure to help navigate the future …

http://snicket.wikia.com/wiki/File:Blindfolds.jpg

CSIRO megatrends

(2015 update)

1 MORE FROM LESS *(ANO)*

Innovation in meeting human needs by more efficient use of mineral, water, energy and food resources in light of escalating demand and constrained supply

2 PLANETARY PUSHBACK *(new) (*)*

Changes in earth systems from the global to microbial are creating challenges for humanity including climate change and antibiotic resistance.

3 THE SILK HIGHWAY *(ANO)*

Rapid growth of emerging economies and the transition from industrialisation into technologically advanced service sectors.

4 FOREVER YOUNG *(*)*

The rise on the ageing population, retirement savings gap, lifespans, healthcare expenditure, diet & lifestyle related illness and mental health awareness

5 DIGITAL IMMERSION *(new)*

The exponential growth in computing power, device connectivity, data volumes, internet users, artificial intelligence and technological capabilities.

6 POROUS BOUNDARIES *(new)*

Changes in organisational models, governance systems and employer-employee relations in a more agile, networked and flexible economy which breaks through traditional boundaries.

7 GREAT EXPECTATIONS *(ANO)*

The rise of the all important experience factor as society and consumers have rising expectation for personalised and positive experiences involving social interaction, morals & ethics and the physical world.

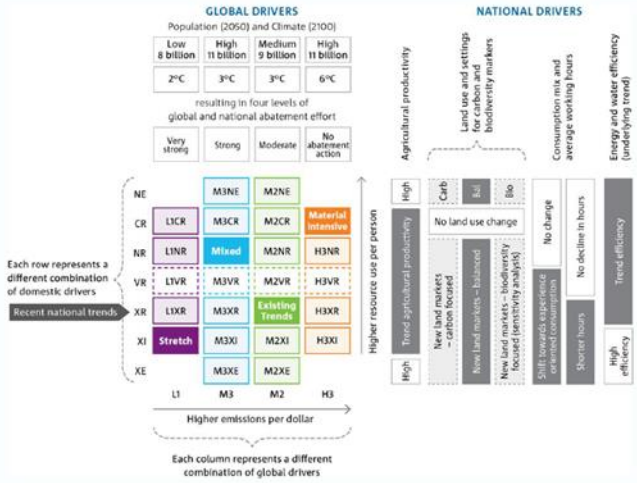
(new) different from the 2012 megatrends

(ANO) or *(*)* – explored or partly explored in the National Outlook 2025

Australian National Outlook 2015

Multiple uncertainties explored across 20 scenarios

FIGURE 23 **THE SET OF NATIONAL OUTLOOK SCENARIOS, IN RELATION TO GLOBAL AND NATIONAL DRIVERS**



Scenario drivers:

- Global demand and population
- Global climate

National and global abatement

- Working hours and consumption mix
- Energy and water efficiency
- Land sector markets
- Agricultural productivity

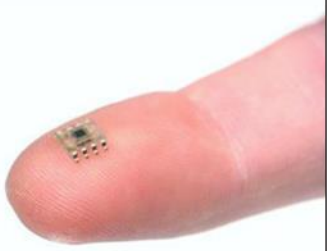
Source: Hatfield-Dodds et al. (2015) *Australian National Outlook 2015: Economic activity, resource use, environmental performance and living standards, 1970-2050*

Source: Hatfield-Dodds et al (2015) www.csiro.au/nationaloutlook

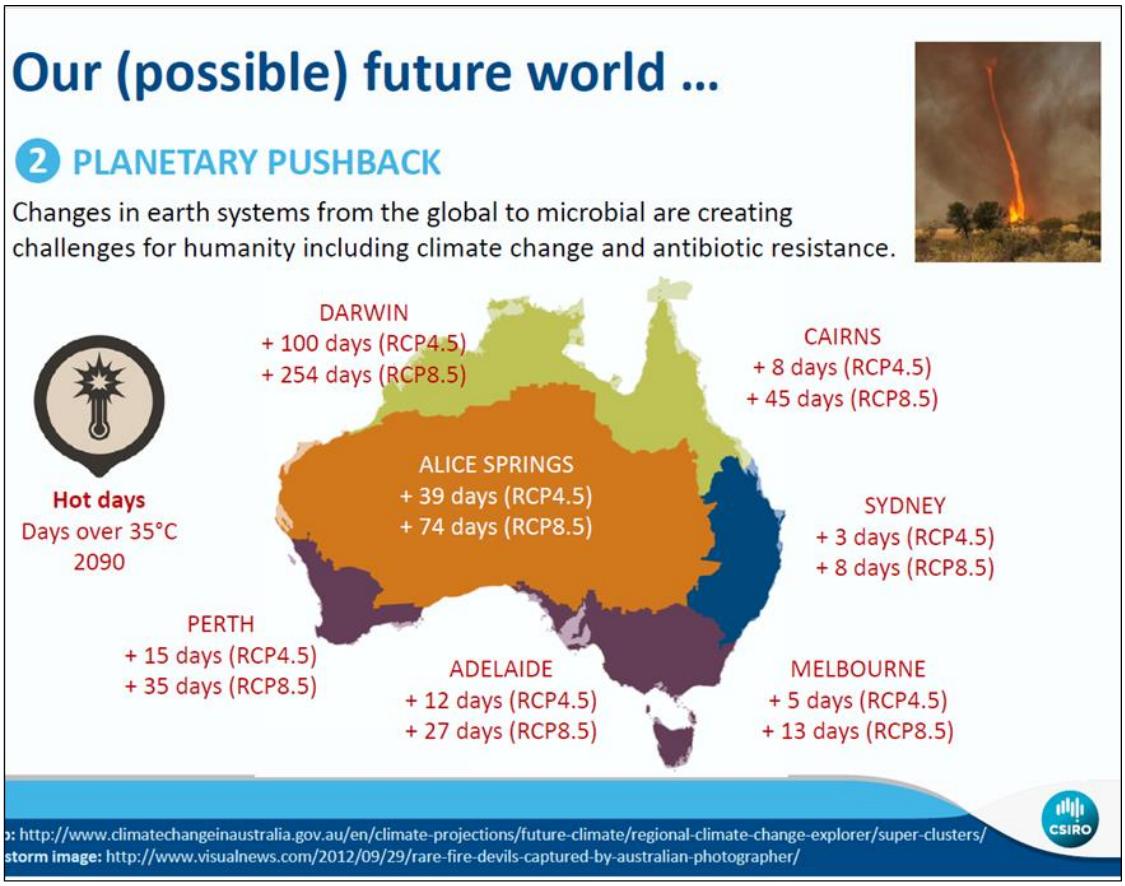
Our (possible) future world …

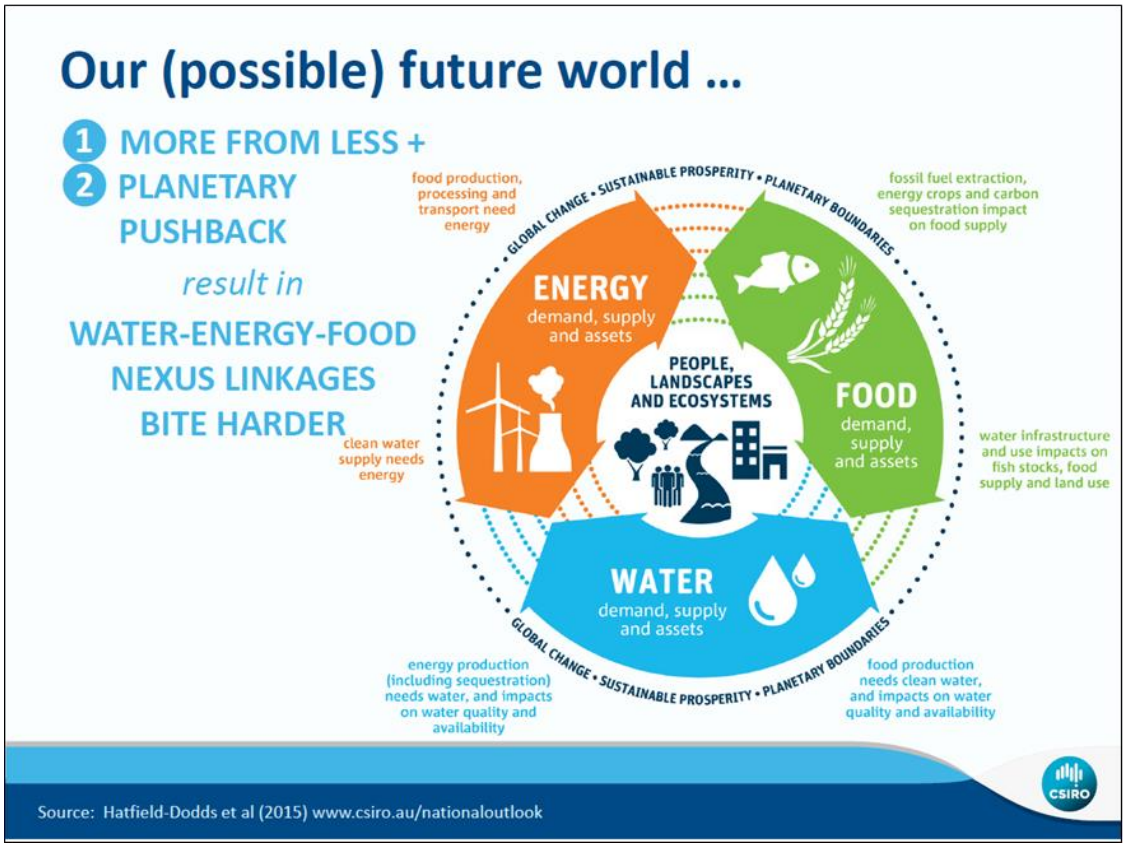
1 MORE FROM LESS

Innovation in meeting human needs by more efficient use of mineral, water, energy and food resources in light of escalating demand and constrained supply



Images: Hajkowicz et al 2012 *Our Future World*
http://i.fosfor.se/i08/2/080225_2.jpg http://www.ophtimalia-medical.fr/mediatheque/images/etude-et-consultance.jpg


Our (possible) future world ...
2 PLANETARY PUSHBACK
Changes in earth systems from the global to microbial are creating challenges for humanity including climate change and antibiotic resistance.
Hot days
Days over 35°C
2090
DARWIN
+ 100 days (RCP4.5)
+ 254 days (RCP8.5)
CAIRNS
+ 8 days (RCP4.5)
+ 45 days (RCP8.5)
ALICE SPRINGS
+ 39 days (RCP4.5)
+ 74 days (RCP8.5)
SYDNEY
+ 3 days (RCP4.5)
+ 8 days (RCP8.5)
PERTH
+ 15 days (RCP4.5)
+ 35 days (RCP8.5)
ADELAIDE
+ 12 days (RCP4.5)
+ 27 days (RCP8.5)
MELBOURNE
+ 5 days (RCP4.5)
+ 13 days (RCP8.5)
CSIRO
storm image: http://www.visualnews.com/2012/09/29/rare-fire-devils-captured-by-australian-photographer/

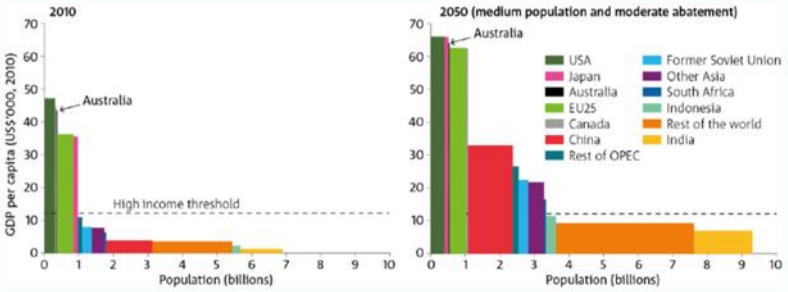

Our (possible) future world ...
1 MORE FROM LESS +
2 PLANETARY PUSHBACK
result in
WATER-ENERGY-FOOD NEXUS LINKAGES BITE HARDER
food production, processing and transport need energy
fossil fuel extraction, energy crops and carbon sequestration impact on food supply
GLOBAL CHANGE • SUSTAINABLE PROSPERITY • PLANETARY BOUNDARIES
ENERGY
demand, supply and assets
PEOPLE, LANDSCAPES AND ECOSYSTEMS
FOOD
demand, supply and assets
clean water supply needs energy
water infrastructure and use impacts on fish stocks, food supply and land use
WATER
demand, supply and assets
energy production (including sequestration) needs water, and impacts on water quality and availability
food production needs clean water, and impacts on water quality and availability
Source: Hatfield-Dodds et al (2015) www.csiro.au/nationaloutlook
CSIRO

Our (possible) future world …

3 THE SILK HIGHWAY

Rapid growth of emerging economies and the transition from industrialisation into technologically advanced service sectors.

FIGURE 5 **THREE BILLION PEOPLE LIVE IN HIGH INCOME NATIONS BY 2050, UP FROM ONE BILLION TODAY**



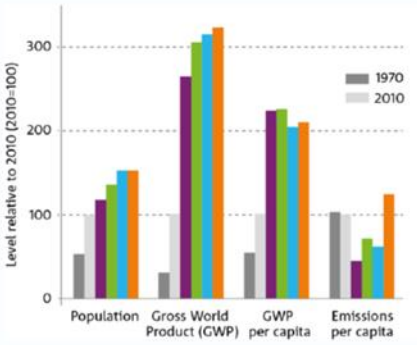
Source: Hatfield-Dodds, et al. (2015) *Australian National Outlook 2015: Economic activity, resource use, environmental performance and living standards, 1970-2050*

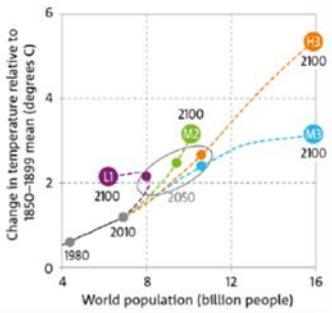
Image: Hajkowicz et al 2012 *Our Future World*
Chart: Hatfield-Dodds et al (2015) www.csiro.au/nationaloutlook

Our (possible) future world …

2 PLANETARY PUSHBACK + 3 THE SILK HIGHWAY

FIGURE 26 **KEY INDICATORS FOR THE FOUR GLOBAL CONTEXT SCENARIOS, 1970, 2010, 2050, OR 1980-2100**





	Climate (2100)	Population (2050)
L1	2°C	Low: 8 b
M3	3°C	High: 11 b
M2	3°C	Mid: 9 b
H3	6°C	High: 11 b

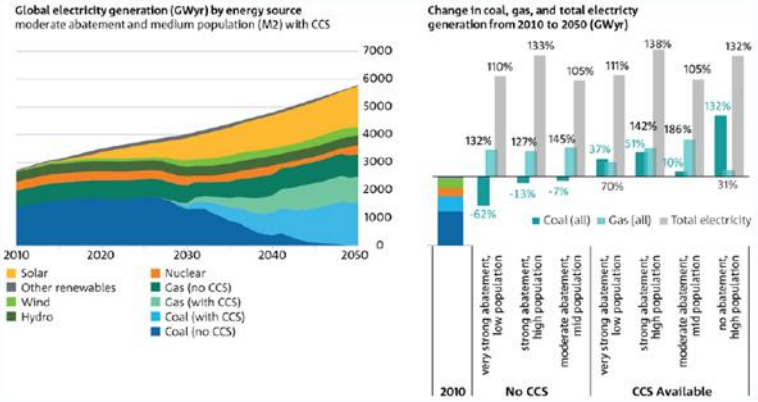
Source: Hatfield-Dodds et al. (2015) *Australian National Outlook 2015: Economic activity, resource use, environmental performance and living standards, 1970-2050*

Chart: Hatfield-Dodds et al (2015) www.csiro.au/nationaloutlook

Our (possible) future world …

2 PLANETARY PUSHBACK + 3 THE SILK HIGHWAY

FIGURE 8 **GLOBAL ENERGY DEMAND GROWS, BUT PROSPECTS FOR SPECIFIC ENERGY RESOURCES ARE UNCERTAIN**



Source: Hatfield-Dodds, et al. (2015) *Australian National Outlook 2015: Economic activity, resource use, environmental performance and living standards, 1970-2050*

Chart: Hatfield-Dodds et al (2015) www.csiro.au/nationaloutlook

Our (possible) future world …

4 FOREVER YOUNG

The rise on the ageing population, retirement savings gap, lifespans, healthcare expenditure, diet & lifestyle related illness and mental health awareness.

FIGURE 24: **AUSTRALIAN DEPENDENCY RATIOS, 1970-2050**

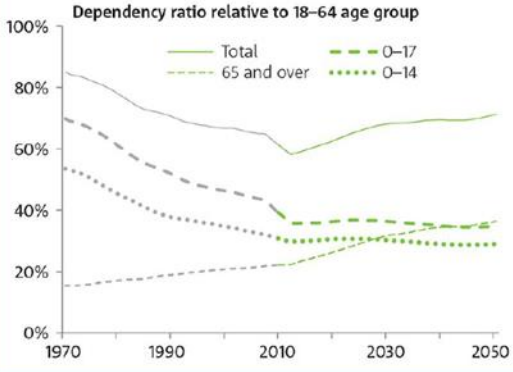
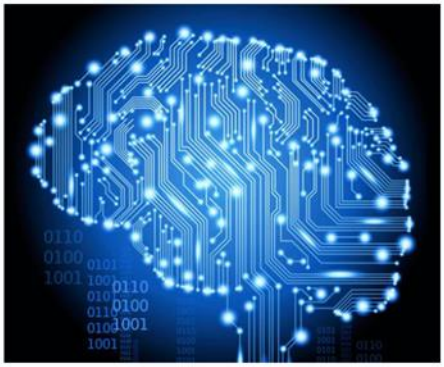


Image: Hajkowicz et al 2015 *Our Future World* (draft)
Chart: Hatfield-Dodds et al (2015) www.csiro.au/nationaloutlook

Our (possible) future world …

5 DIGITAL IMMERSION *(new)*

The exponential growth in computing power, device connectivity, data volumes, internet users, artificial intelligence and technological capabilities.

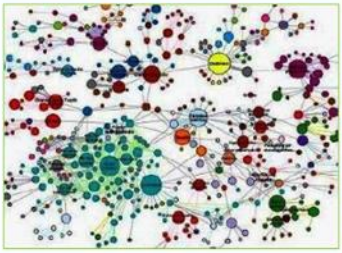


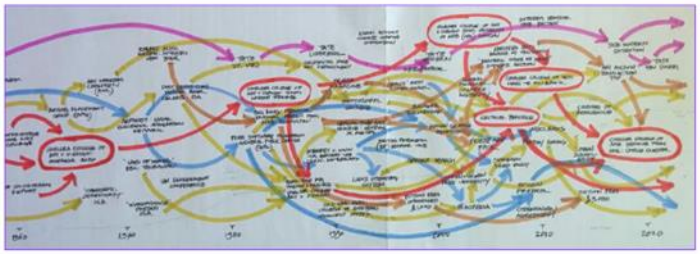
http://alexanders.com/wp-content/uploads/2013/10/print-in-a-digital-world.jpg
http://scienceillustrated.com.au/blog/wp-content/uploads/2012/09/digital-brain.gif

Our (possible) future world …

6 POROUS BOUNDARIES *(new)*

Changes in organisational models, governance systems and employer-employee relations in a more agile, networked and flexible economy which breaks through traditional boundaries.





Images: Hajkowicz et al 2015 *Our Future World* (draft) https://sneakpeek2013.files.wordpress.com/2014/06/logos.jpg?w=558/
Cummings 2015 https://www.flickr.com/photos/chanceprojects/16477676577/in/album-72157650699577578/
Sadovy 2013 http://blogs.sas.com/content/valuealley/2013/01/08/the-value-is-in-the-network

Our (possible) future world …

7 GREAT EXPECTATIONS

The rise of the all important experience factor as society and consumers have rising expectation for personalised and positive experiences involving social interaction, morals & ethics and the physical world.

FIGURE 8: ASSUMPTIONS ABOUT WORKING HOURS ACCOUNT FOR TWO THIRDS OF THE RANGE OF NATIONAL INCOME ACROSS NATIONAL OUTLOOK SCENARIOS

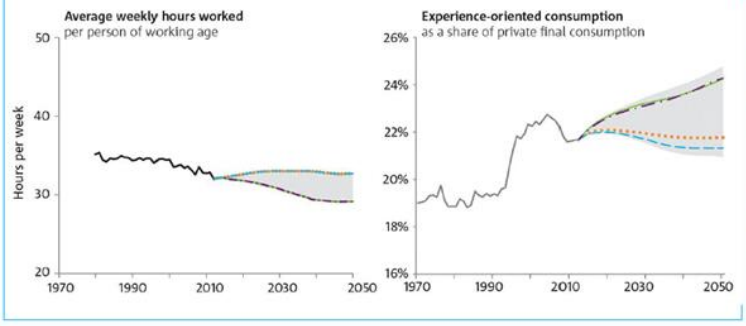
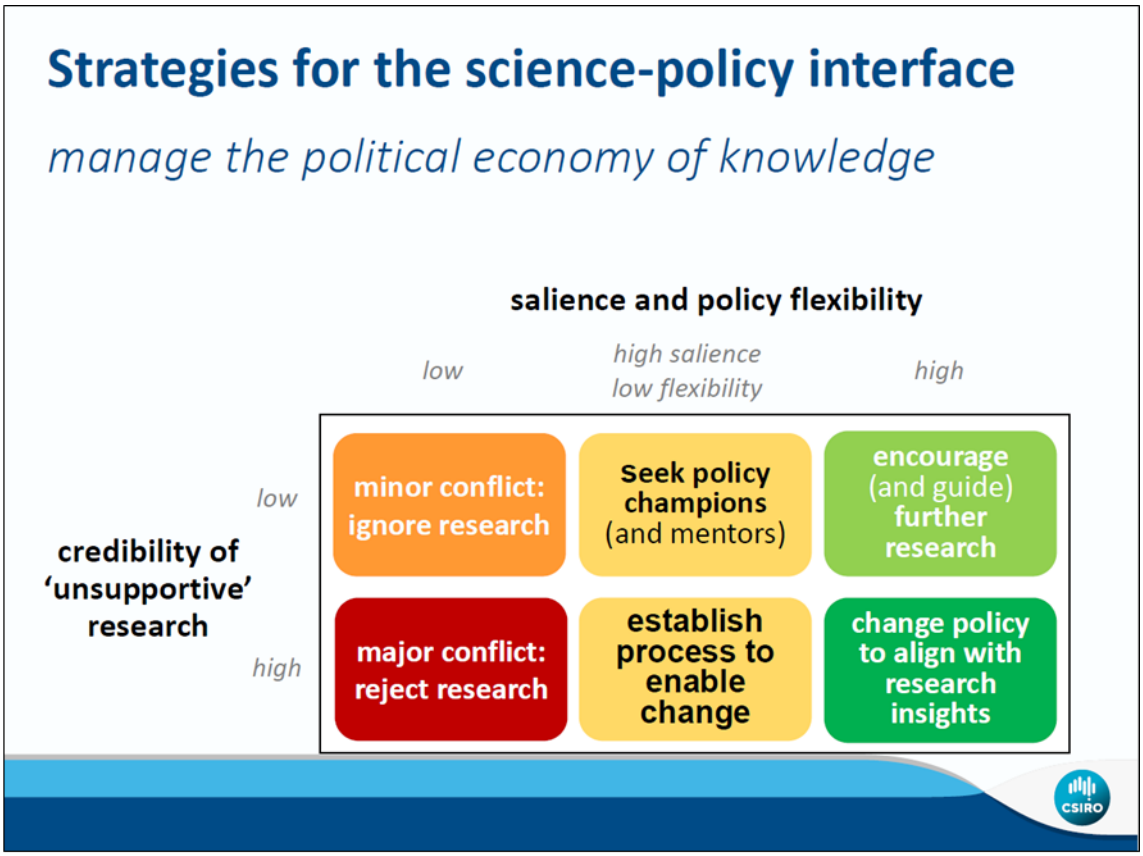


Image: Hajkowicz et al 2015 *Our Future World* (draft)
Chart: Hatfield-Dodds et al (2015) www.csiro.au/nationaloutlook

Strategies for the science-policy interface

harness the value of time
by shaping the future decision context


Strategies for the science-policy interface
manage the political economy of knowledge
salience and policy flexibility
low
high salience
low flexibility
high
credibility of 'unsupportive' research
low
high
minor conflict: ignore research
Seek policy champions (and mentors)
encourage (and guide) further research
major conflict: reject research
establish process to enable change
change policy to align with research insights
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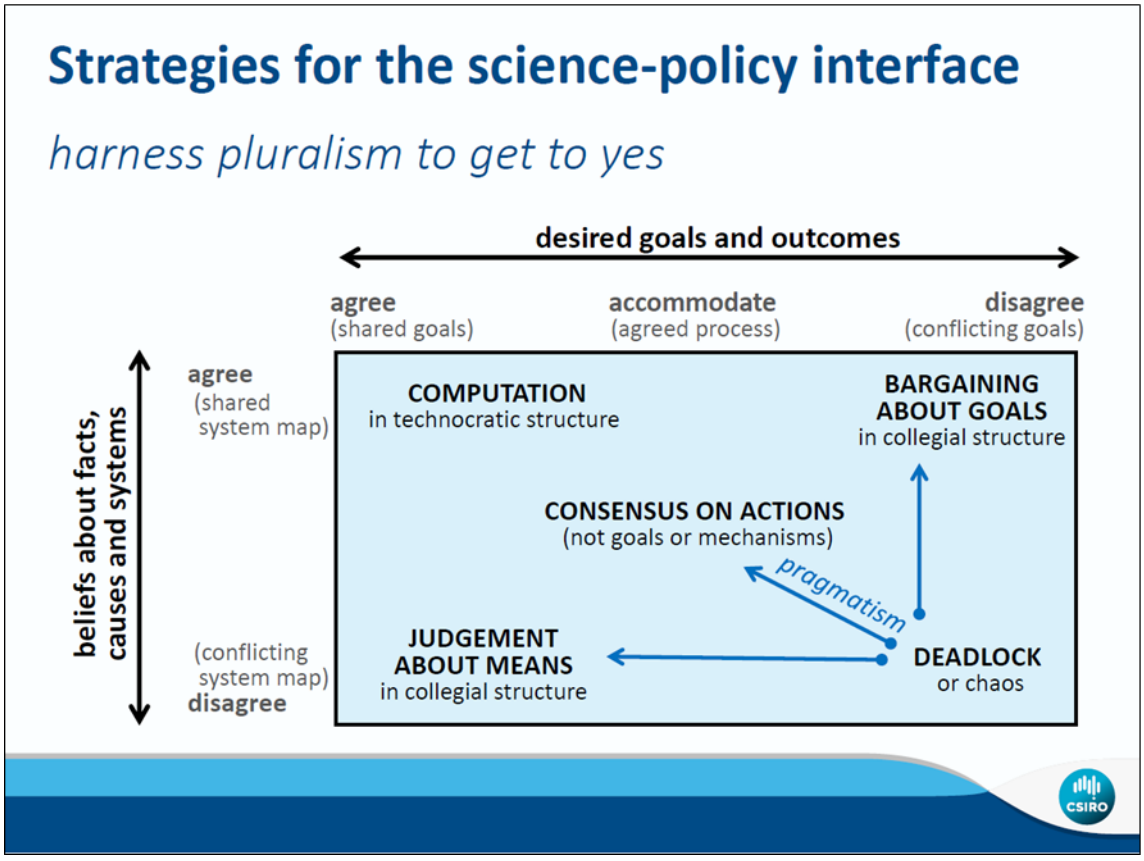
Strategies for the science-policy interface
harness pluralism to get to yes
desired goals and outcomes
agree
(shared goals)
accommodate
(agreed process)
disagree
(conflicting goals)
beliefs about facts, causes and systems
agree
(shared system map)
(conflicting system map)
disagree
COMPUTATION
in technocratic structure
BARGAINING ABOUT GOALS
in collegial structure
CONSENSUS ON ACTIONS
(not goals or mechanisms)
pragmatism
JUDGEMENT ABOUT MEANS
in collegial structure
DEADLOCK
or chaos
CSIRO

Thank-you

Dr Steve Hatfield-Dodds
(Integration Science and Modelling collaboration)

Steve.Hatfield-Dodds@csiro.au
+61 438 626 070 / +61 2 6246 5597
CSIRO Black Mountain Laboratories, Canberra

NATIONAL OUTLOOK 2015
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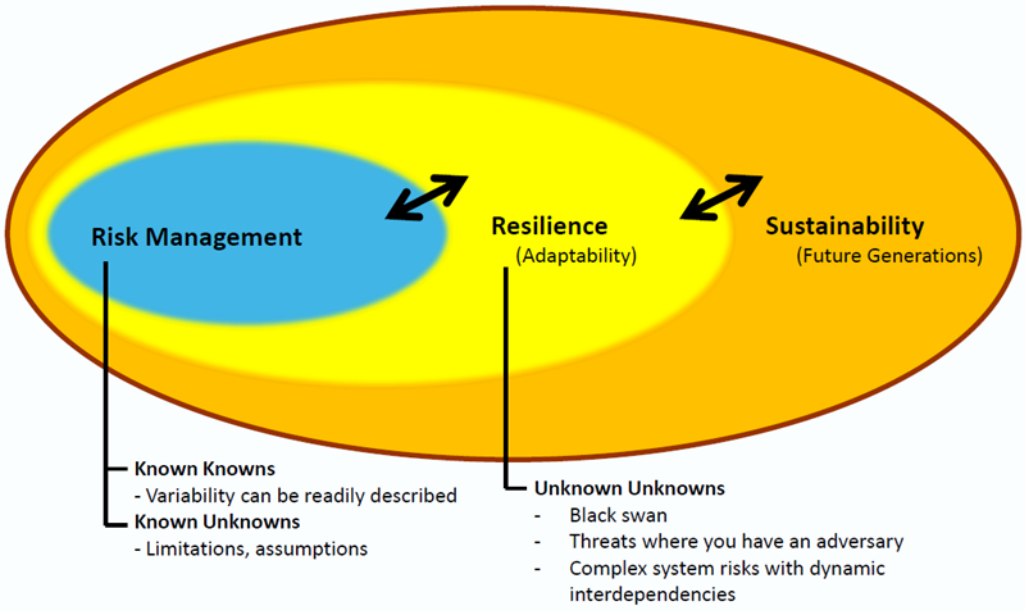
Risk, resilience and sustainability

(New Zealand Treasury)



Blake (2014) The New Zealand Treasury's Living Standards Framework, ISEE Conference paper

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ANNEX V: REFERENCES

ABC (American Broadcasting Company) (2016a), "BP Withdraws from Great Australia Bight Drilling," 11 October 2016, http://www.abc.net.au/news/2016-10-11/bp-withdraws-from-great-australian-bight-drilling/7921956

—— (2016b), "Chevron Reaffirms Great Australian Bight Drill Plans for 2017 or 2018, Despite BP Pulling Out," 16 NOV 2016, http://www.abc.net.au/news/2016-11-16/chevron-oil-gas-exploration-great-australian-bight/8030986

ABS (Australian Bureau of Statistics) (2016), Table 1: Key National Accounts Aggregates, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5204.02015-16?OpenDocument/

APERC (Asia Pacific Energy Research Centre) (2016), APEC Energy Demand and Supply Outlook, 6th Edition, http://aperc.ieej.or.jp/file/2016/5/10/APEC_Outlook6th_VolumeII_EconomyReviews.pdf

—— (2015), Oil Supply Security and Emergency Policy in the APEC Region, http://aperc.ieej.or.jp/file/2016/5/13/Oil_Supply_SEcurity_and_Emergency_Polocy_in_the_APEC_Region.pdf

Bangkok Post (2016), New Oil Fund has Disbursement Rules, 20 August 2016, https://www.pressreader.com/thailand/bangkok-post/20160820/281908772554133

BBC News (2012), "UAE Opens Pipeline Bypassing Strait of Hormuz Oil Route, 15 July 2012, http://www.bbc.com/news/world-middle-east-18848986

BP (British Petroleum) (2016), BP Statistical Review of World Energy, 2016.

BPS (Statistics Indonesia) (2016), Statistical Yearbook of Indonesia, June 2016, https://www.bps.go.id/website/pdf_publikasi/Statistik-Indonesia-2016--_rev.pdf.

Business Insider (2015), "These 8 Narrow Chokepoints are Critical to the World's Oil Trade, 01 April 2015, http://www.businessinsider.com/worlds-eight-oil-chokepoints-2015-4

DOE (Department of Energy, The Philippines) (2016a), Oil Supply and Demand Report 2015, http://www.doe.gov.ph/oil-supplydemand-report-fy-2015

—— (2016b), 2015 Energy Sector Accomplishment

—— (2016c), Philippine Power Situation 2015 https://www.doe.gov.ph/sites/default/files/pdf/electric_power/2015_power_situation_report.pdf

DIIS (Department of Industry, Innovation and Science, Australian Government) (2016a), Australian Energy Statistics 2016, Office of the Chief Economist, https://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Australian-energy-statistics.aspx#

— (2016b), Australian Petroleum Statistics 2016, Office of the Chief Economist, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/aps/2016/Australian_Petroleum_Statistics_242_September2016.pdf

— (2016c), Energy in Australia 2015, Office of the Chief Economist, http://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Energy-in-Australia.aspx

— (2017), Resources and Energy Quarter 2017, Office of the Chief Economist, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx

DFAT (Department of Foreign Affairs and Trade, Australia) (2016), The Importance of Services Trade to Australia), http://dfat.gov.au/international-relations/international-organisations/wto/pages/the-importance-of-services-trade-to-australia.aspx

EIA (US Energy Information Administration) (2017a), Australia Country Analysis Brief, https://www.eia.gov/beta/international/analysis.cfm?iso=AUS

—— (2017b), Thailand Country Analysis Brief, https://www.eia.gov/beta/international/analysis.cfm?iso='THA

—— (2016), Iraq Country Analysis Brief, http://www.eia.gov/beta/international/analysis.cfm?iso=IRQ

—— (2015a), United Arab Emirates Country Analysis Brief, http://www.eia.gov/beta/international/analysis.cfm?iso=ARE

—— (2015b), Iran Country Analysis Brief, http://www.eia.gov/beta/international/analysis.cfm?iso=IRN

—— (2015c), Indonesia Country Analysis Brief, http://www.eia.gov/beta/international/analysis.cfm?iso=IDN

—— (2014a), Saudi Arabia Country Analysis Brief, http://www.eia.gov/beta/international/analysis.cfm?iso=SAU

—— (2014b), World Oil Transit Chokepoints, 10 November 2014 http://www.eia.gov/beta/international/regions-topics.cfm?RegionTopicID=WOTC

Energy Quest (2016), Energy Quarterly Report, March 2016

EPPO (Energy Policy and Planning Office) (2016), Energy Statistics of Thailand 2016, https://www.scribd.com/document/324809947/Energy-Statistics-of-Thailand-2016

IEA (International Energy Agency) (2016a), Closing Oil Stock Level in Days of Net Imports, http://www.iea.org/netimports/?y=2016&m=12

—— (2016b), World Energy Statistics and Balances 2016

—— (2015), Energy Policies and Measures,
https://www.iea.org/policiesandmeasures/pams/indonesia/name-140164-en.php

—— (2014), Energy Supply Security: Emergency Response of IEA Countries 2014,
http://www.iea.org/publications/freepublications/publication/ENERGYSUPPLYSECURITY2014.pdf

MEMR (Ministry of Energy and Mineral Resources of Indonesia) (2017a), Presentation during "Oil and Gas Security Network" (OGSN) Forum held on 29 June 2017, Irkutsk, Russia

—— (2017b), Presentation on "Oil and Gas Security Exercise in Australia (A Regional Capacity Building)" held in Melbourne, Australia on 29-31 March 2017

—— (2015), Laporan Akuntabilitas Kinerja Instansi Pemerintah *(LAKIP) KESDM Tahun 2014,* February 2015, http://esdm.go.id/assets/admin/file/pub/LAKIP_ESDM_2014-FINAL.pdf.

Organization of Petroleum Exporting Countries (OPEC) (2015), OPEC Annual Statistical Bulletin 2015,
http://www.opec.org/opec_web/static_files_project/media/downloads/publications/ASB2015.pdf

PCOO (Presidential Communications Operations Office) (2011). Organizing the Inter-agency Energy Contingency Committee (IECC). http://www.pcoo.gov.ph/issuances/issuances-ao/AO-06.pdf

State of Government of Victoria (2014), Report of the 2012-2013 State Emergency Risk Assessment, State of Victoria through the Department of Justice, February 2014,
,http://assets.justice.vic.gov.au/justice/resources/ccae0110-ea30-4f89-85a2-2bfb4eb06bbf/repor_stateemergencyriskassessment2014emergencyrisksinvictoria.pdf

UN Comtrade (2016a), World Statistics Pocketbook 2016 Edition,
http://unstats.un.org/unsd/publications/pocketbook.

—— (2016b), UN Comtrade Database, http://comtrade.un.org/

WB (World Bank) (2016), World Bank Databank, http://databank.worldbank.org/data/home.aspx