Asia-Pacific
Economic Cooperation

## APEC Oil and Gas Security Studies

# Energy Security of APEC Economies and Changing Downstream Oil Environment

APEC Energy Working Group



Series 14

August 2018

**EWG 05 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 Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org



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# Foreword

During the 11th APEC Energy Ministers' Meeting (EMM11) held in Beijing, China on 2nd September 2014, the Ministers issued instructions to the Energy Working Group (EWG). This includes an instruction to Asia Pacific Energy Research Centre (APERC) to continue its cooperation on emergency response so as to improve the capacity building in oil and gas emergency response in APEC region.

Following this instruction, APERC has started implementing the Oil and Gas Security Initiative (OGSI) in November 2014. One of the three overarching pillars of the OGSI is the publication of the Oil and Gas Security Studies (OGSS).

The OGSS serves as a useful publication to APEC economies by having access to developments and issues on oil and gas security, and information on individual economy's policies related to oil and gas security including responses to emergency situation. The research studies included in OGSS will help encourage the APEC economies to review and revisit their respective policies, plans, programmes and measures on oil and gas security, and may probably help them adopt appropriate approaches to handling possible supply shortage or supply emergencies in the future.

I would like to thank the contributors to the OGSS for the time they have spent doing research works. May I however highlight that the independent research project contents herein reflect only the respective authors' view and not necessarily APERC's and might change in the future depending on unexpected external events or changes in the oil and gas and policy agendas of particular economies or countries.

I do hope that the OGSS will serve its purpose especially to the policy makers in APEC in addressing the oil and gas security issues in the region.

Kazutomo IRIE
President
Asia Pacific Energy Research Centre

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This report, Energy security of APEC economies and changing downstream oil environment, was made possible through the cooperation of those who provided useful insights into the global energy market. The Asia Pacific Energy Research Centre would like to express its gratitude especially to those experts of the following institutes for having kindly provided the opportunities to exchange views and information: Atlantic Council Global Energy Center, AVL Powertrain Engineering, BP, Center for Strategic and International Studies, Chatham House, CNPC Research Institute of Economics and Technology, Department of State government of USA, Economic Research Institute for ASEAN, Energy Information Administration, Energy Intelligence Group, International Energy Agency, Korea Energy Economics Institute, Organization of the Petroleum Exporting Countries secretariat, Petroleum Planning & Analysis Cell of India, The Rapidan Group, and Toyota Motor Corporation


## Authors


| | |
|---|---|
| Dr Ken Koyama | Managing Director and Chief Economist,<br>The Institute of Energy Economics, Japan (IEEJ)<br>Asia Pacific Energy Research Centre (APERC) |
| Mr Ichiro Kutani | Assistant Director and Manager, IEEJ<br>APERC |
| Mr Takashi Matsumoto | Senior Economist, IEEJ<br>APERC |
| Mr Tadashi Yoshida | Senior Economist, IEEJ<br>APERC |

## Other Contributors

| | |
|---|---|
| Mr James M. Kendell | Senior Vice President, APERC |
| Mr Choong Jong Oh | Senior Researcher, APERC |
| Dr Ruengsak Thitiratsakul | Research Fellow, APERC |

## Content



## Table of Figures

# Executive Summary

Along with the increase in petroleum energy consumption, oil consuming economies have been taking various measures such as direct entry into crude oil development, diversification of crude oil import sources, promotion of consuming economy refining capacity and stockpiling of crude oil and petroleum products to respond to a supply crisis.

However, when observing many changes in global oil market, one may come up with new concept of oil security. The study is aiming to seek new policy actions that can enhance oil security in respective economies and the region.

One of major change is in the production side. The increase in non-OPEC crude oil production triggered a decline in crude oil prices and OPEC's oil strategy advanced to cooperation with some non-OPEC economies. In addition, OPEC oil-producing economies are not only selling crude oil but also selling petroleum products with added value, as well as participating in refinery construction projects in consuming economies that aims to secure stable crude oil sales.

On the other hand, in demand side, the construction of refineries has been failed to catch up the pace of oil demand, and petroleum product trading is expanding globally, particularly in developing Asia. Expansion of petroleum product trading has brought opportunity for consuming economies in oil security. This shift can only achievable after having accessible, liquid, and transparent global petroleum product market.

To identify the recommended policy action to strengthen oil security under the new market fundamentals, we firstly categorize APEC member economies under the following conditions:

1) Whether crude production satisfies oil products demand
2) Whether oil demand exceeds one million b/d
3) Whether their current refinery capacity can satisfy domestic demand, including future demand in 2030

Based on this delineation, we presented the implications of the following actions:

A) Whether each economy should independently develop own refining capacity
B) Whether procurement using the petroleum product market is reasonable
C) How to use excess refining capacity

At the same time, we also presented policy implications for the APEC region.

i) Add refining capacity on the Pacific coast and utilize surplus capacity
- Many economies are crude oil importers and have insufficient refining capacity
- Develop own refinery when rational (firm demand and economic viability)
- Utilize surplus capacities in some economies

ii) Create a highly liquid and transparent petroleum product market

- Integration of quality standards for petroleum products
  - ⇒Increase tradability, to reduce transportation and transaction costs of petroleum products
  - ⇒Easy to procure necessary products in an emergency
- Abolish subsidies for petroleum products
  - ⇒Make the market mechanism work under the appropriate price signals

iii) Review the strategic stockpile

- Balance between crude oil and petroleum products
- Not only for import disruption but also to respond to natural disaster

Traditional security policies are still needed and viable. However, economies are suggested to respond to new fundamental and market reality, and combine the traditional with new security policies that best suit to respective economies and to the region.

# Introduction

Since the oil crisis of the 1970s, oil-importing economies have taken various measures to strengthen oil security such as diversification of importing partner economies, adding refining capacities, changing of laws and regulations in the petroleum industry, and modifying oil stockpile.

On the other hand, the current oil market has been different from the environment that was taken between the 1970s and the 1990s. For example,

- An increase in petroleum product trading due to the formation of a petroleum product trading market
- Declines in oil demand in developed economies
- Increase in oil demand mainly in Asian developing economies (i.e. increased oil security risks for Asian economies)
- Changes in the power and strategy of OPEC and non-OPEC economies

Although there is a common part of energy security policy, there are also parts that very flexibly according to environmental changes. As the aspect of the international oil market changes dramatically, oil security measures need a new idea to respond to it.

This study was designed to investigate the following:

1) The process of forming traditional oil security
    - Direct participation in crude oil development in oil-producing economies
    - Diversification of crude oil import sources
    - The stockpile of crude oil and petroleum products, etc.
2) Various changes of the oil market in recent years
    - Changes in the power and strategy of OPEC and non-OPEC
    - The upswing in petroleum products trading and market formation
    - Expansion of Asian oil demand and inconsistent investment in refining capacity
    - Surplus refining and tank capacities in the economies with declining oil demand
3) In light of the petroleum energy environment of each APEC member economy, it is necessary for each economy to decide:
    - Whether to develop own refining capacity in case of shortage
    - How to deal with excess refining capacity in case of surplus
    - What market strategy to be used

The results of this investigation were summarized in the last chapter of this study, implications, with conclusions and recommendations for APEC consideration.

## Chapter 1. Traditional oil security policy

### 1-1. The basic approach to oil security in consuming economies

#### 1-1-1. History of oil security

Energy is an essential resource to every economies and hence, energy security is central to policy makers.

The International Energy Agency (IEA) defines energy security as "the uninterrupted availability of energy sources at an affordable price"[1]. Japan's Energy White Paper 2010 defines it as "being able to secure energy in the quantity necessary for the people's lives, economic and social activities, and national defense, etc., at affordable prices"[2]. Both definitions stipulate securing a stable quantity of energy at an affordable price.

Before delving further into this issue, this section will first discuss the history of oil security.

After mass production of oil became possible in American oil fields at the end of the 19th century, advancements in internal-combustion engines and the discovery of large oil deposits in the Middle East and Africa in the 1950s resulted in a shift of focus from coal to oil as the global leading energy source. By 1973, over 40% of the world's primary energy supply was dependent on oil.

1973 saw the outbreak of the Yom Kippur War and an oil embargo from the OPEC members in the Persian Gulf. This resulted in a quadrupling of crude oil prices over a short period, which had a massive impact on the global economy. Among the affected economies, members of the Organization for Economic Cooperation and Development (OECD) were severely affected as they depended on oil for over 50% of their energy needs. The oil crisis prompted a heightened awareness to economic vulnerability from oil supply disruption. Particularly among the OECD members, energy security issues became increasingly discussed as matters related to national security. Diversification of supply sources away from oil became one of the key strategies to improve energy security.

As a result, the share of oil in global primary energy supply declined from 45% in 1973 to less than 30% in 2015 but oil still remain an important source of energy supply to many economies.

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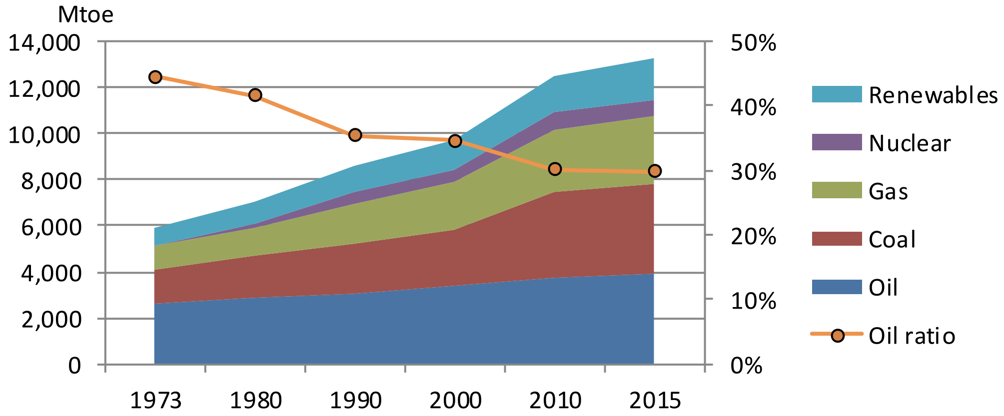
1 https://www.iea.org/topics/energysecurity/

2 http://www.meti.go.jp/english/report/downloadfiles/2010_outline.pdf

Fig. 1-1. Global primary energy sources, 1973 - 2015




Source: Created from *IEA World Energy Balances, 2017.*

Next, the major developments in oil security from the 1970s to the present are summarized below.

**1970s: The Dawn of Oil Security**

The two oil crises in 1973 and 1979 sent shocks to all oil-importing economies and prompted increased focus on energy security as described above. In 1974, the IEA was founded to coordinate response within the OECD in the event of an interruption in oil supplies, and an international oil reserve framework was established.

Energy policy initiatives differ across economies. The United States and other oil-producing economies emphasized policies focused on expanding domestic production. Meanwhile, economies such as Japan that lack indigenous resources opted to promote the use of alternative energy sources such as nuclear power and natural gas, in addition to policies focused on reducing energy consumption.

**1980s: Establishment of Oil Security**

Anxieties about oil supplies subsided and prices stabilized. In Japan, policies were implemented that aimed to reduce oil use, as illustrated by the enactment of the Petroleum Alternative Energy Act[3] and the Energy Conservation Act[4].

**1990s: Development of Energy Security**

Other than the Gulf War of August 1990 that caused a temporary interruption in oil

[3] Law Concerning Promotion of the Development and Introduction of Alternative Energy (1980)
[4] Act on the Rational Use of Energy (1979)

supplies from Iraq and Kuwait as well as a reduction in production thereafter, the oil market was considered relatively stable through the 1990s. With the relative stability of oil supplies, producer economies such as the USA and the UK pressed forward with an attempt at something new in the form of deregulation aiming for harmony of primary energy. Meanwhile, import-reliant economies sought to stick to traditional security policies such as securing foreign resources, reducing oil reliance and energy conservation.

**2000s: Maturation of OIL Security**

The 2003 Iraq War caused an increase in crude oil prices. Subsequent instability in the Middle East as well as hurricane damage by Katrina in the USA also caused instabilities in oil supplies that created upward pressure on oil prices. Crude oil prices were also sharply inflated by an influx of speculative investment tied to the subprime loan issue. As a result, alternative energy sources became increasingly cost-competitive. These led to further diversification of the world's primary energy sources.

### 1-1-2. Oil security policy in consumer economies

The following section will examine oil security policies pursued in oil-consuming economies, with Japan as an example since Japan has a high dependency on oil as a primary energy source and relies on imports for almost all of its oil.

1) Direct participation in crude oil development in oil-producing economies

   Most consuming economies are highly reliant on oil for their energy and rely on imports for most of their supply. This section will examine the history and circumstances of crude oil development oriented toward achieving a stable quantity of oil.

2) Diversification of crude oil import sources

   In the 1970s, the oil trade was very unbalanced, with the Middle East accounting for 60% of the volume of international crude oil transactions worldwide (export volume). This section will examine the state of crude oil import source diversification aimed at reducing geopolitical risk.

3) Diversification of primary energy sources

   After the sudden jumps in oil prices caused by the oil crises, there was a rush to introduce alternative energy sources (called "new energy" in Japan). This section will examine the development and introduction of non-fossil fuel energy sources and the diversification of primary energy sources stemming from heightened awareness of environmental problems in the 1990s and beyond.

4) Promotion of methods of refining oil in consumer markets

Oil refinery locations can be chosen either to be placed in producer economies or in consumer markets. This section will examine the chronology and benefits of both methods, beginning with the method of refining in producer economies that arose as petroleum products first entered circulation as products in the 1800s, and proceeding to the method of refining in consumer markets that spread with the increase in demand for petroleum products in the 1900s and beyond.

5) Regulation of the domestic oil industry and oil market

Oil policy in consumer economies that rely on oil imports prioritize the stability of supply. Additionally, broad regulation governed oil imports, refining, and sales through the early 1980s in order to protect and foster the industry. Later, deregulation and liberalization followed to further develop the industry. This section will examine this shift from regulation to deregulation.

6) Reserves of crude oil and petroleum products

After the multiple global oil supply interruptions that occurred in the 1970s, oil reserves were established that could be released in emergencies to maintain supplies and mitigate any economic damage. This section will examine the history of that international cooperative effort and the primary reserve frameworks in place.

### 1-2. Direct participation in crude oil development in oil-producing economies

#### 1-2-1. History of crude oil development

The history of crude oil development dates back to the end of the 19th century in the United States, but the 20th century saw the formation of the oil development framework centered on the so-called “Seven Sisters,” the seven major European- and American-owned inter oil companies (“oil majors”).

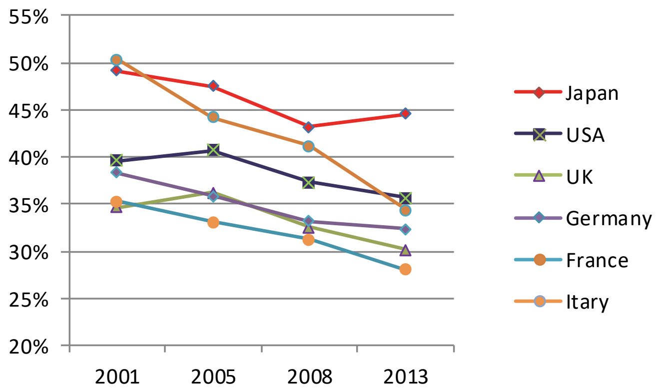
The oil majors continued to dominate inter oil markets for a long period. The Organization of the Petroleum Exporting Countries (OPEC) was formed in 1960, and several Arab-Israeli Wars occurred through the 1970s. Due to concerns regarding the use of energy resources, many oil concessions were transferred from the European and American oil majors to national oil companies (NOC) in the producing economies.

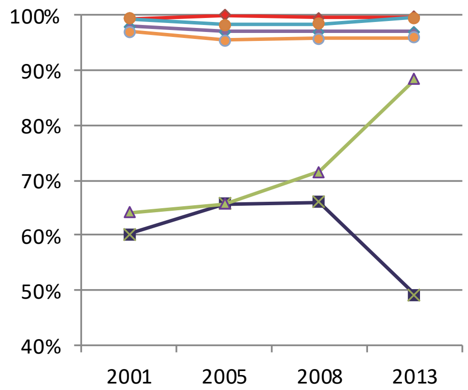
NOCs were once considered inferior to the European and American oil majors in terms of financial and technical capabilities. However, as NOC gained experience with development and mineral exploration over the years, they have increasingly comparable to oil majors in some technical fields.

In this way, the rise of resource nationalism in oil-producing economies and the intensification of competition for natural resources caused by increased demand from emerging economies created heightened geopolitical risks. To enhance oil security, consuming economies became increasingly active to participate in crude oil development directly.

As shown in the charts below, major economies have reduced their dependency on oil in their primary energy supply mix. However, oil still remains a key primary energy source and many of these economies still depend largely on imports to meet their oil needs.

**Fig. 1-2: Oil dependency as a proportion of primary energy sources (left) and dependency on oil imports for oil consumption (right)**




Source: Created from annual editions of *IEA ENERGY BALANCES OF OECD COUNTRIES*.

**1-2-2. Japanese crude oil development**

Petroleum mining began in the United States in the latter half of the 19th century and rapidly spread around the world with the development of modern excavation technology. At the beginning of the 20th century, oil fields were developed in the Middle East. In Japan, crude oil was mined from natural percolations and shallow wells for refinement and use, but only very limited quantities were found.

Overseas oil development by Japanese companies began in 1960 with the discovery of the Khafji oilfield[5] in the Middle East by the Arabian Oil Company. In 1967, the Japan

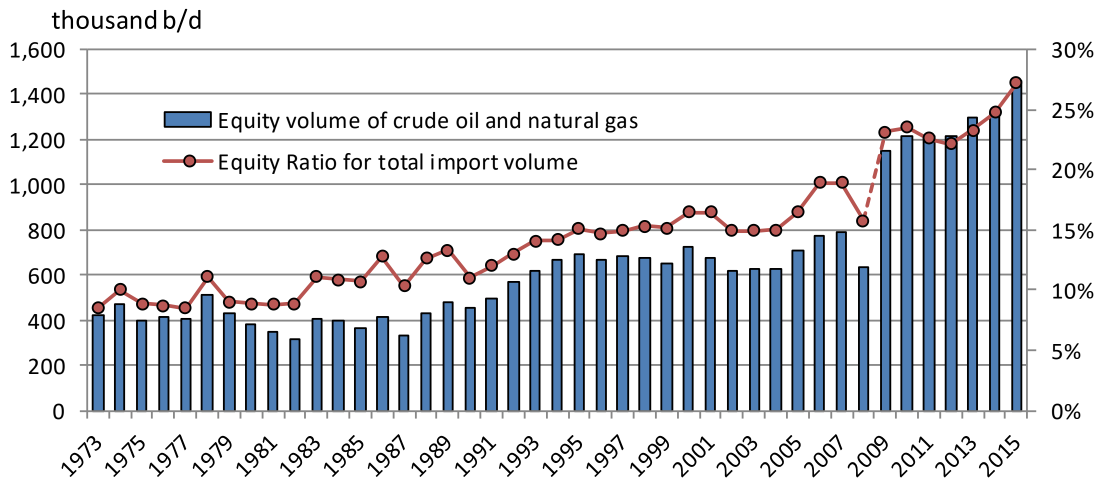
[5] A huge oilfield that extends from Saudi Arabia through to what was once a neutral zone on the border. Work began here in 1961, but rights expired on the Saudi Arabian side in 2000 and on the Kuwaiti side in 2003, resulting in withdrawal.

Petroleum Development Corporation (today JOGMEC) was established to pursue the attainment of independently developed crude oil, and it gradually expanded into oil development overseas.

Though small in scale relative to the European and American oil majors due to its late start, the transaction volume of independently developed crude oil, so called "the equity crude oil" and natural gas by Japan in FY 2015 was 1.464 million barrels per day, which is approximately triple its volume of the same in the 1970s. The ratio of equity crude oil (and later natural gas) has also grown from 8.5% in 1973 to 27.2% in 2015.

From the 2010 Basic Energy Plan to the present, the Japan has set its target for this "equity ratio" to exceed 40% by 2030.

**Fig. 1-3: Ratio of independently developed crude oil by Japan, 1973 - 2015**




Source: Agency for Natural Resources and Energy

・Until 2008, only crude oil was considered for the "independent development ratio," but the definition was revised in 2009 to include natural gas, as well.

・The main causes of the increase in the independent development ratio in 2015 were: 1) The acquisition of an interest in onshore Abu Dhabi mines; 2) increased production in Oceania and the North Sea; and 3) reduced volumes of natural gas imports.

Oil development by consuming economies is a form of direct investment in producing economies and contributes to technology transfers and the creation of employment opportunities. This in turn contributes to building stronger relationship between producing and consuming economies and stronger collaborative relations with the NOC in such economies. From a security standpoint, therefore, oil development by consuming economies has value beyond just trade volumes.

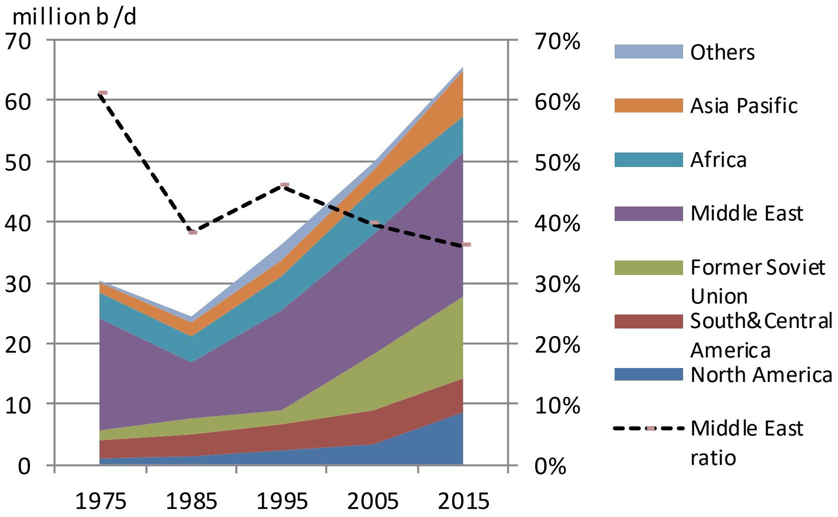
### 1-3. Diversification of crude oil import sources

#### 1-3-1. Security-related geopolitical aspects

The most important problems pertaining to oil security are regional imbalances caused by the uneven distribution of oil resources and the political instability of the Middle Eastern region, where there are vast oil resources.

According to BP statistics, Middle Eastern exports exceeded 60% of exports in the 1970s. The series of Arab-Israeli Wars resulted in a temporary drop in this figure, but it increased again afterwards. Beginning in the 1990s, increased production from the former Soviet Union and the North America gradually overlook Middle East as the top exporters by 2015. However, the absolute quantity of those exports remained unchanged.

**Fig. 1-4: Global crude oil trade (exports), 1975 - 2015**




Source: Created from annual editions of *BP Statistical Review of World Energy.*

#### 1-3-2. Japan's sources for crude oil imports and import volumes over time

This section will examine the diversification of consumer economies' crude oil import sources using the example of Japan.

The post-war Japanese economy developed at a tremendous rate, and its demand for energy increased consequently. Japan imported its oil from a limited range of economies, namely Middle Eastern economies such as Saudi Arabia and Iran.

Meanwhile, the burning of large amounts of fossil fuels for energy caused an environmental pollution problem due to the sulfur dioxide gases produced. This resulted in environmental legislation enacted in the late 1960s that called for a reduction in the sulfur content of petroleum products.

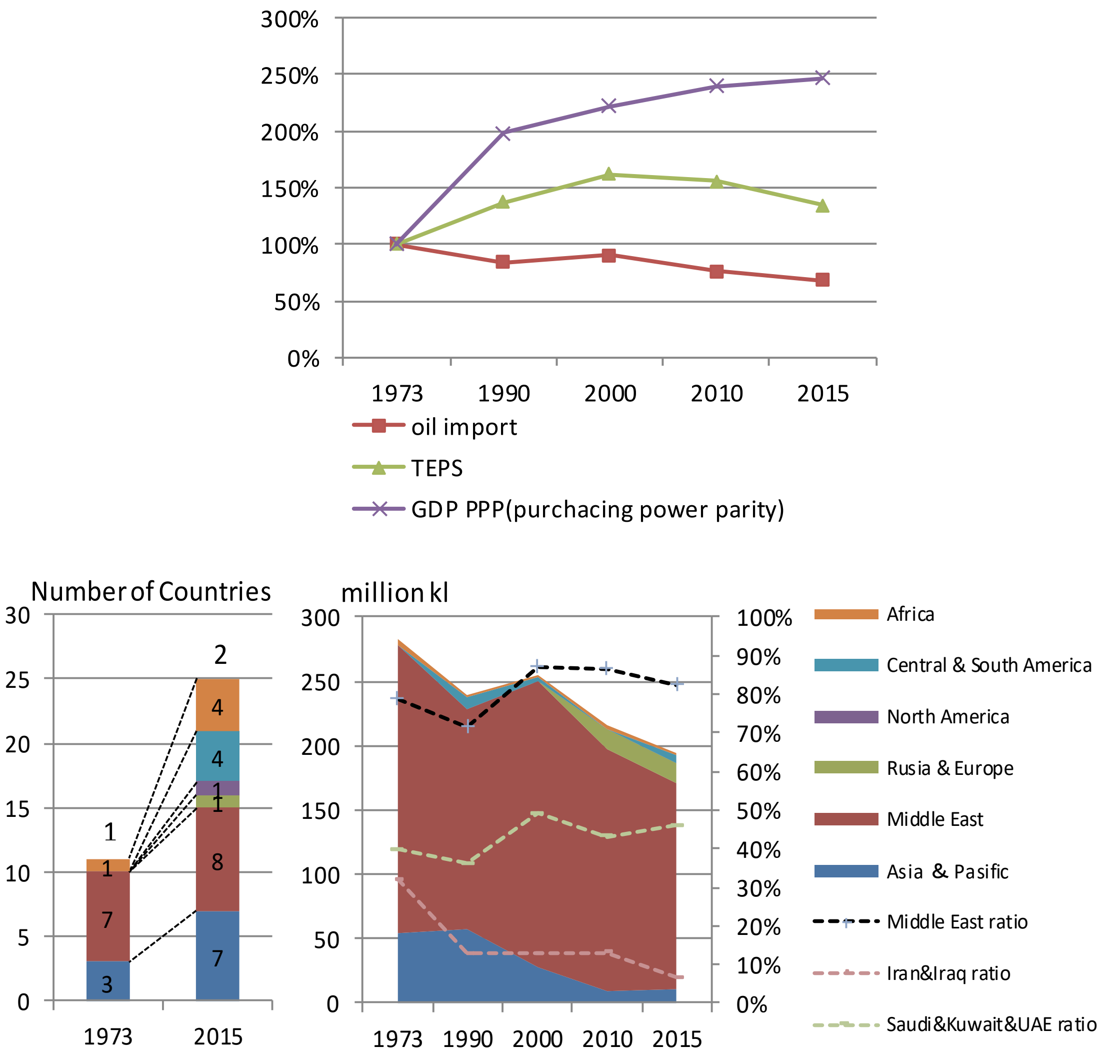
As a result, beginning in the 1970s, Japan began to import greater volumes of oil from economies that produce low-sulfur crude such as Indonesia and Africa, in addition to importing moderate-sulfur crude primarily from Middle Eastern economies. In addition to these demand-related changes, Japan also improved its position from a security perspective by building stronger relationships with Middle Eastern economies in addition to working to diversify its sources of crude oil imports to include Russia, Africa, Canada (non-conventional resources), Venezuela (heavy oil), and the Arctic. As a result, Japan more than doubled its number of sources for oil imports from 11 economies in 1973 to 25 economies in 2015.

Additionally, the promotion of alternative energy policies and energy conservation policies resulted in a decline in import volumes in the 1980s despite the growth of the economy[6]. Although import volumes would later increase slightly, energy conservation policies pushed forward after the 2011 earthquake have reduced total volumes.

Although Japan is still heavily dependent on the Middle East for crude oil imports, risk has been reduced through the cutting of the proportion of imports from politically unstable economies, such as Iran in the 1970s or Iraq in the 1990s, and the increasing of the proportion of imports from relatively stable economies such as Saudi Arabia, the UAE, and Kuwait.

[6] To avoid distortions caused by cost-of-living prices (inflation) and exchange rates, the graph uses the IEA's purchasing power parity GDP in 2010 US dollars.

Fig. 1-5: Changes in the sources of Japan's crude oil imports and import quantities




Source: Created from Agency for Natural Resources and Energy data and the 2016 IEA *World Energy Balances*.

## 1-4. Diversification of primary energy sources

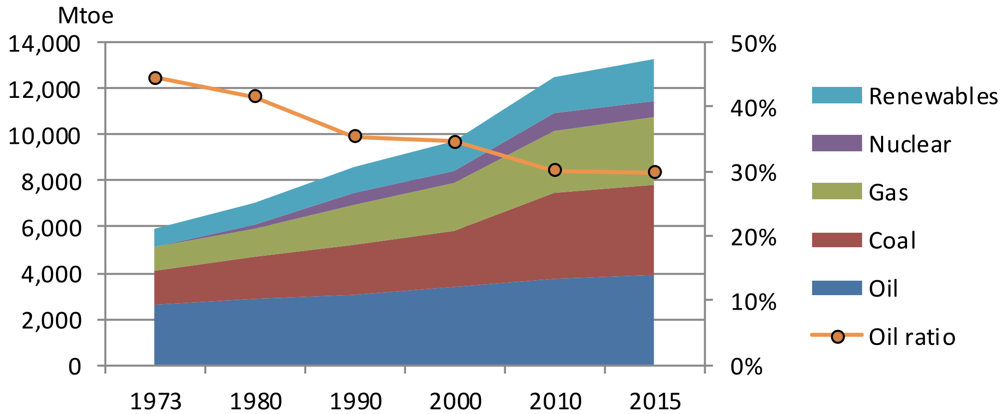
### 1-4-1. History of primary energy source diversification

After the sudden spikes in oil prices caused by the oil crises of the 1970s, there was a rush to introduce alternative energy sources (called "new energy") in Japan.

Additionally, in 1995 the first Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change was held. The Kyoto Protocol was adopted at the 1997 COP3 meeting and approaches to global environmental problems gained broad traction worldwide. "Environmental harmony" became an important pillar of

Japan's energy security policy. In the 2000s, this resulted in a strengthening of policies promoting the implementation of renewable energies in various economies and the further diversification of primary energy sources.

**Fig. 1-6: Global primary energy sources, 1973 - 2015 (reproduction)**



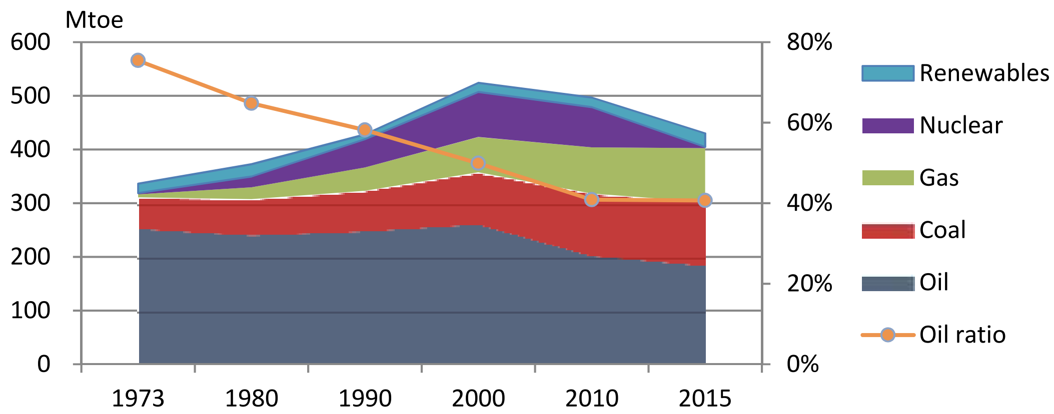

Source: Created from IEA *World Energy Balances, 2017*.

### 1-4-2. Diversification of Japan's primary energy sources

In Japan, the Law Concerning Promotion of the Development and Introduction of Alternative Energy was enacted in 1980 to accelerate the conversion to alternative energy sources and the development of new sources ("new energy"). On this basis, the Cabinet decided on "alternative energy supply targets" in the same year, and in October 1980 the New Energy and Industrial Technology Development Organization (NEDO) was established.

As a result of these policies, dependency on oil dropped from 75% in 1973 to 41% in 2015, indicating the ongoing diversification of primary energy sources.

**Fig. 1-7: Japan's primary energy sources, 1973 – 2015**




Source: Created from the annual editions of IEA's *Energy Balances of OECD countries*.

Among other important energy security policies, Japan also began importing liquefied natural gas (LNG) from the USA in 2017 due to lower gas prices caused by the increased production of shale gas in recent years. This is combined with an effort to diversify import sources, and the introduction of various contract types that are not linked to crude oil prices.

## 1-5. Promotion of methods of refining oil in consumer markets

### 1-5-1. History of refining oil in consumer markets

Oil refinery locations can be chosen either to be placed in producer economies to refine and export, or in consumer markets to be refined domestically from imported crude oil.

#### Early stages of oil use: Refining oil in producer economies

Petroleum products first entered the market in the 1800s, when kerosene began to be used as fuel for the Western-style lamps. Western-style lamps also came to Japan from the United States in the latter half of the 1800s. Japan's kerosene imports continued to increase year after year, and small crude oil production and oil refinery sites were even established in Niigata and elsewhere on the coast of the Sea of Japan. However, as demand for petroleum products was limited to mostly kerosene, they were mainly imported directly) from the international oil majors rather than being produced at domestic refineries. Therefore, throughout this period the main method in use was to refine oil in the producer economies.

#### Beginning of oil refinement in consumer markets

In the 1900s, the first oil fields were discovered in Iran and the zeal for upstream development spread to the Middle East. Global oil demand grew beyond just kerosene to include fuels for internal-combustion engines (gasoline, diesel fuel, heavy oil). This increased demand for multiple petroleum products triggered the construction of oil refineries in consumer markets around the globe. Demand for petroleum products surged in Japan beginning in the 1920s and domestically produced crude oil was not enough. Refineries began to be built along the Pacific coast that used primarily imported crude oil[7]. This chain of events served as the cause of the beginning of the refinement of oil in

[7] Beginning with Tsurumi in 1922 (Nippon Oil); Tokyo in 1926 and Yokohama in 1929 (both Ogura Oil); Osaka in 1929 (Maruzen Koyu); Kudamatsu in 1931 (Nippon Oil); Kawasaki in 1931 (Mitsubishi Oil and Hayama Sekiyu); and so on.

consumer markets.

**Development of oil refinement in consumer markets**

In subsequent years, with the Manchurian Incident in 1931, the Second Sino-Japanese War in 1937, and Japan's entry into the Second World War in December 1941, securing petroleum products for military use became an extremely important for Japan. In same way, throughout the world, military demand created a need to achieve oil security, to secure crude oil directly and to secure petroleum products through refining crude oil in consumer markets.

**Spread of oil refinement in consumer markets**

After the war, development and production of Middle Eastern crude oil by the European and American oil majors began. The oil majors needed to build a system by which to avoid the overproduction of crude oil as well as to secure markets to which they could sell the Middle Eastern crude oil that they produced. In 1947, the United States formulated the Marshall Plan to aid the reconstruction of war-devastated Europe, and throughout western Europe oil refineries began to be both rebuilt and newly established.

In the immediate post-war period, Japan met its oil demand through its limited domestic crude oil resources and oil released for use by the American occupational forces. However, in 1949, the United States approved the re-opening of refineries on the Pacific coast and the restarting of crude oil imports. These encouraged expansion of refineries in Japan.

**1-5-2. Advantages of refining oil in consumer markets**

The following summarizes the benefits of having oil refining conducted in consumer markets over refinement in producer economies?

1) Pricing for crude oil is more transparent than that for petroleum products. In 1945, there was no international oil futures trading market. The only crude oil prices at that point were the FOB Mexican Gulf Coast prices for shipments sent out from the coast of the Gulf of Mexico by the United States. However, with the increased production of Middle Eastern crude oil, there emerged FOB Persian Gulf Coast prices for shipments out of the Persian Gulf in the Middle East, which gave rise to a two-benchmark framework. Actual shipping expenses were then added on top of these prices to arrive at the Cost, Insurance and Freight (CIF) prices for crude oil.

   On the other hand, there was no common methodology used for calculating prices of petroleum products, except for certain products such as heavy oil for ships that are constant in one location and used in large quantities. There were also many types of petroleum products, and to that extent there were few individual transactions for such products and they were not invariable or price indications were not constant.

Thus, prices for crude oil were relatively more transparent, than for petroleum products to a certain extent, and hence making it more desirable to import crude oil over petroleum products.

2) The crude oil market is more liquid. There are no strict demands placed on the specifications of crude oil since it could be refined further into other distillates. However, more stringent specifications are demanded from petroleum products since they are used as fuel for internal combustion engines, and variation in specifications would affect the performance of the combustion engine. Therefore, if an economy were to import petroleum products, it would need to select products of a quality that meets its economy's standards, limiting its supply options. However, if crude oil is refined domestically, it is easier to import crude oil from global sources and manage the product quality of petroleum products supplied to the market, in economies away from hubs of petroleum products trade.

3) In terms of transportation, crude oil has the benefit of being easier to transport in large quantity over petroleum products.

   Due to higher market liquidity, crude oil could be transported in bulk via large oil tankers over long distances to any market. On the other hand, varied market requirements for specific petroleum products led to more targeted shipping routes. Therefore, the quantity of petroleum products per shipment is more varied, with most shipments made to nearby locations. Therefore, there was a natural difference that emerged over time between the growth of crude oil tankers and ships carrying petroleum products.

   Therefore, import of crude oil would be better able to enjoy economies of scale over import of petroleum products.

### 1-5-3. Role of oil refining in the consumer market of Japan

After the Second World War, all industries in Japan required urgent reconstruction and restoration, and to that end, the government needed to introduce a variety of new regulations. In this environment, oil refining in the consumer market of Japan served to make the regulatory net easier to accomplish by using product imports as a supplementary method of supply.

For example, in order to promote oil policy, the government introduced crude oil import controls based on the foreign exchange allocation system, followed by the enactment of laws such as the Petroleum Industry Law and the Petroleum Stockpiling Law. Later, the Provisional Measures Law on Importation of Specific Kinds of Petroleum Refined Products (i.e. the "Special Petroleum Law") was enacted in 1986 to liberalize petroleum product imports.

However, in reality, these laws served to protect the domestic oil industry, or the domestic oil refining industry. The foreign exchange allocation system was established to enable the importing of cheap crude oil rather than petroleum products, and the Petroleum Industry Law required oil refiners to create petroleum supply plans and granted licensed approval for oil refining work. The Petroleum Stockpiling Law obligated oil refiners to maintain reserves, but this also served to eliminate businesses that lacked tanks for their product. The Special Petroleum Law established a registration system for petroleum product imports and required licensees to comply with the following:

1) Equipment capable of producing the imported "specific kind of petroleum products" (gasoline, kerosene, diesel) to substitute for the imports if the imports decline in quantity;
2) Equipment for storing the "specific kind of petroleum product" or crude oil; and
3) Equipment for adjusting and regulating the quality of imported product.

## 1-6. Regulation of the domestic oil industry and oil market

### 1-6-1. History of Japanese oil policy

As per the framework established by the Petroleum Industry Law, Japan maintained import controls on petroleum products from the 1960s. However, further development of the international oil markets and stronger competition in the mid-1980s prompted further deregulation of the oil industry.

As a result, in January 1986, the Provisional Measures Law on Importation of Specific Kinds of Petroleum Refined Products (Special Petroleum Law) was enacted as a temporary measure to ease the pressure from the liberalization of petroleum product imports. Later, in November 1986, an Investigative Commission on Problems in the Oil Industry was established and the following "Deregulation Action Plan" was formulated to promote oil industry efficiency and further oil policy development.

**Fig. 1-8: Deregulatory measures implemented during "the first stage of deregulation"**

| Timing | Description |
|---|---|
| July 1987 | Added flexibility to licensing approval for secondary refining equipment |
| March 1989 | Ended guidance on gasoline production ceilings |
| October 1989 | Ended guidance on maintaining a certain quantity of kerosene stock before the high-demand season |
| March 1990 | Abolished registration transfer rules and construction guidance for gasoline filling stations |
| September 1991 | Added flexibility to the management of licensing approval for primary refining equipment |
| March 1992 | Ended guidance on crude oil processing ceilings |

Of the measures above, it was feared that the removal on crude oil processing ceilings in 1992 would result in overproduction and upset the market. However, the market remained stable because each oil company set production that was roughly appropriate for demand.

In the 1990s, amidst the collapse of Japan's asset price bubble, there was a demand for greater economic revitalization that focused attention once again on further market deregulation.

A Subcommittee on Problems in Oil Policy was established in February 1994, and in April 1995 the Special Petroleum Law was abolished and following legal changes implemented:

**Fig. 1-9: Deregulation measures implemented during "the second stage of deregulation"**

| Timing | Description |
|---|---|
| March 1996 | Abolished the Special Petroleum Law (i.e. the liberalization of petroleum product imports) |
| April 1996 | Enactment of the Quality Control Law (i.e. revision of the Gasoline Sales Law) |
| April 1996 | Revised the Petroleum Stockpiling Law |
| July 1997 | Effective liberalization of the authorization system for petroleum product exports |
| December 1997 | Abolished the gasoline supplier verification system |
| December 2001 | Abolished the Petroleum Industry Law |

In this way, the Japanese oil industry is now in a state of free competition. The industry has been increasingly integrated and reorganized, and as of September 2017, oil refining and direct sales are concentrated into four groups: JXTG, Idemitsu Kosan, Showa Shell Sekiyu, and the Cosmo Oil Company. There is a focus on the future course of the industry, as oil demand is expected to continue to decline in the future due to the dropping population caused by low birth rates as well as due to changes in the makeup of the industry and the economy.

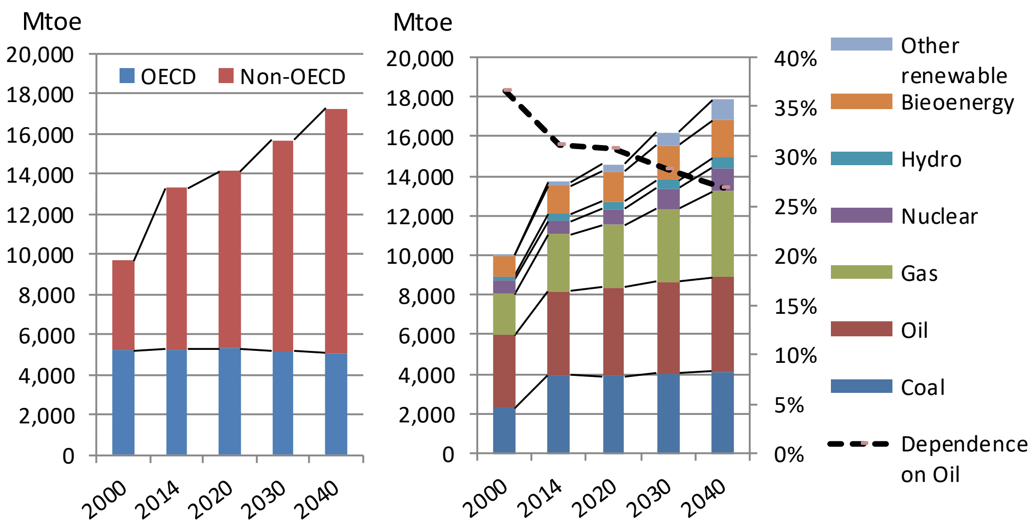
## 1-7. Reserves of crude oil and petroleum products

### 1-7-1. Outlook on the future of oil demand

As shown in the left diagram below, global energy demand is expected to decline in OECD member economies due to ongoing energy conservation efforts and similar initiatives. In non-OECD member economies such as China and India, however, energy demand is expected to grow, and hence demand is expected to grow overall.

By energy source, global alternative energy development is expected to result in lower oil usage relative to other energy sources, but consumption in absolute terms is anticipated to remain unchanged, and thus oil is expected to remain an important energy resource in the future.

**Fig. 1-10: Global primary energy demand by region and fuel type, 2000 - 2040, including future forecasts**




Source: Created from the 2016 IEA *World Energy Outlook*.

### 1-7-2. History of international cooperation towards achieving oil security

After petroleum became the leading source of energy in the 1950s, oil supplies were interrupted several times due to events like the Suez Crisis and the Iranian revolution.

With the aim of helping with oil supply interruptions, the OECD issued a recommendation to its member economies in 1962 that they maintain oil reserves equal to 60 days' worth of their net oil imports, expanded to 90 days' worth in a subsequent recommendation in 1971.

The main requirements for membership in IEA are that a economy 1) is an OECD member, and 2) comply with IEA's recommended oil stockpile (i.e. equal to 90 days' worth of net oil imports based on the daily net imports of the economy in the previous year). In the event of an emergency interruption of oil supplies or the risk of such an interruption, member economies coordinate the release of their reserves.

### 1-7-3. IEA member economies' oil reserve systems

In order to build and maintain their obligatory 90-day reserves, IEA member economies may use the following systems.

1) **Government stocks: Method of achieving emergency reserves typically using government funds**

   The government uses its tax revenues to acquire and administer land and oil for its emergency reserves, either directly by the government itself or through a reserves-administration organization.

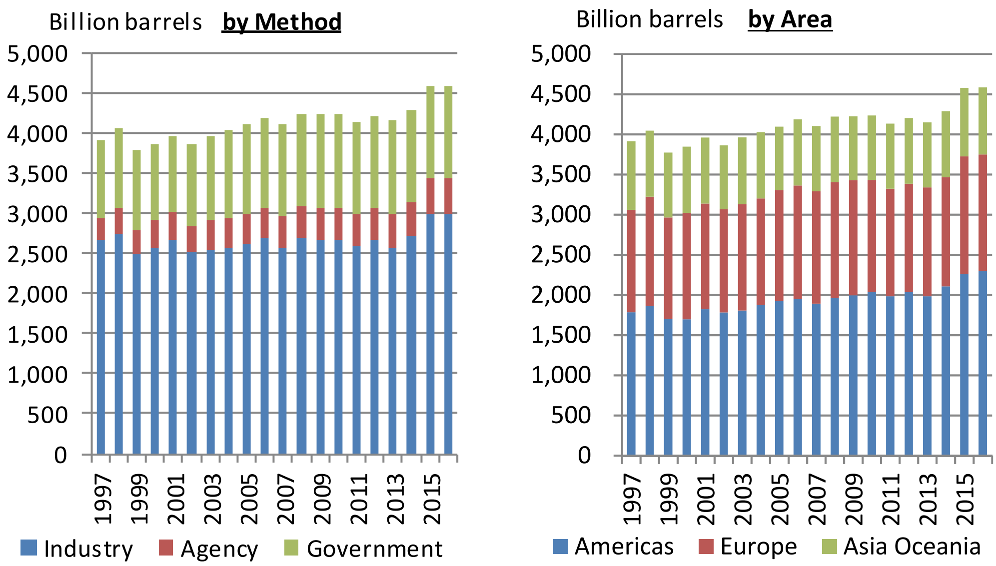
2) **Agency stocks: Emergency reserves are managed by an agency established by a public or private company**

   A system typically centered on a public reserves-administration organization established by law that builds and maintains reserves using contractor funds. The specific legal position or system used many differ slightly depending on the specific economy's market structure and approach.

3) **Industry stocks: Private companies are obligated to build emergency reserves or use their commercial inventories as reserves**

   A system wherein oil companies or other private companies are legally obligated to maintain reserves at or above a set level using their own facilities and at their own cost. Also called a corporate reserves system.

Fig. 1-11: Reserves in OECD areas, 1997 – 2016




Source: Created from the IEA's 2017 *Annual Statistical Supplement*.

### 1-7-4. International cooperation on oil reserves

The IEA was established in 1974, as one of the objectives for energy security, mainly oil, in member economy. In recent years, the proportion of oil demand in IEA member economies has been declining, but when IEA was established it occupied 70% of the world.

Under these circumstances, international cooperation on oil reserves is advancing. The IEA held Emergency Response Exercise in China in 2015, and more recently the Stockholding Workshop for India in March 2018. These workshops served to share knowledge and experience of IEA economies regarding strategic reserves to individuals in China and India. Also, the ASEAN economies signed the ASEAN Petroleum Security Agreement (APSA) in 1986. In 2002, the IEA began exchanging information with the ASEAN Council on Petroleum (ASCOPE) to support the revision of APSA, helping China, India, and ASEAN to build a system for strategic oil reserves for emergency situations.

Of the IEA's 30 member economies, six[8] use a system of "oil reserves." Japan holds periodic bilateral conferences with the United States Department of Energy and the Korea National Oil Corporation to strengthen collaborative relationships due to their large reserves, proximity to Japan, and other reasons. These conferences are held through the activities of the JAPAN Oil, Gas and Metals National Corporation (JOGMEC).

Meanwhile, Japan has also begun working with the oil companies of oil-producing

[8] Japan, USA, Korea, Poland, Czech Republic, New Zealand.

economies such as Saudi Arabia and the United Arab Emirates (UAE) to lend out petroleum tanks within Japan for use as a relay and storage hub for commercial crude oil destined for East Asian markets, in an agreement whereby Japan is to be given priority access to oil supplies in the event of a supply crisis. These projects were launched as "joint reserves with oil-producing economies," first with the UAE in December 2009 and then with Saudi Arabia in February 2010. The aim is to make effective use of the tank facilities as well as strengthen relationships with oil-producing economies.

### 1-7-5. Types of oil stored in the reserves

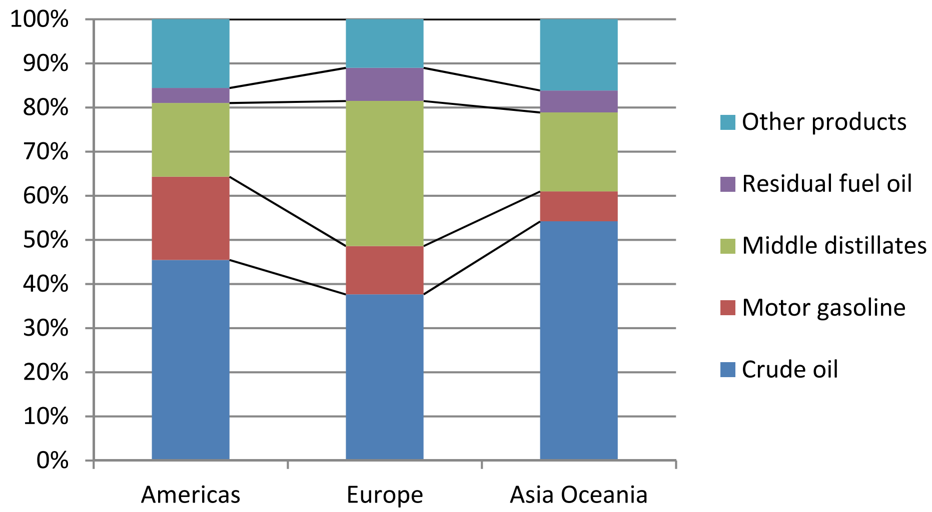
There is some debate over whether it is preferable to store crude oil or petroleum products as stockpiles. Each has its benefits and drawbacks.

For example, oil products are readily usable, offering the benefit that it would be possible to rapidly provide a supply of the necessary type of oil even if refining capabilities are lost. On the other hand, oil products are difficult to store and product standards change rapidly, making deposits and withdrawals of reserves necessary whenever there is such a change. Meanwhile, crude oil is more flexible, but there is a lead time required to refine crude oil into the desired petroleum products.

Therefore, it is difficult to determine which is better for any specific economy, and each economy selects the type of oil for its reserves based on its own refining, crude oil transport method, and other aspects of its situation. There is great variety in this respect across all regions and economies from the Americas to Europe, Asia and Oceania, and elsewhere.

It has also been noted that reserves of petroleum products such as jet fuel that have internally standardized quality specifications could be flexible enough for lending between economies. However, these types of products are not stored in reserves or lent between economies for a number of reasons: there is a limited amount in circulation, there is no need to limit the range of refueling sites as airplanes and similar vehicles can travel between locations, the quality standards for jet fuel are difficult to meet, and there is a higher priority to store consumer kerosene, which is similar is terms of the quality of the product.

Fig. 1-12: Breakdown of private inventories by region and category within OECD (2016)




Source: Created from the IEA's 2017 *Annual Statistical Supplement.*

## Chapter 2. Recent changes in the oil market

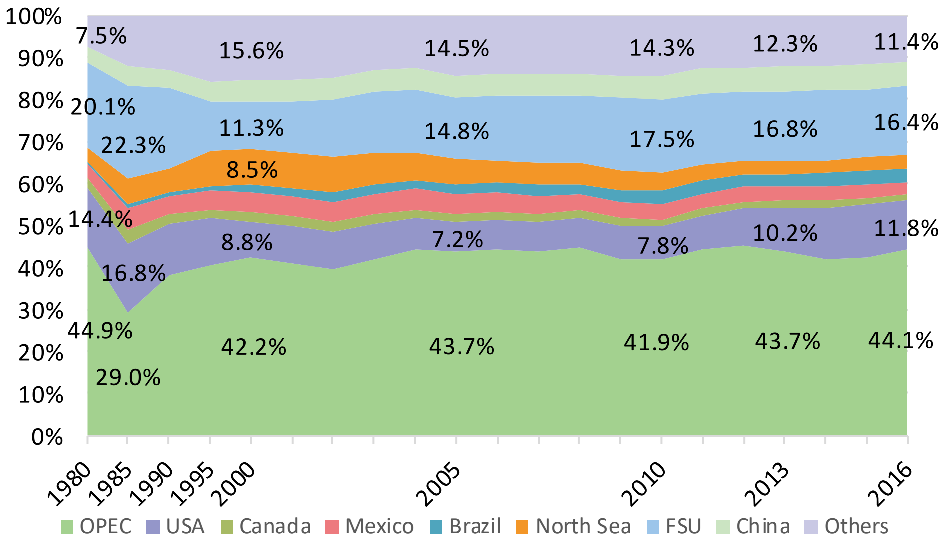
### 2-1. Changes in the power and strategy of NOC in oil-producing economies

#### 2-1-1. Increase in crude oil production by non-OPEC economies

The crude oil production volumes since the 1970s are printed in the annual OPEC publication *Annual Statistical Bulletin.* Over the course of this history, OPEC crude oil production once dropped dramatically: in the 10-year period of the 1980s that included the Iran-Iraq War, the introduction of oil futures trading on the market in 1983, and Saudi Arabia ending its public disclosure of Arabian Light crude oil prices and establishing a netback pricing system in 1985. OPEC's market share over this period dropped rapidly from 44.9% in 1980 to 29% in 1985.

OPEC's market share gradually recovered towards the end of the 1980s. However, when Iraq invaded Kuwait in August 1990, Iraq's 2.7 million b/d and Kuwait's 1.5 million b/d disappeared from the market. It was primarily Saudi Arabia and Iran that seemed to cover the drop in production from Iraq and Kuwait, and it would take several years before the UK and Norway, non-OPEC economies, were able to contribute with real production increases in the North Sea oil fields.

**Fig. 2-1: Market shares of OPEC and major non-OPEC economies, 1980 - 2016**




Source: Created from OPEC, *Annual Statistical Bulletin.*

Comparing the market shares of OPEC and non-OPEC economies in the period since 2000, the North Sea, Canada, and "Others" display a declining trend, whereas the USA and former Soviet Union economies (Russia, Azerbaijan, Kazakhstan, etc.) display a growing trend. Former Soviet economies' share grew through 2010 before seeming to enter a period of stagnation, while the USA's share jumped up nearly 5 percent between 2010 and 2015, but has been declining since 2016. Meanwhile, OPEC has been wavering at over 40% throughout the period.

### 2-1-2. Changes in OPEC strategy

#### OPEC gains the power to dictate crude oil prices

Taking a broad look at the oil market in the latter half of the 20th century, the oil market was hit by "oil shocks" following the 1973 Yom Kippur War. In this period, six oil-producing OPEC member economies in the Persian Gulf used oil as a political weapon, cutting supply. This completely transferred the power to dictate crude oil prices over to OPEC. Later, crude oil prices jumped up due to the 1979 Iranian Revolution and the 1980 outbreak of the Iran-Iraq War.

#### Finding a way to retain the power to dictate prices

Saudi Arabia and non-OPEC economies responded to these supply shortages with increased production, but as global demand cooled down, this turned into a supply glut in 1981. OPEC then set out to adjust production, attempting to maintain its benchmark crude oil price at $32/bbl. However, within OPEC there were efforts to lower the official price of African crude oil and some oil-producing economies rushed to increase production. By June 1982, OPEC had lost its cartel capabilities.

In the March 1983 OPEC general meeting, they decided to lower the benchmark price for crude oil to $29/bbl and set a production ceiling at 17.5 million b/d, while Saudi Arabia was designated the "swing producer" for the group. Later, there were price drops caused by sluggish sales in African economies and the production ceiling was reduced to 16 million b/d, but this was not adhered to. As a result, the production volume of Saudi Arabia, which maintained the official prices, temporarily sank to as low as 2.5 million b/d.

#### Introduction of market prices for crude oil

At the July 1985 OPEC general meeting, Saudi Arabia made it clear that they could not serve as the swing producer for the group. Also, in September Saudi Arabia implemented a netback pricing system[9], estimating the value of crude oil on the market

[9] A netback pricing system derives the realized price of crude oil by working backwards

and adopting a method of setting crude oil prices. At the same period, American WTI crude oil futures began trading on the market, causing structural changes in the oil markets. OPEC's power to control oil prices was significantly diminished in this period.

**Crude oil prices drop as OPEC declares intention to retake market share**

At the December 1985 OPEC general meeting, OPEC declared its intention to recapture the market share lost by non-OPEC economies. The market began to weaken in response, and by January of the following year North Sea crude oil had dipped below $20/bbl and crude oil prices had dropped dramatically across the board. In order to protect their own economies' market share, individual oil-producing economies used netback pricing, market-linked pricing[10], and other methods to determine prices that would give them an advantage over other producers, accelerating the decline in prices. Prices dropped from $20/bbl to $7/bbl in just six months.

**Return of the benchmark pricing system**

Amidst collapsing prices, OPEC decided at its August 1986 general meeting to reduce production levels from over 20 million b/d to 16.5 million b/d, and in its December general meeting it voted to maintain strict compliance to a 15.8 million b/d production ceiling for the first half of 1987 in addition to returning to the $18/bbl benchmark pricing system. Saudi Arabia also ended its netback pricing system at this time. Meanwhile, OPEC began publishing the "OPEC basket price" as a pricing index. The basket price is a weighted average of representative crude oil prices in OPEC member economies.

**Financial instruments based on oil prices**

In August 1990, Iraq invaded Kuwait, resulting in embargoes on both economies. Iraq threatened to attack Israel; tensions arose over inspections in Iraq; the Soviet Union collapsed at the end of 1991, causing disorder and confusion; and the global economy entered a slump in 1993. All of these factors caused waves in crude oil prices. In 1994, the global economy began recovering and the U.S. Federal Reserve Bank (FRB) raised interest rates in February of the same year. This caused a dip in stocks and bonds in American financial markets, sending capital flood into the crude oil market instead. As a result, from 2000 on, the oil futures market became more of a speculative "money game" and included increasingly more oil-based financial instruments, against a backdrop of

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based on the yield of oil products at their spot price in a consumer economy. The costs of refining, transport, and other factors are then deducted to determine the FOB price.

[10] A method of price-setting based on prices in the crude oil market.

global monetary easing. Oil came to be heavily impacted by trends in the futures market and trading in other financial derivatives. From this point on, not only the activities of OPEC but their relations to non-OPEC activity came under focus as one of the most important factors affecting crude oil prices.

**Collaboration with non-OPEC economies**

The prime example of collaboration and cooperation with non-OPEC economies was the December 2001 agreement between OPEC and non-OPEC economies to cut production. In this agreement, 11 OPEC economies (not including Iraq) and 5 non-OPEC economies (Russia, Norway, Mexico, Oman, Angola) agreed to cut production by around 2 million b/d from January to June 2002.

Although crude oil prices had dropped below $20/bbl at the end of 2001, these collaborative production cuts resulted in a recovery of the price to $30/bbl. With OPEC alone, the market share was 41.1%, but when combined with non-OPEC market share increased to 63.8%.

Another round of collaborative production cuts was agreed to in December 2016 between 14 OPEC economies (not including Libya and Nigeria; Indonesia withdrew) and 11 non-OPEC economies (Russia, Azerbaijan, Kazakhstan, Mexico, Oman, Malaysia, Bahrain, Brunei Darussalam, Equatorial Guinea, Sudan, and South Sudan) to cut production by around 1.8 million b/d from January to June 2017 (extended until end of 2018 in later discussions). Participating economies accounted for a market share of 65.8%.

**Global expansion into the downstream oil sector (development of unique strategies for securing oil revenues)**

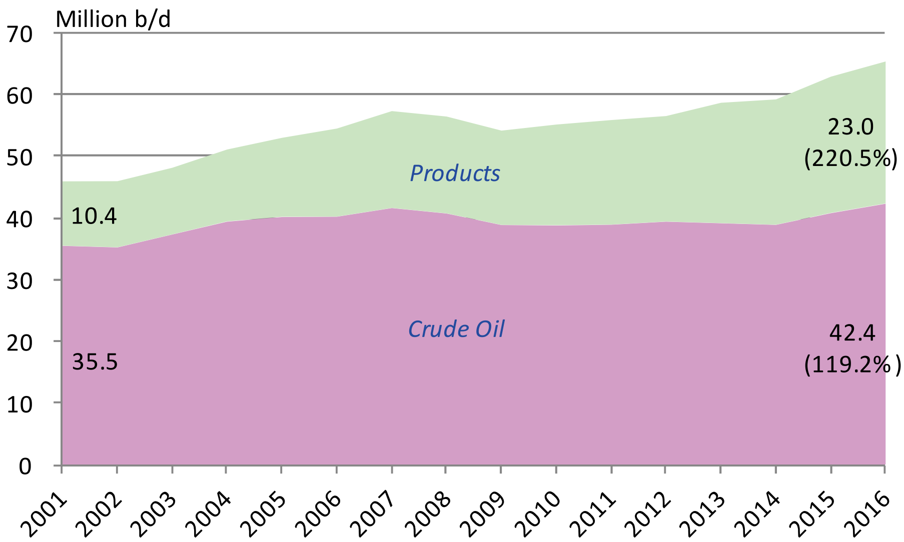
An example of OPEC oil-producing economies' expansion into the downstream oil sector is the entry of Kuwait Petroleum International, founded in 1983, into Europe's oil refining and petroleum products trading business. In the latter business, the company established the "Q8" brand, a play on the pronunciation of "Kuwait". In addition, OPEC economies have entered the market in consumer economies by acquiring stock in local oil companies, such as Saudi Aramco's 1991 acquisition of stock in Korean company S-Oil and its 2004 acquisition of stock in Japanese company Showa Shell Sekiyu. Another example, though not of an oil company in an oil-producing economy but rather a government-run fund, is of the UAE's International Petroleum Investment Company (IPIC)'s 2007 acquisition of stock in the Cosmo Oil Company and its 1994 investment in Austrian energy company OMV.

Direct involvement in the downstream oil sector has been picking up steam again in recent years. Noticeable examples of this in consumer economies includes the involvement in 2002 of Saudi Aramco in the management of refineries owned by the American company Motiva (in 2017, ownership was split between Saudi Aramco and Royal Dutch Shell on a per-refinery basis, whereby Saudi Aramco assumed ownership of the Port Arthur refiner (600,000 b/d) and other interests), as well as Saudi Aramco's 2007 acquisition of a 25% interest in Chinese company Sinopec's Fujian refinery (240,000 b/d); its 2016 acquisition of a 45% interest in the Cilacap refinery (400,000 b/d) with Indonesian company Pertamina; and its 2017 acquisition of a 50% interest in the newly-constructed Rapid refinery (300,000 b/d) with Malaysian company Petronas.

**2-2. Upswing in petroleum products trading and market formation**

Looking at trends in the oil market in the 2000s, there was an increasing trend in the trade volume of petroleum products. According to the BP *Statistical Review of World Energy*, global oil trade volumes grew by around 40% in the 15 years from 2001 to 2016. Among others, trade in crude oil grew by around 20%, while trade in petroleum products increased by around 120%.

**Fig. 2-2: Trade volumes in crude oil and petroleum products, 2001 - 2016**




Source: Created from the BP *Statistical Review of World Energy*, "Oil Trade Movement"

In what regions is the increase in petroleum product trade volumes occurring? The table below shows how product exports and imports changed by region from 2001 to 2016. Overall petroleum product trade volumes increased by 120%, increasing across most regions and economies. Exports grew especially in the United States and Asia, while imports grew especially in Asia. The increase in exports and decrease in imports in the United States are thought to be attributable to the increase in volumes of domestic refining resulting from increased shale oil production.

**Fig. 2-3: Changes in petroleum product trade volumes by region**

| (million ton) | Products Export | | | Products Import | | |
|---|---|---|---|---|---|---|
| | 2001 | 2016 | Change | 2001 | 2016 | Change |
| USA | 41.7 | 203.1 | ↗ | 118.3 | 104.5 | |
| The Other Americas | 75.1 | 67.8 | | 35.5 | 160.3 | ↗ |
| Europe | 40.5 | 132.2 | ↗ | 105.3 | 200.8 | ↗ |
| FSU | 70.6 | 159.7 | ↗ | 5.5 | 13.9 | |
| Middle East | 107.9 | 184.3 | ↗ | 4.4 | 55.1 | ↗ |
| Africa | 39.3 | 34.4 | | 18.3 | 92.4 | ↗ |
| China | 7.9 | 46.0 | ↗ | 28.0 | 74.5 | ↗ |
| Japan | 4.5 | 14.7 | | 45.2 | 39.1 | |
| Other Asia Pacific | 61.4 | 263.0 | ↗ | 94.8 | 364.8 | ↗ |
| ・Australasia | 5.0 | 3.9 | | 4.4 | 27.6 | |
| ・India | na | 61.9 | | na | 30.0 | |
| ・Singapore | na | 93.7 | | na | 121.4 | |
| ・Others | 56.4 | 103.5 | ↗ | 90.4 | 185.8 | ↗ |
| Asia Pacific Total | 73.8 | 323.7 | ↗ | 168.0 | 478.4 | ↗ |
| Unidentified | 26.4 | | | 20.0 | | |
| Total | 475.3 | 1,105.2 | ↗ | 475.3 | 1,105.2 | ↗ |

Source: Created from the BP *Statistical Review of World Energy*, "Oil Trade Movement"

How should developments in Asia be understood? Only the general points can be seen because the published BP statistics do not contain specific trade volumes by economy and region for 2001. However, India and Singapore were aggregated into "other Asian Pacific states" in 2001 but extracted out in 2016. Therefore, although exports from "other Asian Pacific states" totaled 61.4 million tons in 2001, exports from "other Asian Pacific states" more than quadrupled in 2016 to a total of 263 million tons. Of these 263 million tons, exports from India totaled 61.9 million tons, exports from Singapore totaled 93.7 million tons, and exports from the remaining other economies totaled 103.5 million tons. The aggregated total from 2001 of 56.4 million tons included exports from India and Singapore, and most of the total was likely attributable to exports from India's Jamnagar Refinery (660,000 b/d), put into operation by Reliance Industries in 1999, and from the entrepôt trade hub of Singapore. In 2016, a second Jamnagar refinery (completed in 2009; production of 580,000 b/d) and Essar Oil's Vadinar refinery had been added in India, and petroleum product exports had increased to an extent exceeding domestic demand to economies such as Korea and Chinese Taipei.

Meanwhile, total imports for all of Asia grew 180% from 168 million tons in 2001 to 478.4 million tons in 2016. Imports for "other Asian Pacific states" grew 280% from 94.8 million tons in 2001 to 364.8 million tons in 2016, of which one-third were attributable to Singapore at 121.4 million tons. The "Others" category accounted for 185.8 million tons despite excluding Australia, India, and Singapore, indicating that imports also grew drastically in other economies. This increase in imports for Singapore and other economies is thought to be mainly due to the growth of the Singapore oil distribution market, stronger quality regulations in Asian economies for petroleum products' environmental impact.

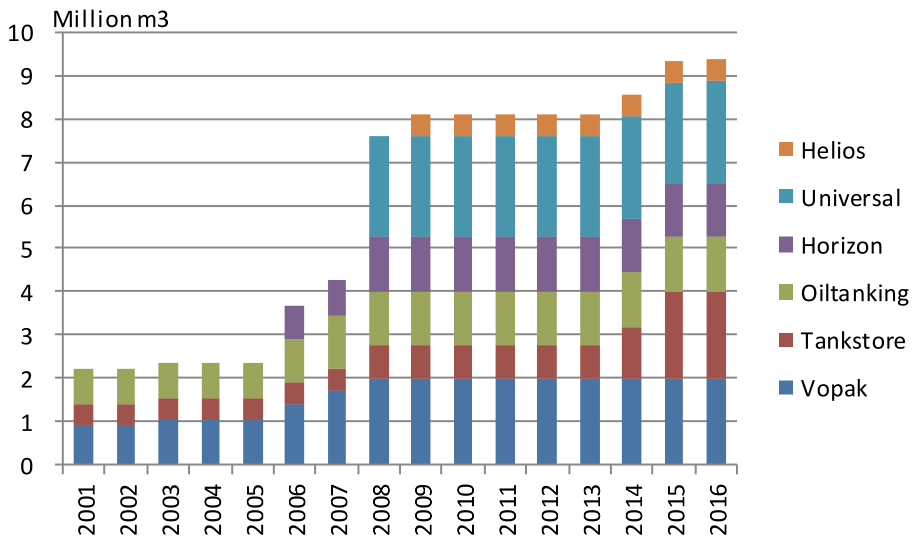
### 2-3. Increased transparency in pricing and better adaptation to price volatility

#### 2-3-1. Enrichment of the Singapore oil distribution market

Singapore developed as a unique market in which traders and independent tank operators are free to engage in business. Especially after 2000, as oil demand grew in developing economies in Asia, Singapore became an important hub of the oil distribution market.

Singapore's tank capacity by oil terminal over time can be used as an example to illustrate the way in which Singapore has grown. From 1990 on, a 3-company structure kept petroleum product tank capacity hovering around 1.5 and 1.8 million $m^3$, but this grew to 2 million $m^3$ in 2001 and then to 9 million $m^3$ in 2016. This is due to the demand for tanks in Singapore in order to participate in FOB Singapore transactions using the indices on Singapore's oil futures market described below.

Fig. 2-4: Singapore tank capacity by terminal, 2001 - 2016




Source: Created from data on each company's website

Although not shown in the diagram above, there are a total of 71 jetties across all terminals, some of which are capable of receiving Very Large Crude Carriers (VLCC). These jetties are used to refuel VLCC with heavy fuel oil, aiding Singapore's role in trading.

Additionally, there are various divergent quality specifications for petroleum products in Asian economies. To address this, quality is adjusted by connecting oil tanks with adjacent refineries via pipelines, and oil tanks and petrochemical tanks can also be connected to enable traders to provide gasoline component materials to one another. Singapore's functionality in trading was thus developed further.

### 2-3-2. Singapore's futures market

In the oil futures market, liquidity and market price reliability are required. The "Platts Window"[11] was introduced in Singapore in 1992, before being introduced later in Europe in 2003 and the United States in 2007. This resulted in a global oil futures market in which regional markets are connected to each other with almost no breaks in trading time, from Singapore to Europe and to the United States, and then back to Singapore the next day, increasing liquidity. Moreover, the constant publication of the state of "buying" and "selling" in the market as global markets inherit each other's trends

[11] Platts Oil Pricing and MOC Methodology Explained, June 2010, https://www.platts.com/IM.Platts.Content/InsightAnalysis/IndustrySolutionPapers/moc.pdf

also increases the reliability of market prices. Through this, Singapore's oil futures market has risen to be on par with American and European oil futures markets.

Trading takes two forms: "physical" trading that entails buying and selling real physical commodities, and "paper" trading that does not require the buying or selling of real physical commodities. In Singapore, the oil distribution market and the oil futures market developed in tandem. Put in extreme terms, the oil distribution market deals in real physical commodities, whereas the oil futures market creates profits and losses through numerical differentials and does not involve real physical commodities.

Paper trading is often used for hedging. In the oil industry, "hedging" means to offset the price fluctuation risk of a petroleum product by also engaging in the opposite type of trade. For example, when buying a petroleum product on the spot market, future price fluctuation risk can be offset by also reserving the sale of the petroleum product on the futures market. A prime recent example of this type of transaction was hedging by shale oil producers in the United States. In order to lock in a sale price at a profitmaking level (e.g. $70/bbl), the producers used the futures market to reserve the right to sell at $70/bbl. If the spot price is $80/bbl when it comes time to close their futures position, they use paper trading to buy their position back at $80/bbl and simultaneously sell the physical commodity at $80/bbl, effectively resulting in a sale at $70/bbl. Even in the reverse scenario, where the spot price has dropped to $50 bbl, the position is bought back at $50/bbl and the physical commodity simultaneously sold off at $50/bbl, effectively resulting in a sale at $70/bbl. For this reason, shale oil production did not drop even when spot prices sank below the break-even point.

### 2-3-3. Pricing mechanisms in major economies

**China**

Domestic petroleum product prices in China are controlled by the government, and in the early 2000s international market prices for crude oil were constantly divergent from the government-controlled prices. Thus, the sudden growth in domestic demand in China resulted in an increasingly large percentage of crude oil being imported, with the proportion of imports exceeding 50% in 2009. This caused huge losses for Chinese oil companies that had to be covered by the Chinese government.

In 2009, the Chinese government introduced a pricing system in which petroleum product prices were strongly linked to international crude oil market prices. The government would set a "price ceiling" for retail and wholesale, and refiners and distributors could freely set their own prices as long they were below the ceiling. The crude oil prices used as indices for the price ceiling were Brent, Cinta, and Dubai prices, and the price ceiling would change if these prices varied more than 4% over 22 consecutive business days. However, there were problems with this method of price-setting, including that it did not allow for immediate response to changes in crude oil prices, and that the government would delay changing the price ceiling out of fears of inflation.

As a result, in order to further strengthen the linkage to market prices in the international crude market, the Chinese government in 2013 changed the basket of crude oil prices used to determine its price ceiling to the Brent, Dubai, and ESPO prices, in addition to shortening the period to 10 consecutive business days and abandoning the 4% price fluctuation range. These revisions significantly strengthened the linkage between the retail "price ceiling" and Singapore's product prices.

### Malaysia

In Malaysia, government price controls have been in place since the 1983 Automatic Price Mechanism (APM) was enacted. This system was used as an effective policy tool for supporting the poorer classes of the Malaysian population. Retail prices under APM are comprised of six components: 1) Production costs, 2) Retail costs, 3) Delivery costs, 4) Retail shop profit margins, 5) Oil company profits, and 6) Taxes or subsidies. Prices are based on Singapore product prices and costs, but the government will use subsidies to adjust prices in response to fluctuations in Singapore product prices and maintain local retail prices at a fixed level.

However, sudden jumps in crude oil prices cause increases in fuel subsidies that place stress on the government's finances, impacting the government's fiscal balance as well as the economy's trade balance and other aspects. As a result, in December 2014 Malaysia ended its subsidies for RON95 gasoline and diesel oil, switching over to prices linked to market prices on the international oil markets.

### Korea

In Korea, the Petroleum Business Act enacted in 1970 stipulated that, as of 1976, the petroleum product distribution would use a three-stage vertical structure: Direct sales by oil producers ⇒ distributors ⇒ gas stations. Reselling between vendors was prohibited. However, the government unveiled a policy in May 2009 under which reselling between vendors would be permitted in an attempt to promote competition in the domestic oil distribution market and lower domestic retail prices.

As direct sales by oil producers at their own outlets improved, the government in 2008 ended the sign pole display system at gas stations, and retail vendors were enabled to sell a variety of direct-sales products. In 2012, in order to further stimulate trading outside of producer outlets, the government established an oil exchange at the Korea Exchange (KRX) e-commerce market and began dealing in imported petroleum products.

Korea's price-setting mechanism, from a position as an exporter in Asia and especially in the Singapore market, is based on the MOPS (Mean of Platts Singapore) price published by Platts and takes into account freight costs, brand costs, and shifts in supply and demand in the domestic market.

### Chinese Taipei

In Chinese Taipei, the Petroleum Law was established in November 2001. This law ended the monopoly of the state-owned CPC Corporation and enabled any company to participate in the importing business if it satisfied three requirements: It must be a joint-stock company; it must own an oil tank; and it must have reserves equal to 60 days' worth of the volume it sells in a day. In reality, the market since 2001 has been dominated by an oligopoly consisting of the CPC and the private Formosa Petrochemical Corp.

Beginning in 2001, a path was established for the private sector to participate in the petroleum sector, but the government intervened in retail prices for petroleum products through 2008. These prices were decided with reference primarily to the Singapore products market and considered factors such as oil companies' costs, international competitive strength, and tax revenues. As a result, the prices decided often diverged from international petroleum product prices.

A new policy, the Action Plan for Stabilizing Current Prices, was introduced in 2008 in a shift to make domestic petroleum product prices come in line with crude oil prices in international markets. Afterward, retail prices for gasoline and diesel oil were gradually lowered.

In this way, each economy is generally doing away with old, opaque, arbitrary methods of setting domestic petroleum product prices and conforming to international prices instead. Together with the extensive oil tank capacity in Singapore's oil distribution market and the spread of Platts in Singapore's futures markets, this could be considered as a proof that petroleum product liquidity and market price reliability have increased.

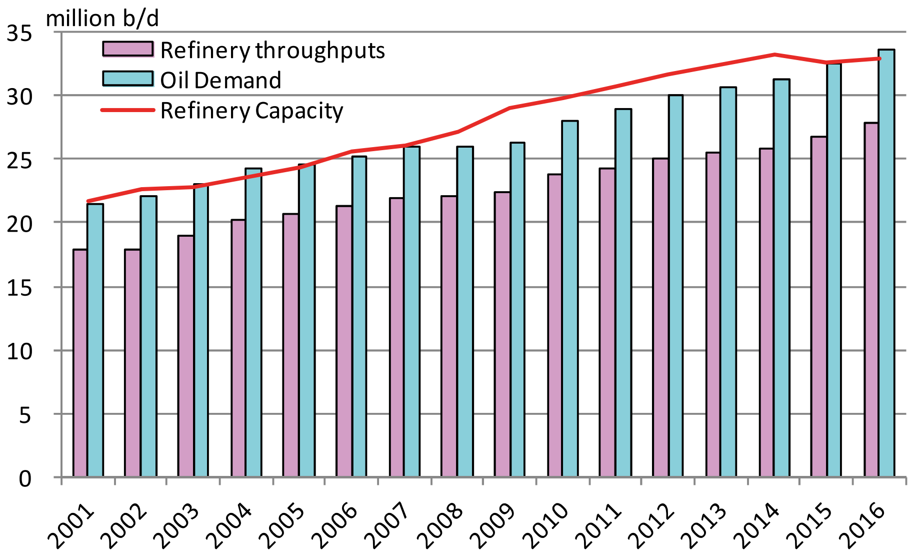
Korea and Chinese Taipei in particular, both economies being built on product exports, are now able to quickly handle petroleum product exports to Asia and the Pacific Rim due to refining companies' full stock of export-oriented facilities and the linkage of domestic prices to MOPS.

## 2-4. Expansion of Asian oil demand and inconsistent investment in refinery capacity (both insufficiency and excess)

### 2-4-1. Oil supply and demand in Asia

According to the BP *Statistical Review of World Energy 2017*, oil demand in Asia as a whole grew 57% from 2001 to 2016, from 21.45 million b/d to 33.60 million b/d. Meanwhile, refinery capacity grew 51% from 21.70 million b/d in 2001 to 32.80 million b/d in 2016. If oil demand is simply compared to refinery capacity, it can be seen that refinery capacity has changed from a 300,000 b/d surplus in 2001 to an 800,000 b/d shortage in 2016. When crude oil is refined, there is an increase in the volume of petroleum product produced called “processing gains” that creates the illusion that almost the full refinery capacity is fulfilled.

**Fig. 2-5: Refinery capacity and oil demand in Asia, 2001 - 2016**




Source: Created from BP *Statistical Review of World Energy,* “Refinery Capacity, Throughput, Oil Consumption”

However, in reality, excess or shortage is caused by the following factors.

1) Refinery capacity cannot always be maintained at 100% due to inevitable downtime from regular inspections and unforeseen accidents. There are also factors that it is more economical to import petroleum products such as naphtha and LPG from other areas. Therefore, looking at the volume of crude inputs, the BP statistics show refinery utilization at just 76-85% with a chronic product

shortage throughout Asia.

2) Even if there is a balance in terms of the total volume of petroleum products, processing crude oil inevitably produces joint products. In producing needed petroleum products, unneeded products will also inevitably be created during the process. Similarly, if refining is conducted so as to minimize the unneeded products created as much as possible, the result will be a lack of the products that are actually needed. In reality, there is a tendency to operate refineries so as to maximize production of the most profitable or highest-priced petroleum products, resulting in many cases in gasoline or diesel oil production being maximized.
3) Asia is looked at as a whole, but if individual economies are examined, both excesses and shortages will be found on an economy-by-economy basis.

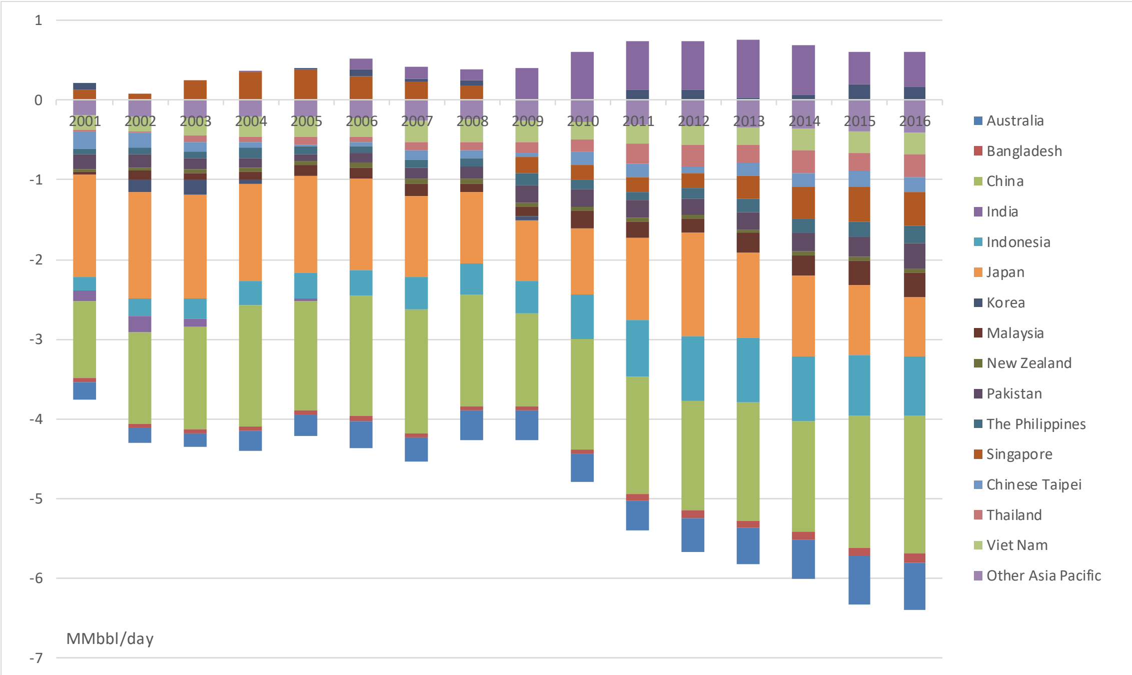
### 2-4-2. Oil supply and demand in major economies

In this section, the above three points will be examined in more detail. Calculating differences between the volume of crude oil inputs and oil demand on a economy-by-economy basis reveals a large surplus in Singapore in the early 2000s, a surplus in Korea beginning in 2005, and a surplus in India beginning in 2009.

There are generally supply shortages in all other economies. China, in particular, shows a growing supply shortage. Refinery capacity in 2001 was 5.6 million b/d and grew to 14.3 million b/d in 2016, having been built up by an order of 2.5 times. Yet the demand for petroleum products in 2001 grew from 4.8 million b/d in 2016 to 12.4 million b/d in 2016, a change of 2.57 times. Thus the on-paper supply shortage grew by around 1.8 times from 2001 to 2016, from 960,000 b/d to 1.7 million b/d. Still, it must be remembered that some of these imports include imports of heavy oil as a raw material for refining by small-sized "teapot refineries".

Shortages are growing every year in Indonesia and Malaysia. Meanwhile, in Australia, changes in energy policy have resulted in refinery capacity halving from 800,000 b/d in 2001 to 450,000 b/d in 2016. This has resulted in an increase in petroleum product imports in Australia. In Japan, refineries have been consolidated and capacity cut since 2006 in response to low oil demand and worsening profit margins for refineries. As a result, refining volumes were declined according to the oil demand. Presently importing petroleum products is mostly naphtha due to the decrease in production naphtha.

Fig. 2-6: Shortages of petroleum products by Asian economies, 2001 – 2016




Source: Created from BP *Statistical Review of World Energy,* "Refinery Throughput, Oil Consumption"

### 2-4-3. Refinery construction planning in Asian economies

Working under the assumption of growth in oil in the future, this section will examine the state of major refinery construction and upgrading from 2015 to the present in economies that are chronically in an importing posture.

### China

From the start of the 2000s to the present, China has been a constant importer of petroleum products in the order of over one million barrels per day. This combined with stronger quality controls on petroleum products and increased demand from the petrochemical industry have caused a flood of construction projects to build new refineries and expand on, modernize, or upgrade existing refineries.

Fig. 2-7: Major refinery construction and upgrading in China

| Company | Partner | Status | Ref Name | Capa.(b/d) | Project |
|---|---|---|---|---|---|
| NORINCO | Saudi Aramco | New | Panjin | na | MOU of Refining, Petrochemical and Retail Project, May 2017, Panjin, Liaoning |
| Zhejiang Petrochemical | - | New | Zhoushan | na | Oil & Petrochemical Complex, on going |
| CNPC | Rosneft | New | Tianjin | 320,000 | 9.1 million b/d ESPO crude oil as feed, FS stage, by end of 2020 |
| PetroChina | - | expansion | Yumen | - | 5.9% Capa up, on going |
| PetroChina | - | up grade | Dushanzi<br>Tahanan<br>Jinxi<br>Lanzhou | -<br><br><br>250,000 | below 10ppm for Gasoline and Diesel, on going<br>below 10ppm for Gasoline and Diesel, on going<br>install RFCC & Alkylation, on going<br>below 10ppm for Gasoline and Diesel, Jan. 2017 |
| Sinopec | - | up grade | Maoming | - | High grade Lubricant oil, June 2016 |
| Shandong Dongming Petrochemical | - | up grade | Shandong | - | Low Sulfur Diesel, on going |
| PetroChina | - | up grade | Liaoyang | - | Russian Crude oil as feed, on going,<br>Production of value added products, on going |
| PetroChina | - | up grade | Sichuan | - | Production of value added products, on going |
| Hengli Petrochemical | - | New | Changxing | 400,000 | below 10ppm for Gasoline and Diesel, on going<br>Paraxylene Max production, on going |
| Sinochem | - | expansion | Quanzhou | +60,000 | From 240,000 to 300,000b/d, Approval by Gov. |
| CNOOC | Shell | expansion | Dayawan | - | Additional Ethylene cracker, Dec 2015 Agreement |
| Sinopec | - | expansion<br>up grade | Jiujiang | +60,000 | From 100,000 to 160,000b/d, 240,000ton/y of Hydro Cracker, Oct 2015 |
| PetroChina | - | up grade | Hunbei | 100,000 | Octane boost plant, Sept 2015 |
| CNOOC | - | up grade | Zhongjie | 46,000 | Heavy type crude oil processing, planning |
| Sinopec | - | New | Caofeidian | 240,000 | Saudi crude oil as feed, After 2020 |
| Sinopec | - | New | Guangdon | 300,000 | by end of 2017 |
| Sinopec | - | New | Hainan | 100,000 | After 2020 |
| CNPC PetroChina | - | New | Anning | 260,000 | Saudi and/or Kuwait crude oil as feed through Myanmar Pipeline, by end of 2018 |
| CNPC PetroChina | - | New | Guangdon | 400,000 | by end of 2018 |
| CNOOC | - | expansion | Ningbo Daxie | +160,000 | From 140,000 to 300,000b/d, by end of 2020 |
| CNOOC | - | expansion | Huizhou | +200,000 | From 260,000 to 460,000b/d, by end of 2018 |

Source: Created from information on company websites and oil industry publications

## Indonesia

As Indonesia's refinery capacity covers only half of its oil consumption, Pertamina wishes to expand refinery capacity from its current state of 1.05 million b/d to 1.7 million b/d by the first half of the 2020s.

Fig. 2-8: Major refinery construction and upgrading in Indonesia

| Company | Partner | Status | Ref Name | Capa.(b/d) | Project |
|---|---|---|---|---|---|
| Pertamina | - | expansion<br>up grade | Balikpapan | +160,000 | From 260,000 to 360,000b/d,<br>install CCR & Hydro Cracker, by end of 2019 |
| Pertamina | Rosneft | expansion<br>up grade | Tuban | +200,000 | From 100,000 to 300,000b/d, install secondary unit for gasoline, diesel & jet fuel and Petrochemical complex Facilities, under FS, by end of 2021 |
| Pertamina | Saudi Aramco | expansion<br>up grade | Cilacap | +50,000 | From 350,000 to 400,000b/d, install secondary (FCC, Hydro desulfurizain) unit for gasoline, diesel & jet fuel, below 10ppm, by end of 2021 |
| Pertamina | under consideration | New | Bontang | 300,000 | below 50ppm for Gasoline and Diesel, by middle of 2023, Oman is one of the candidate |
| Pertamina | China, Iran, Oman | New | Java or Smatra | 300,000 | rumor as of 2015,<br>Possibility of being duplicated with Bontang's plan |

Source: Created from information on company websites and oil industry publications

### Malaysia

In Malaysia, on the basis of the Refinery & Petrochemical Integrated Development (RAPID) plan, the aim is to address domestic demand by building a new 300,000 b/d refinery by 2019 and to produce automobile fuel oil with sulfur content no greater than 10 ppm. In February 2017, Petronas and Saudi Aramco entered an agreement whereby they would both invest 50% in the RAPID plan, Saudi Aramco would provide a maximum 50% of crude supply, and Petronas would provide natural gas, electricity, and utilities.

**Fig. 2-9: Major refinery construction and upgrading in Malaysia**

| Company | Partner | Status | Ref Name | Capa.(b/d) | Project |
|---|---|---|---|---|---|
| Petronas | Saudi Aramco | New | Pengerang RAPID | 300,000 | 50:50, below 10ppm for Gasoline and Diesel, 70% crude oil supply by Saudi, on going, by end of 2019 |

Source: Created from information on company websites and oil industry publications

### Viet Nam

Viet Nam has many refinery construction and expansion projects underway, with the aim of expanding refinery capacity, increasing choice of crude oils for processing, and meeting the Euro 5 standards (sulfur content of no more than 10 ppm). Among these, the Russian company Gazprom was planned to participate in a project to expand the already-operational Dung Quat refinery, but Viet Nam's Ministry of Industry and Trade withdrew tax incentives, prompting Gazprom to abandon the plan in January 2016. As a result, the current plan is to raise 30% of the $1.82 billion construction fees via IPO and cover the remaining 70% with loans.

**Fig. 2-10: Major refinery construction and upgrading in Viet Nam**

| Company | Partner | Status | Ref Name | Capa.(b/d) | Project |
|---|---|---|---|---|---|
| PetroVietnam | - | expansion | Dung Quat | +40,000 | From 150,000 to 190,000b/d, by end of 2020, 30% of the investment amount ($1.82Billion) will be covered by IPO |
| PetroVietnam | KPC, Idemitsu, Mitsui | New | Nghi Son | 200,000 | on going, by end of 2017 |
| PetroVietnam | AOC, Total | New | Long Son | 200,000 | original schedule is end of 2021, but withdrawal by Qatar, consideration for entry by Total as of Jan 2017 |
| PTT | Saudi Aramco | New | Nhon Hoi | 400,000 | original schedule is end of 2022, but postponement policy by PTT as of Jan 2017 |
| Petrolimex | JXTG | New | Van Phong | 200,000 | on going, by end of 2024 |

Source: Created from information on company websites and oil industry publications

### Other

Other refinery construction and expansion planning is underway in Cambodia, Thailand, and Myanmar. In many other economies, such as India, Pakistan, Singapore, and the Philippines, there are refinery modernization and upgrading projects underway to improve sulfur content and energy efficiency, produce high-octane gasoline, and improve the yield of high-priced products.

**Fig. 2-11: Other major refinery construction and upgrading**

| Company | Partner | Status | Ref Name | Capa.(b/d) | Project |
|---|---|---|---|---|---|
| Cambodian Petrochemical | Hong Kong Diamond Industry | New | Prek Toal | 100,000 | Phase-1 : 40,000b/d, by end of 2019<br>Phase-2 : 60,000b/d, after 2022<br>below 10ppm for Diesel |
| Thai Oil | - | expansion up grade | Sriracha | +135,000 | From 275,000 to 410,000b/d, Production of low sulfur fuel, plannning |
| Myanmar Petrochemical | Guangdong Zhenrong Energy | New | Dawei | 100,000 | In April 2016, the Myanmar Investment Commission approved the refinery construction for Guangdong Zhenrong Energy Limited in China |

Source: Created from information on company websites and oil industry publications

## 2-5. Surplus refinery facility capacity and surplus stock capacity in economies with declining oil demand

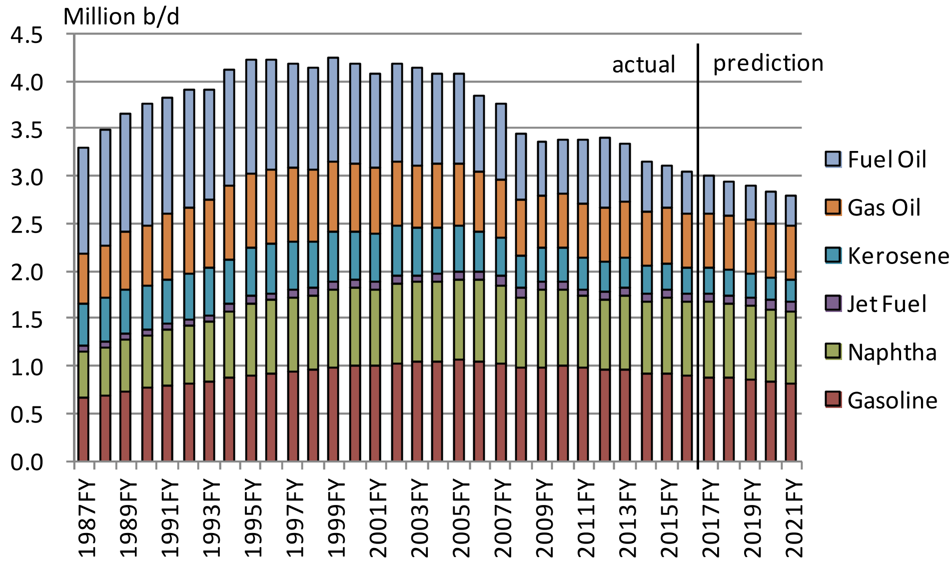
Japan, Korea, and Chinese Taipei exhibit declining domestic demand. This section will examine Japanese public-private initiatives in this area.

### 2-5-1. Response by oil companies

While oil demand is growing in Asia as a whole, total oil demand has been declining every year in Japan since the beginning of the 2000s. The Ministry of Economy, Trade and Industry (METI) predicted this trend to continue for the next five years in its April 2017 petroleum product demand forecast, predicting ongoing declines for all types of oil (at annual rates between 0% and -6.0%).

The reasons for the decline are explained as follows for each type of oil. For automobile fuels, gas mileage improvements, less mileage overall, and less freight traffic have been identified as causes of declines in demand. For heater fuels, the causes have been identified as shifts in the fuels used and improvements to energy efficiency. For industrial heavy fuels, the causes have been identified as shifts in the fuels used, improvements to energy efficiency, and declines in productive activity associated with aging and shrinking working population.

**Fig. 2-12: Japanese oil demand, 1987 - 2021**




Source: Created from the Ministry of Economy, Trade and Industry, *Yearbook of Mineral Resources and Petroleum Products Statistics*

However, the structural causes of these declines in oil demand are not new to recent years, and the signs have been present for somewhat longer. The progress of member economy policies, based on the last two oil shocks, to extricate the economy from dependence on oil; social changes such as declining population and more efficient transportation; and demand for efforts toward addressing climate change problem are all major reasons for the decline in oil demand.

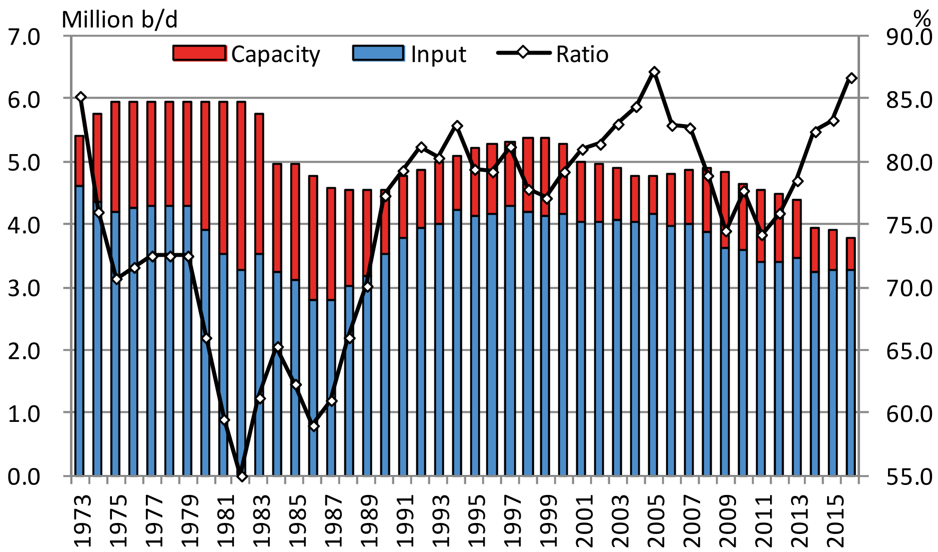
Based on a member economy policy of "refining in the consumer market"[12], Japan's oil industry supplied the domestic market with petroleum products. Only for naphtha, used in petrochemicals, is over 60% of domestic demand met through imports because petrochemicals companies can import it independently, but this is an exception. Japan's crude oil processing capacity has been built up to match domestic oil demand, and in the late 1970s this capacity reached around six million barrels per day. However, in the 1980s there was a dramatic drop in demand for industrial fuel and the fuel oil C input, causing a decline in the volume of crude oil processed. Refinery utilization dropped to under 60%. Later, after around 700,000 b/d of processing capacity was scrapped,

[12] Crude oil is imported and refined domestically to supply the domestic market with petroleum products. Using this method, Japan is able to maintain levels of quality that conform with Japanese environmental standards and maintain its edge in emergency circumstances.

utilization recovered to almost 80% in 2000. Another 500,000 b/d of facilities were scrapped through 2005, bringing utilization up to 87%.

However, as petroleum product demand continued to decline in the following years, crude oil processing capacity remained at roughly the same level. Utilization sank to a level below 80%. In 2013, refinery facilities were upgraded and atmospheric distillation equipment capacity was cut, bringing utilization back into the 80% range.

**Fig. 2-13: Japanese refinery capacity and utilization, 1973 - 2016**

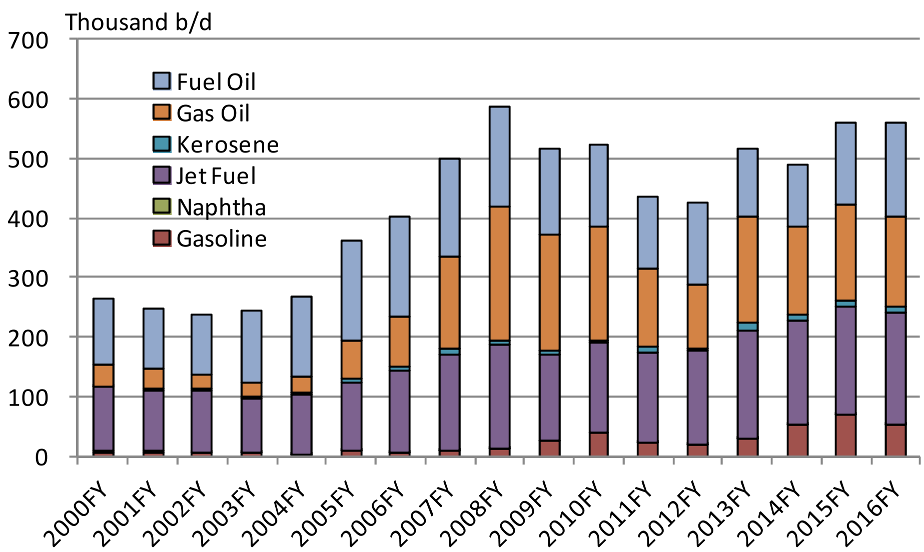



Source: Created from the Ministry of Economy, Trade and Industry, *Yearbook of Mineral Resources and Petroleum Products Statistics*

Until the 2000s, the Japanese oil industry was a supply-and-demand balancing act as demand for heavy oils declined but demand for gasoline, kerosene, diesel, and other fuel oils increased. In response, Japanese oil companies constructed secondary processing facilities that would break down heavy oils and increase production of gasoline, kerosene, and diesel fuel. These secondary processing facilities would thereby pursue the highest possible return by reducing production of unneeded petroleum products while producing other needed petroleum products.

However, demand for these fuel oils began to ebb after 2000, making it necessary to cut back on crude oil processing. Japan even began exporting petroleum products, producing diesel fuel in high demand in overseas markets by making effective use of underused secondary processing facilities. Japan was thus able to put its surplus refinery facility capacity to use.

Fig. 2-14: Japanese petroleum product exports, 2000 - 2016




Source: Created from the Ministry of Economy, Trade and Industry, *Yearbook of Mineral Resources and Petroleum Products Statistics*

### 2-5-2. Government response

In July 2009, Japan established the Act on Upgrading Energy Supply Structures (often referred to in English as "Sophisticated Methods of Energy Supply Structures"). This law revised conventional alternative energy policy that aimed only to lower dependence on fossil fuels and abolished the concept of the replacement of oil as an energy source. The act prescribes the following initiatives:

1) Promotion of innovative energy technology, unconventional resource development, etc.
2) Expanded implementation of non-fossil energy (nuclear, hydro, geothermal, alternative energies, etc.)
3) Promotion of more sophisticated and effective use of fossil fuels (crude oil, natural gas, coal, etc.)

The specific items on which energy suppliers were supposed to work were announced in July 2010 as "the Evaluation Criteria for the Promotion of the Effective Use of Fossil Fuel Energy Resources". These criteria included the target of raising the proportion of heavy oil cracking unit (coker) capacity in Japan to 13% (i.e. the ratio of coker capacity to atmospheric distillation equipment capacity) by the end of March 2014. Additionally, oil refining companies were required to achieve one of three levels of improvement in this regard relative (in percentage terms) to the initial proportion of coker capacity in place at their company. The level of improvement that each company was required to achieve varied depending on their initial state of development in this regard. The companies could achieve these goals by building new cokers or expanding existing ones, removing atmospheric distillation equipment, operationally improving facilities, developing new technologies or techniques, etc.

In April 2014, new evaluation criteria was announced based on subsequent crude oil procurement, domestic oil demand, and other factors. Under the new criteria, the definition of "the proportion of coker capacity" was broadened to "residual oil processing units," which also included heavy oil direct desulfurization equipment, fluidized catalytic crackers, and solvent deasphalting equipment. The new target was to increase this new proportion of "residual oil processing unit" capacity (i.e. the ratio of "residual oil processing unit" capacity to atmospheric distillation equipment capacity) to 50% by the end of March 2017. Additionally, in order to meet these targets, refineries were permitted to collaborate with each other and their facilities were permitted to be flexible with equipment capacity through business restructuring. By the end of March 2017, this had resulted in a reduction of Japanese crude oil processing capacity to around 60% (3.52 million b/d) of its peak.

**2-6. Liberalization and price transparency in the domestic oil market**

This section will examine trends in recent years using the example of Japan, which features both stronger regulation and deregulation.

Japanese regulation of its oil industry began in July 1962 with the enactment of the Petroleum Industry Law, which was passed to prioritize securing a stable oil supply. This was followed by the Petroleum Stockpiling Law[13] passed in April 1976 to complement the Petroleum Industry Law, the Gasoline Distribution Business Act[14] in May 1977, and the Provisional Measures Law on Importation of Specific Kinds of Petroleum Refined Products (Special Petroleum Law)[15] in January 1986, together implementing a wide range of regulations on oil imports, production, and sales.

Later, the target of oil policy became to achieve not only a stable oil supply but an

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13 Enacted to help secure a stable oil supply.
14 Enacted to ensure thorough quality control and a reliable supply of gasoline, etc.
15 Enacted to promote imports of gasoline, kerosene, and diesel fuel under orderly circumstances.

efficient supply based on market principles. This entailed a stream of regulatory reforms: The Special Petroleum Law was repealed in March 1996; the Gasoline Distribution Business Act was revised in the following April (i.e., the Act Concerning the Maintenance of Quality of Gasoline, etc. [Quality Assurance Act] was enacted); the Petroleum Industry Law was repealed in December 2001; and the Petroleum Stockpiling Law was revised in January 2002 (i.e., the New Petroleum Stockpiling Law was enacted).

As these regulatory reforms progressed, such as the repeals of the Special Petroleum Law and the Petroleum Industry Law, oil industry was liberalized at every level from production to imports to sales. It became increasingly important to strengthen the market mechanisms in the Japanese oil market. In order for the market to function effectively, it required infrastructure in the form of the broad publication of pertinent information. This is because during the pre-deregulation era, oil supply and demand information was limited to statistical data gathered by the government in order to understand macroeconomic trends in the economy. This is not a type of source that will promptly and accurately reflect fast-moving oil supply and demand information, and as informative data it was inadequate. As a result, oil industry organizations began providing supply information on a weekly basis in 2003, and an environment began to take shape in which market mechanisms could really function with real-time data.

Not only trends in supply and demand are fast-moving: price trends are as well. Domestic product prices change as crude oil prices change. If those changes involve a long time lag, there is a greater risk of both the supply side and demand side suffering losses. Therefore, there arose a need to build a distribution market that could reveal proper, reasonable prices at appropriate timings. In order to build that distribution market, the important conditions required for the domestic oil futures markets are:

1) High linkage with overseas oil futures market
2) To be able to provide highly transparent price indexes
3) High liquidity

In Japan, gasoline and kerosene appeared at the Tokyo Commodity Exchange (TOCOM) in 1999, and in the late 2000s Japanese oil companies began using wholesale prices linked to TOCOM and other sources. However, the spot prices used as indexes were sometimes far lower than costs, and in 2014 this method was revisited. It was replaced with a "cost-linked method" whereby individual oil companies would determine prices based on crude oil prices and other trends in supply and demand. This is a case study of a failure attributable to the immaturity of the market at that time.

If the domestic oil futures market were to mature in this way, oil companies would be able to set sale prices at which they could recover their costs and consumers would also be able to buy at prices matching the prices in overseas oil futures markets. Government intervention in these prices may sometimes be reasonable, but in the long-term it is better for consumers to leave the prices to the markets.

Chapter 3. Discussion of the new oil security

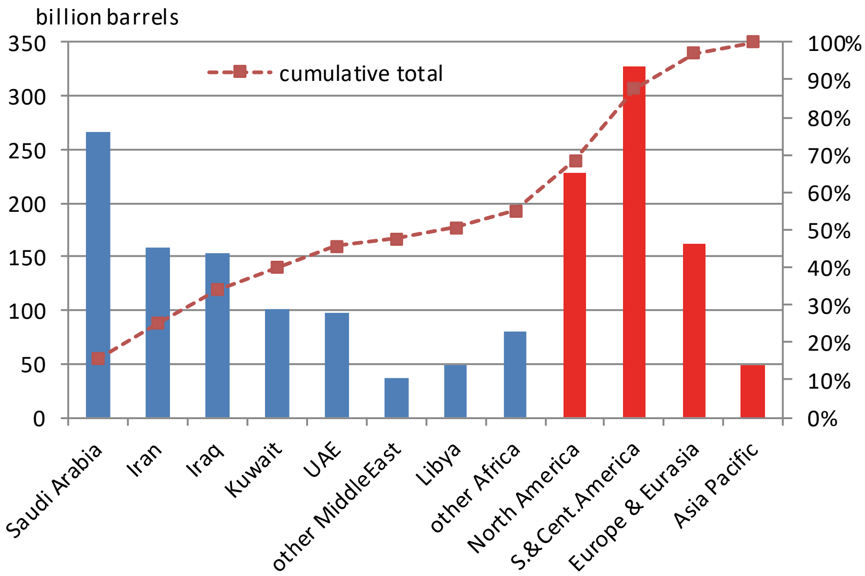
3-1. Issues in traditional oil security policy

3-1-1. Diversification of crude oil suppliers

1) Instability in the Middle East and Africa

As explained in Chapter 1, oil is unevenly distributed across the globe, and the Middle East region accounts for a high proportion of the crude oil trade. Even looking at proved reserves, an important element in considering future diversification of supply, the Middle East and Africa alone account for over 50%. Thus, the world will continue to be reliant on the Middle East and Africa regions in the future, but these regions are rife with elements of instability.

Fig. 3-1: Global proved oil reserves (late 2016)




Source: Derived from BP, *Statistical Review of World Energy 2017*

The oil-producing economies of the Middle East face instability because of religious antagonism between Sunni and Shia, Arab and Persian, and so on. The turmoil continued in 2017, when Saudi Arabia, the UAE, and other Arab states broke off relations with Qatar.

The Arab Spring pro-democracy movement that began in Tunisia in north Africa in 2011 later spread to Egypt, Libya, and Syria. The Arab Spring that occurred in Syria began as a pro-democracy movement in opposition to the autocratic regime of President

Assad, but eventually it became much like a religious conflict. Emerging from armed Sunni groups, the Islamic State of Iraq and Syria (ISIS) turned into the Islamic State (IS), and surrounding Middle Eastern economies were pulled into the conflict. American and Russian interests have crossed paths and the long quagmire of a civil war drags on.[16]

In the African region, Libya is said to continue to be an incubator for dormant IS activity. The extremist organization Boko Haram in Nigeria continues to conduct suicide bombings, and in South Sudan the conflict between government and rebel forces has slowed to a stalemate.

The Strait of Hormuz, the Strait of Malacca, and similar choke points are considered to be important strategic locations for marine traffic in the world. According to a 2014 EIA report, 30% (17 million b/d) of the world's marine crude oil trade in 2013 passed through the Strait of Hormuz. Moreover, over 85% of the crude oil passing through the strait in 2013 was bound for Asian markets (Japan, India, Korea, China, etc.). This strait has experienced several marine crises in the past because of clashes between the Arabs and the Persians.

In recent years, the Middle East and Africa region has been in a state of latent instability due to developments such as the breaking-off of relations between Saudi Arabia and Iran in January 2016 and between the Arab economies and Qatar in June 2017.

Because crude oil resources are disproportionately concentrated in these regions, it is not possible to consider oil supplies without the Middle Eastern and African economies. However, it is important for efforts to diversify crude oil suppliers to extend beyond Middle Eastern and African economies.

**2) Rise of the non-OPEC economies**

Due to technological progress by international oil companies throughout the 1980s and 1990s, production increased significantly in non-OPEC oil-producing economies and regions including the North Sea oil fields, Central and South America, and West Africa. In the 21st century, new production methods using hydraulic fracturing ("fracking") have enabled once-difficult extraction of shale oil, an unconventional type of oil, primarily in the United States and Canada. Development of this type of extraction has been prodded along by high oil prices that made shale oil more competitive.

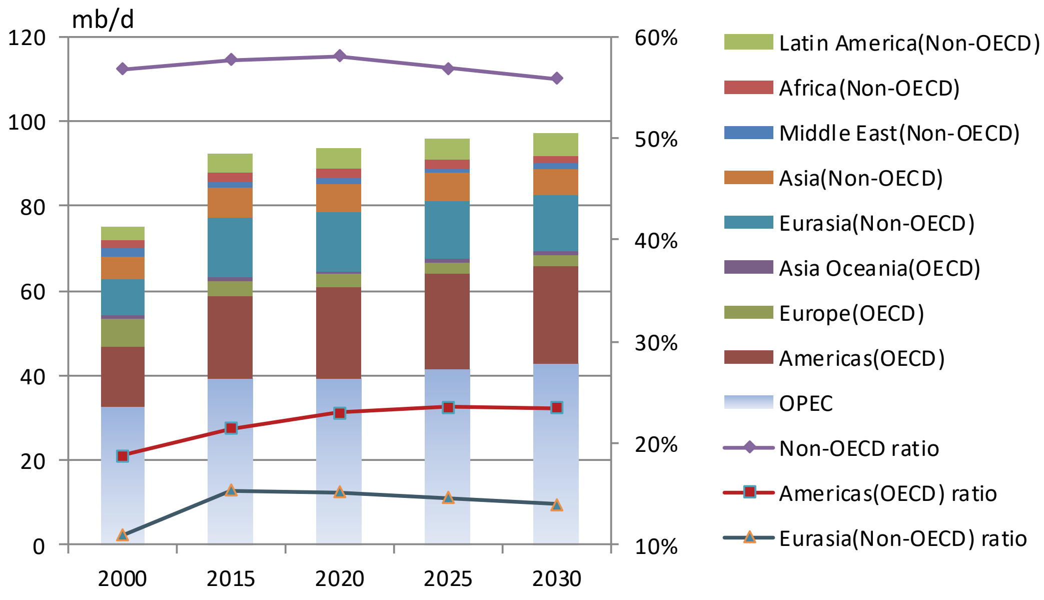
In natural resource-rich Russia, economic slowdowns in its Soviet-era trade partners (CIS economies) after the fall of the Soviet Union resulted in low energy demand and a

[16] In October 2017, the Syrian Democratic Forces with the backing of the United States and other allies took complete control of the IS capital of Raqqa.

shift in exports instead to Germany, Italy, Poland, and other European economies. In recent years, Russia has begun exploring diversifying its oil export partners and increased exports to the Asia-Pacific region. In December 2009, the Eastern Siberia–Pacific Ocean oil pipeline entered operation, contributing to increased oil production in the eastern Siberia region. In the Far East near the Japanese province of Hokkaido, the island of Sakhalin contains large oil and natural gas fields developed jointly by several international companies, and development there continues to this day.

According to the August 2017 IEA *Oil Market Report*, production by non-OPEC economies is expected to increase by 700,000 b/d (of which 600,000 b/d were from the USA) in 2017 and by 1.4 million b/d (of which one million b/d were from the USA) in 2018. According to the IEA, the proportion of production attributable to non-OPEC economies is expected to continue to increase until 2020 primarily because of growth in the United States and Canada. Afterwards, growth in production in Russia is expected to slow down, and the market share of OPEC economies will increase again as they are expected to increase production.

**Fig. 3-2: Global crude oil production result and future forecasts**




Source: Derived from IEA, *World Energy Outlook 2016*

In general, investment in crude oil development is affected by oil prices. If oil prices remain low, uncertainties arise in the progress of development in non-OPEC oil-producing economies.

In particular, the costs of extracting unconventional resources like shale oil are quite high relative to producing from large oil fields such as in the Middle East, and due to sluggish oil prices, shale oil production has been on the decline since peaking in March 2015. However, subsequent improvements in technology and concentration of production sites have led to the belief that production costs will continue to decline, and in line with the recovery trend of crude oil prices, shale oil production shows an upward trend since 2017. Such sites are considered to have great potential as new oil suppliers along with Russia.

From an energy security perspective, unreliable supply due to the aforementioned political instability in Middle Eastern and African oil-producing economies is a great risk. Economies that import oil from these regions face pressure to diversify the types of energy they use, promote energy conservation, build oil reserves systems, and diversify their oil suppliers.

However, there are many difficulties with hastily diversifying oil suppliers. Diversification requires the following types of gradual and multilateral steps:

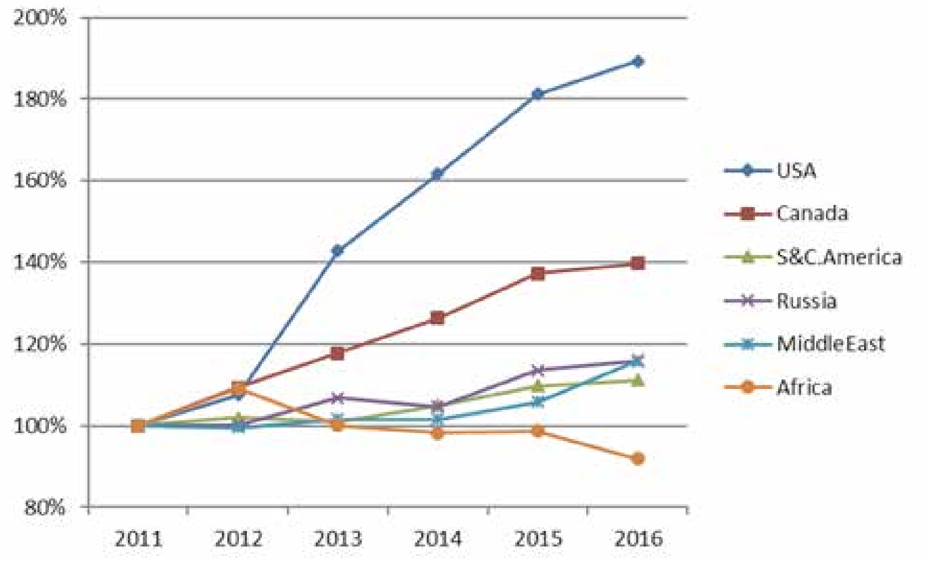
1) Reducing risk of unforeseen situations by strengthening relationships with current suppliers;
2) Strengthening "resources diplomacy" initiatives aimed toward acquiring interests in the Middle Eastern, African, and Central and Southern American regions;
3) Diversifying suppliers by increasing procurement from Russia and Central and South America, in addition to considering procurement from the United States, which has recently lifted its ban on exporting crude oil.

**3) Transport costs from new production sites**

In the past, crude oil exports have primarily come from the Middle East. However, the 2010s saw the start of extraction of the unconventional shale oil and the United States lifted its ban on crude oil exports at the end of 2015, leading to a rise in exports from North America of both crude and petroleum products.

Russia saw the construction of a new Far East pipeline in addition to its existing European pipeline. Its extraction facilities include Sakhalin-I's De-Kastri Oil Terminal (October 2006: 200,000 b/d) and Sakhalin-II's Prigorodnoye terminal (Dec. 2009: 100,000 b/d), as well as the Nakhodka's Kozmino terminal (300,000 b/d) established in December 2009. All of these terminals will now be exporting to Japan, Korea, and India.

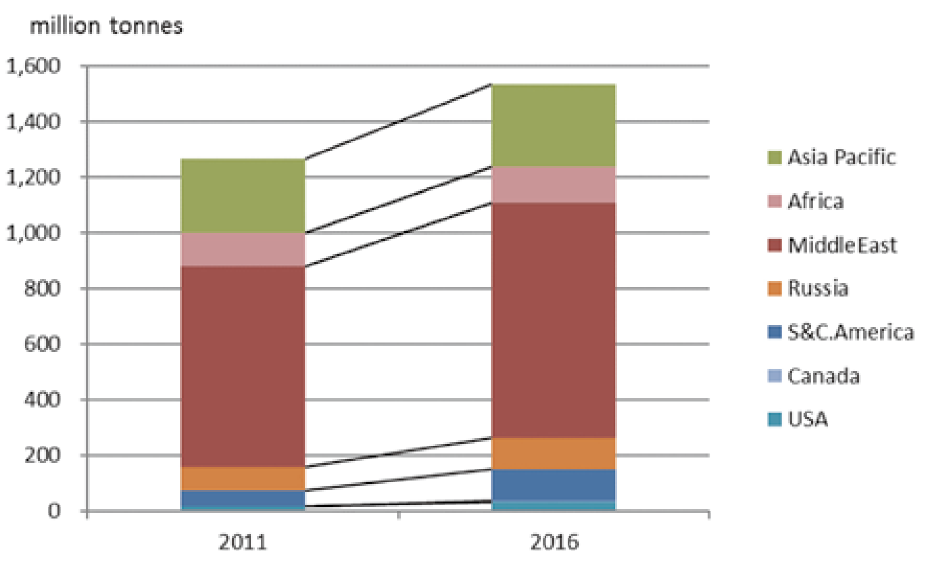
Fig. 3-3: Global oil exports, 2011 - 2016 (index with 2011 levels as 100%)




Source: Derived from BP *Statistical Review of World Energy 2017*

Looking at exports to the Asia region in 2011 and 2016, the proportion of Middle Eastern exports remains high, but exports from the United States, Canada, and the North American region; Central and South America; and Russia are steadily increasing. For Asia, it is significant that imports from these regions mostly do not need to pass through any chokepoints to reach Asia, giving high hopes for their potential as choices in efforts to diversify suppliers in the future.

Fig. 3-4: Oil exports to Asia by area




Source: Derived from BP *Statistical Review of World Energy 2017*

However, not every supplier is adequate, and a supplier cannot be said to contribute to energy security unless it provides a stable and affordable supply.

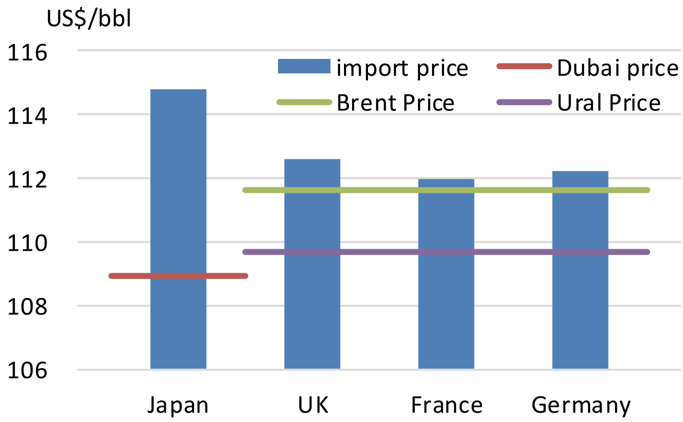
For example, before the Kozmino terminal was built, crude oil could not be exported from Russia to the Far East during the winter because both the De-Kastri terminal and the Prigorodnoye terminal would freeze over. Only since the Kozmino terminal was established have winter crude oil shipments been possible.

Moreover, the opening of the Eastern Siberian Pipeline Ocean (ESPO) crude oil pipeline also enabled more reliable and cheaper transportation of crude oil from production sites to shipping ports, as it had previously been transported by rail.

**Transport costs**

The price of imported crude oil in each economy varies depending on the types of oil imported, the composition thereof, shipping rates, and insurance fees.

**Fig. 3-5: International comparison of crude oil import prices (2012)**




Source: Import prices created from Agency for Natural Resources and Energy, Japan. Crude oil prices created from the IMF and Bank of Russia.

The above diagram contains yearly average crude oil import prices by economy for 2012, a year in which average crude oil prices exceeded $100/bbl, as well as the average 2012 prices for Dubai crude, Brent crude, and Ural crude. However, the crude prices used as indexes and actual import prices may not have a constant differential because each economy imports multiple types of crude oil, and even for the same type of crude, the price may differ depending on the month of shipment.

Even taking these factors into account, a comparison of the differential between Japan's actual import price and the Dubai index price against the differentials in Europe with the Brent price or Ural price show that the differential faced by Japan is obviously larger. This could be said to reflect the difference in the cost of transporting oil from each producing economy to each consuming economy.

These differences in transport costs are largely attributable to transport distances. The table below shows data published by the Worldscale Association on January 1 of each year regarding the distance and tanker freight rates for shipping from major global shipping ports to Yokohama Port.

**Fig. 3-6: Distance and standard tanker freight rates from major oil shipping ports to Japan (Yokohama) (January 2016)**

| Region | Shipping port (Economy) | Nautical mile (mile) | Freight ($/ton) |
|---|---|---|---|
| Middle East | Ras Tannurah (Saudi Arabia) | 6,594 | 19.06 |
| | Basrah (Iraq) | 6,788 | 19.21 |
| | Jebel Dhanna (UAE) | 6,483 | 19.06 |
| South East Asia | Dumai (Indonesia) | 3,094 | 10.72 |
| East Asia | Nakhodka (Russia) | 905 | 5.54 |
| West Africa | Forcados*1 (Nigeria) | 11,017 | 30.43 |
| North America | Los Angeles (USA) | 4,840 | 15.81 |
| | Salina Cruz (Mexico) | 6,600 | 19.29 |
| South America | Puerto La Cruz*2 (Venezuela) | 8,361 | 25.96 |
| Oceania | Gerringong (Australia) | 4,901 | 15.99 |

Source: Standard tanker freight rates, published by the Worldscale Association.

*1: Around the Cape of Good Hope. *2: Through the Panama Canal.

The standard tanker freight rates are based on 75,000-ton tankers moving at 14.5 knots, consuming 55 tons of fuel per day, 5 tons per day in port, and 100 tons per voyage on non-sailing activity. Fuel prices are based on the previous year's September global average prices from Cockett Marine Oil Ltd. of London. Port charges and a fixed charterage of $12,000 per day are also included.

Actual charterage is determined by combining the standard tanker freight rates with elements of spot rates (customarily marked "WS"), resulting in WS 80 (i.e. 80% of the standard tanker rate), WS 100 (i.e. 100%), WS 120 (i.e. 120%), etc.

The Panama Canal, an important strategic point for marine transport that connects the Pacific and Atlantic Oceans, was refashioned as the "new Panama Canal" (Panama Canal expansion project) in June 2016 in order to handle increased traffic and larger vessels. As a result, although the canal became wide enough for vessels up to 49 meters in width to pass through, standard supertankers (60m VLCC) are still unable to pass through. Thus VLCC supertankers headed from the U.S. Gulf of Mexico to Japan are forced to round the Cape of Good Hope, a route which requires 36 days rather than the 21 days that a Panama Canal route requires.

For these reasons, it is important not to forget everyday economic efficiency concerns when considering oil and energy security.

**4) Term contracts and spot contracts**

This section will examine oil security based on contracting methods, an approach that differs somewhat from oil supplier diversification.

When an oil company typically purchases crude oil, it determines the total amount of crude oil that it will procure based on its annual oil processing plan and breaks this down by API grade. The company will then break that down even further by month, but the necessary amount per month is not constant due to seasonal demand, refinery inspections, and other factors. This variation in the amount needed can be absorbed if there is enough capacity in the storage tanks, but typically contracts are signed with a distinction made between periodic oil procurement ("term contracts") and oil procurement only when needed ("spot contracts"). In the Japan, the ratio of term contracts to spot contracts has shifted from the conventional 8:2 to a ratio of 6:4 in the present.

From an oil security perspective, the major standard underlying the ratio of term contracts to spot contracts is that, typically, term contracts ought to be the baseline due to their guarantee of supply for a set period and their typically lower cost, while spot contracts can be used to cover any remaining variance. However, as described above, many oil-producing economies suffer from political instability, and careful attention must be paid to the presence of geopolitical risks. If such risks are taken into consideration, the most practical approach becomes to sign primarily term contracts with low-risk economies and increase the proportion of spot contracts with high-risk economies.

In reality, oil tank capacity differs from company to company based on their facilities, and therefore the proper ratio of term contracts to spot contracts also varies based on the ability of the company to absorb imbalances in supply and demand. Additionally, if crude oil processing volumes are extremely low, depending on the market environment, it may be necessary to resell oil as the amount procured through even term contracts will be surplus. Therefore, it is necessary to reconsider the "destination clause" as reselling becomes a potential option (typically, destination clause restrictions are rooted in the trade-off with the price).

Moreover, in Asia at present it is commonplace for imports from the United States and Russia to be spot contracts due to their low rates. Therefore, as shown in the previous section, the proportion of spot contracts will ultimately increase if the volume of transactions with these economies increases.

### 3-1-2. Increasing domestic refining capacity

#### 1) Demand forecasts and refining capacity

Global oil demand continued to increase through the mid-2000s. An expansion of domestic refining capacity was planned to keep pace with this and the appropriate construction work was completed. However, around 2005, environmental and energy conservation policies began to gain steam in OECD economies and ongoing technological progress kicked off a decline in oil demand. This resulted in the closure and consolidation of refineries in many OECD economies.

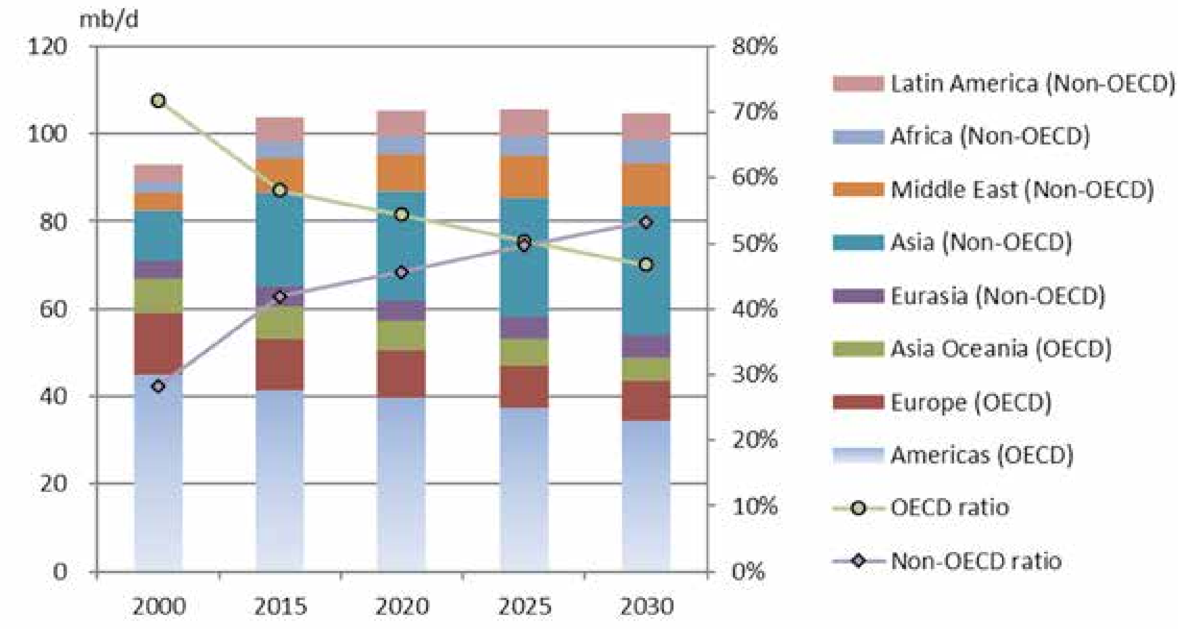
According to demand forecasts published by the IEA, the decline in demand in OECD economies will continue, but demand is expected to increase in non-OECD economies. This will result in a level trend worldwide through 2030.

At the 3rd Technical Meeting on Asian Energy and Oil Outlook held at the OPEC headquarters on 2 October 2017, a demand forecast was presented by each participating institution. All institutions are predicting an increase in demand for oil and point out that demand for transportation and petrochemicals is high in Asia. In a discussion of restrictions on the use of internal combustion engines for automobiles, the general opinion was that all the internal combustion engines will not disappear at once. But the rate of increase in oil will decline because of energy efficiency progress, substitution of alternative fuels and electrification, although the number of vehicles increases.

Furthermore, in interviews in the US in January and February 2018, the effect of complex issues such as vehicle sharing and autonomous vehicle as well as technical progress of advanced vehicles, on oil demand forecasting was raised.

On 9th March 2018 IEA held the World Energy Investment Roundtable in Paris. At a session on the ongoing transformation of the oil and gas industry, discussions took place on investment based on the theory of peak oil demand. In this discussion, world oil demand in 2040 is expected to be kept around 70 million b/d. At that time, a regional imbalance will occur. In other words, OECD's oil demand will decline over the long term, and OECD's excess refining capacity will become readily apparent. On the other hand, in developing economies where oil demand continues to increase, the movement to expand refining capacity will continue. If expansion of refining capacity in these areas is the same as or higher than the demand increase, an imbalance of refining capacity could occur worldwide. Nevertheless, continued oil development investment is necessary to maintain crude oil supply, taking account of the decline of the production volume because of the natural decline of existing oil fields.

**Fig. 3-7: Global oil demand, 2000 – 2030**




Source: Derived from IEA, *World Energy Outlook 2016*

Maintenance of domestic refining capacity is one of the building blocks of stable energy supply due to increases oil demand and the necessity of a stable supply of that oil.

However, 5 to 10 years is typically necessary for a refinery construction plan to be written and for that refinery to actually begin operation. Therefore, there is a delay between when demand increases and when a refinery is actually constructed. To account for this delay, demand forecasts are used to determine when to invest in refineries.

Refinery investment is a massive expense, and thus fine precision is demanded in oil demand forecasts, regarding oil’s place within the energy market overall and per-export demand. In some cases, rather than improving precision, it is perhaps more accurate to say that demand is moving in a given direction. It may be necessary for the government to regulate or support energy use through legislation. For example, demand changes just by the government subsidizing or ending subsidies for energy prices. Additionally, if financial incentives are given to encourage purchases of electric vehicles, which do not directly use fossil fuel energy, consumers will move to acquire electric vehicles and gasoline consumption will ultimately decline. In this way, energy policy is an important part of demand forecasts.

Based on these demand forecasts, it may be necessary to build up domestic refining capacity. It is also important to determine by how much to aim to increase capacity relative to the demand forecast. Considering that it requires several years to construct an oil refinery, it must be decided whether the refinery ought to satisfy 100% of demand at the time it becomes operational, or 100% of demand several years after it becomes operational.

Although oil demand is currently on the decline in OECD economies and on the incline in non-OECD economies, it must be considered that demand may one day peak even in non-OECD economies. For example, in response to declining oil demand in Japan, the government led efforts to upgrade refineries (i.e. convert to building refineries that could refine high-quality petroleum products) and eliminate surplus refining capacity.

Nothing definitive on the subject can be stated because of economies' differing perspectives on government involvement in the market. Moreover, policy interventions into the market should generally be restrained in nature. However, given that ensuring security is a government role unattainable by market principles alone, and given the massive costs and risks associated with investment in refinery capacity, a certain level of policy intervention is likely permissible in this area.

**2) Addressing needs for higher-quality products**

Demand for petroleum products does not increase evenly across the board for all products. Ever since automobiles became commonplace in society, there has been conspicuous growth in demand for gasoline, diesel, and other vehicle fuels. There are also certain quality standards in place for fuel for internal combustion engines, and the movement toward "sulfur-free" fuel that achieves both clean vehicle emissions and improved fuel economy led to demand for low-sulfur fuels. In addition to this, the International Maritime Organization (IMO) plans to introduce regulations on sulfur in residual fuel oil in 2020. Once the high-sulfur heavy fuel oil C currently used as ship fuel is replaced with low-sulfur heavy fuel oil C and diesel fuel, much of the previously-used high-sulfur oil will be rendered useless.

To address this, the oil industry is procuring more light crude oil that produces large volumes of fractions such as gasoline and diesel fuel, as well as introducing coker that can break down heavy crude oil and refine it into large volumes of gasoline, diesel fuel, and other products in order to reduce the yield of heavy fuel oil C.

Because light crude oil is more expensive than heavy crude oil, it is common to upgrade the facilities without changing the quality of the crude processed, such as by adding a coker. Special licensing is required to operate such a unit, and for this reason one such unit costs several hundred million dollars, though the exact price depends on the capacity of the unit.

This sort of effort to improve petroleum product quality is expected to continue into the future. When choosing to supply petroleum products through domestic refining, it is necessary to consider not only simply increasing refining capacity but also how to improve oil quality. If the costs of improving quality become excessive, it is also possible to choose to primarily import products as a means of supply instead.

In interviews in the US in January and February 2018, we discussed higher-quality products. Introduction of IMO regulation has a major impact on a refinery's economics. Especially sophisticated refineries will benefit greatly for the time being. However, from a long-term perspective, if the demand composition of petroleum products changes dramatically because of a decline in gasoline demand, there is a possibility that sophisticated refineries may not necessarily be advantageous. Also, from a short-term point of view, while OPEC is mainly reducing heavy crude oil production, the United States produces light shale oils. So, heavy crude oil is less available (surplus of light crude oil). As a result, the price differential due to the quality of crude oil will narrow. This may have an impact on securing refining margins at sophisticated refineries because heavy crude oil is inferior to light crude oil.

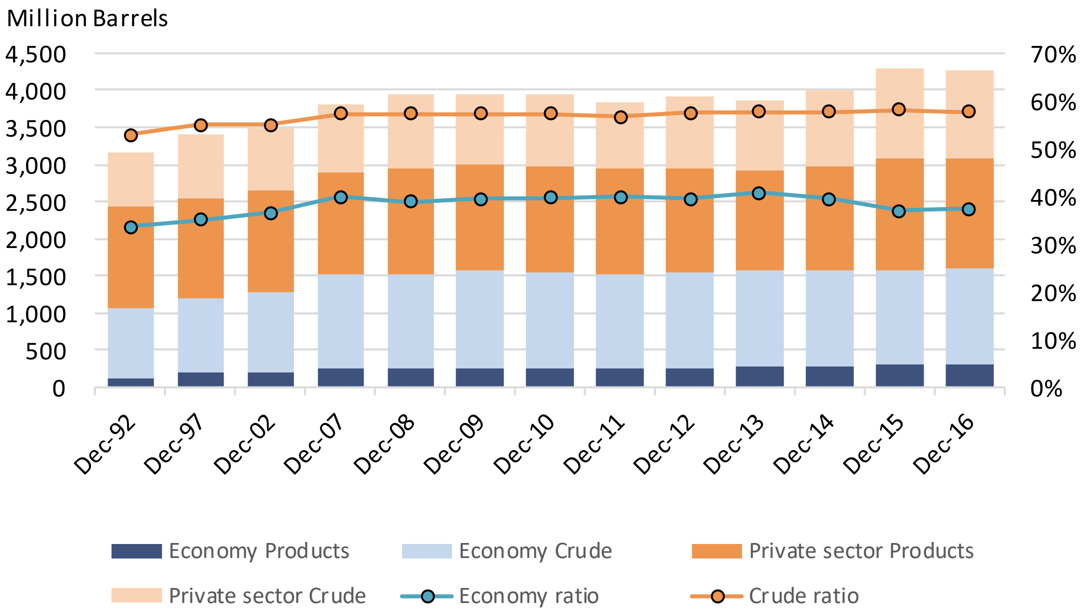
At the IEA's Roundtable in March 2018, it was predicted that high margins will be secured at refineries with a coker because of the IMO regulations. However, there is no guarantee that this will continue. Since IMO regulation will expand demand for diesel oil / and decrease heavy oil demand, the price spread between diesel oil and heavy oil can be expected to increase. As a result some ships may use desulfurizers, altering the demand balance for diesel oil and heavy oil. Therefore, when planning the refinery construction, it is necessary to pay attention to these environmental changes.

### 3-1-3. Emergency response

#### 1) Stockpile

All IEA member economies maintain a stockpile equal to "90 days of net imports". This is one of the general standards in place since 1980. To this day, those stockpiles generally consist of 40% government stockpile (approx. 60% private-sector stockpile), and generally 60% crude oil stockpile (approx. 40% petroleum product stockpile). Crude oil stockpiles constitute the overwhelming majority of member economy stockpiles, and private-sector stockpiles are mostly petroleum products due to the inclusion of distributor inventory. There is a difference in implications between a crude oil stockpile and a petroleum product stockpile. A crude oil stockpile serves to cover interruptions in supply from oil-producing economies, and there is a strong implication that it is to be used together with a private-sector crude oil stockpile to fulfill demand until a switch in suppliers can be made. Meanwhile, a petroleum product stockpile serves to cover daily supply, and there is a strong implication that it is to be used as a very short-term measure with immediate effects. Therefore, neither crude oil reserves alone nor a petroleum products stockpile alone can be said to amount to a perfect emergency response measure.

**Fig. 3-8: OECD total oil reserves volume, 1992 - 2016, including ratios between member economy vs. private sector and crude vs. products**




Source: Derived from the IEA *Monthly Oil Market Report*

In IEA documents, member economy stores range from 12 days' to 220 days' worth of stock. This depends on the volume of oil demand, dependency on oil imports, ticket contracts with nearby economies, and domestic oil stockpile policies, and each has been set with a goal of achieving oil security.

Meanwhile, oil stockpile measures are also underway in non-OECD economies. China in 2016 constructed a petroleum stockpile in nine locations, increasing its crude oil stockpile by 27.4% year-on-year to a total of 33.25 million tons. Viet Nam in 2012 enacted a State Reserves Act that includes other resources as well as a plan to achieve 700,000 tons of crude oil reserves by 2020. Indonesia in 2014 established the National Energy Policy (NEP), which establishes its plans to study oil reserves in the future. There are also plans in place in Myanmar and Cambodia to establish oil reserves projects.

The planning of these projects by multiple economies is anticipated to take 10 to 20 years and is likely to require technical assistance from experienced OECD economies.

**2) Policies for domestic emergencies**

The stockpile in Japan before 2011 was intended to be used to cover interruptions in supplies of crude oil or petroleum products from overseas. However, recent years have seen supply interruptions stemming from domestic natural disasters, such as the August 2005 Hurricane Katrina, the October 2010 Mentawai earthquake in Indonesia, and the March 2011 Tohoku earthquake in Japan. Interruptions in supply caused by natural disasters can occur in both net importer economies and net exporter economies, and all economies must be prepared for such events. Additionally, if climate change is assumed to have an impact on events, stockpiles can be considered one type of climate change adaptation measure. Given that the range of ways has increased in which a stockpile is an effective tool, there is perhaps a need to refine the role that stockpiles play.

In the event that supply is interrupted because of domestic inability to receive or deliver shipments, it is obviously difficult for a foreign economy to provide direct support because of sovereignty issues. Therefore, each economy must plan to first secure a stable domestic supply on its own in the event that this sort of interruption in supply occurs. Domestic demand should of course be curbed as one response measure, but it is also important to draft rules for releasing stockpiles and establish routes and means of transport in order to ensure that supply is achieved, in addition to conducting emergency response drills in normal, non-emergency circumstances.

## 3-2. Potential for attaining oil security utilizing the recent oil market

### 3-2-1. Consideration of oil security based on product imports

#### 1) Uniform petroleum product quality

The wide range of product types must be considered in the product trade. In addition to the broad categories of gasoline, naphtha, kerosene, diesel, and heavy fuel oil, gasoline can be 90 or 95 octane; naphtha can be light naphtha, heavy naphtha, or full-range naphtha; diesel varies by Cetane number; and for all petroleum products, there is a grade based on the proportion of sulfur contained in the product. In this way, there are countless types of products. Sulfur content in particular, being an environmental problem, faces a variety of numerical standards for each economy. From an oil security perspective, even if the variety of kinds of products is not reduced, it is likely advisable to consolidate the grades of products to a certain extent.

However, this sort of consolidation and standardization has both benefits and drawbacks such as increased costs, and it is not possible to create uniformity in one stroke. It may perhaps be necessary to gradually consolidate products on the basis of distribution volume ranking, ranking of difficulty of achieving targets, or ranking based on international aims.

The United Nations Environment Programme (UNEP) supports the achievement of various planned targets by economy and year, such as Status of Fuel Quality and Vehicle Emission Standards, Status of Fuel Quality and Light Duty Vehicle Emission Standards, etc. Meanwhile, in October of last year, the International Maritime Organization (IMO) settled on an anti-atmospheric pollution policy of tightening restrictions on sulfur contained in the high-sulfur heavy fuel oil C ship fuel, in order to reduce sulfur oxide (SOx) emitted by ships. The policy is planned to be tightened beginning in 2020. It seems as though petroleum products are heading into a phase of quality standardization and unification.

Problems such as these cannot be resolved by the decision of any one economy. Instead, resolution ought to be achieved through dialogue with nearby economies and conferences including third-party organizations.

#### 2) Pricing mechanism forecasts (pricing transparency)

Price transparency is an essential part of the pricing mechanism. Two types of pricing transparency are required. First, it must be clear what price indexes were used to set the import prices. Next, it must be clear how domestic prices are set based on those import prices.

International futures markets that use indexes (international trading prices) with what are considered to be highly transparent prices include Europe, the United States, and Singapore. Although, strictly speaking, prices differ based on transaction timing and quantity, in general transactions can be conducted at fair prices regardless of who participates in trading. It is typical for local costs (delivery costs, labor costs, etc.) and a standard profit to be added on top of these trading prices to arrive at a domestic retail price.

Sometimes, there are policies in place to reduce the domestic retail price to less than the import price. In this case, a "fuel subsidy" is applied to the whole or partial difference between the import price and the domestic retail price. Typically, subsidies are policies implemented to foster local domestic industry and improve the competitiveness of industry exports. Meanwhile, the fuel subsidy is a policy introduced primarily as support for low-income individuals. This is fine if implemented for a set period, but once such measures are introduced it is very difficult to withdraw them. As a result:

- If not compensated for the amount of the subsidy in full, oil importers and domestic retailers will be forced to bear the cost of the subsidy for a long period, which could lead to a shortage of petroleum products;
- The subsidies may promote wasteful energy consumption by low-income individuals;
- The subsidies may place the government under financial pressure. (Etc.)

Fuel subsidies are discussed by the IEA under "New Policy Scenarios" in the *World Energy Outlook 2011.* In the relevant scenario, the IEA calculates that if all subsidies for fossil fuels were abolished across the world, the amount of increase in CO2 emissions forecast to be produced by developing economies from 2009 to 2035 would be cut by 30%. The IEA argues that cutting subsidies for fossil fuels in developing economies and then investing that money in renewable energy would solve three problems: financial problems, temperature warming problems, and energy security problems.

Developing economies, including some oil-producing economies, have announced the reduction or elimination of fuel subsidies in recent years, and there has been increasing transparency between international trading prices and domestic retail prices. This is thought to contribute to promoting company participation in product distribution markets as well as contributing to the development of the petroleum product trade.

### 3) Liberalization of the refining sector

In developing economies, it is important for the national oil company to drive the domestic oil market. Oil extraction and development in the upstream sector in particular are often core elements supporting the economy, and for this reason the existence of the national oil company is essential. Additionally, in that stage of growth of the economy, policies are required to protect everything from the upstream sector through the downstream sector. However, once a certain level of growth has been achieved, it is necessary to permit private oil companies to participate in the refining and sales sectors to promote stimulation of the industry.

This sort of competition between the national oil company and private oil companies can be expected to create a more flexible supply system (i.e. appropriate products sold at appropriate prices).

### 4) Mutual exchange of oil refining capacity

In progressing forward with simple petroleum product trade, the concept arises of mutual exchanges of oil refining capacity.

No one believes that oil demand will continue to grow for eternity. Although coal once flourished, it fell from its throne as the main energy source with the arrival of oil. In the present, oil too is beginning to be removed from its throne with the rise of renewable energy in the electricity sector and the rise of alternative (non-fossil) fuel vehicles in the transportation fuel sector.

At a time like this, there is likely no economy that intends to build an excessive number of new refineries simply because oil demand will increase in the near future. If oil demand is going to peak at some point, excess refining facilities need to be avoided.

This leads to concepts such as contracting out refining to nearby economies and building refineries jointly with nearby economies. Rather than relying on the domestic supply-demand balance alone to serve demand, these methods consider achieving balance with the inclusion of nearby economies.

#### i) Contracting out refining to nearby economies

Under this approach, economies with extra refining capacity lend their facilities to economies with insufficient capacity to help them serve their oil supply. This is a business that has spread in Asia from the late 1980s and early 1990s.

For example, Economy A has a 200,000 b/d refinery but currently only 120,000 b/d in domestic oil demand. Typically, it is desirable to achieve refinery utilization of over 80% in light of fixed costs and variable costs, but that means Economy A must process at least 160,000 b/d of crude oil. Therefore, Economy A should find a destination for at least 40,000 b/d.

Meanwhile, Economy B lacks refining capacity and must find a supplier for 50,000 b/d of petroleum products. Economy B contracts with Economy A for 40,000 b/d of oil refining work, signing a "refining contract" agreement to pay contracted refining fees and receive petroleum products. Economy B decides to buy the remaining 10,000 b/d from the oil trading market.

This method leads to the effective use of excess refining capacity in Economy A. Without this method, and operating at 80% utilization with a focus on exports, Economy A will face the following drawbacks:

・Funding burden due to the time lag between the payment for the crude and the receipt of payment for the petroleum product exports;
・Risk of price variability in the oil market during the period;
・Labor required to seek out a destination for exports;
・Risk of dumping due to not being able to find an export destination; and
・Price hedging costs for using the futures market to ensure that dumping is not necessary.

Meanwhile, Economy B gains the following benefits:

・Receives a steady, regular supply of petroleum products; and
・Through regular purchases, Economy B can take a long-term view, using the futures market to hedge against price variation at the time of importing.

If a refining contract is to be signed, the following points must be decided:

・Processing fee for the contracted refining work;
・Type of crude oil to use;
・Yield of petroleum products;
・How to dispose of unwanted oil types and how the relevant costs should be distributed; and
・Amount of product per transaction and the transaction frequency

Both economies gain other benefits in addition to the above and further cut unnecessary costs. For example, Economy B can co-load necessary crude oil on a tanker chartered by Economy A. If the procurement size can be maximized, both economies can cut freight costs.

### ⅱ) Joint construction of refineries with nearby economies

A collaborative approach is possible between multiple nearby economies expecting growth in oil demand. For example, neighboring Economy B would be a fine partner. Another possibility is to work with a partner economy to which work is already contracted (or vice versa) to move to the next step of joint refinery construction.

For example, both Economy A and Economy B are predicted to see oil demand growth, but there is a need for some economy of scale. Neither Economy A nor Economy B could enjoy these benefits alone: only when joined together.

In working together on the joint construction of a refinery, the two economies must conduct prior discussions to determine what the refining capacity should be, where the refinery should be build, which economy should be responsible for operating the refinery, and how the construction costs should be divided.

However, if the refinery is a joint construction project, both economies avoid the risk of designing a refinery with excessive refining capacity in pursuit of economies of scale and paying excessive construction costs, increasing the amount of time until the refinery earns its investment back.

This expansion of the regional network through refining contracts and jointly constructed refineries will likely lead to better oil energy security.

### 5) Mutual lending in emergencies

Closer collaboration through mutual contracting and joint construction of refineries leads to the approach of economies lending oil to one another in emergencies. In OECD economies at present, each economy has oil reserves, and under this system the economies can collaborate at times of emergency. Can this same approach be applied to the Asia region?

The key ideas discussed here are constructing a stockpile system, release of stockpiles, and the provision of support for petroleum product supply.

### i) Constructing a stockpile system

For example in the Philippines, a 2002 presidential order requires private refiners to hold 30 days' worth of stockpile and oil distributors to hold 15 days' worth of stockpile. Meanwhile, the establishment of a strategic oil stockpile is under consideration as an extremely important part of the economy's oil emergency preparedness policy.

In Singapore, the government stockpile established by the national oil company in

1980 was shut down in 1983. The government in Singapore does not recognize a necessity of a government stockpile because domestic oil consumption is low and private companies have sufficient procurement and storage capacity for petroleum products. There is a requirement for private companies to maintain 90 days' worth of fuel oil stockpile for electricity purposes, but there is no compulsory obligation on domestically operated refineries or private oil companies to maintain a stockpile. However, refineries' regular operational inventories are estimated to be at about 50 days' worth.

Malaysia is not currently considering establishing an oil stockpile because it is an oil-exporting economy and because of the high initial and maintenance costs required for such a stockpile. There is also no legal framework in place for an economy stockpile, and there are no such obligations on private-sector commercial inventories.

In each of these cases, policy decisions are made regarding an economy stockpile within the context of that economy. However, from the perspective of regional mutual lending in emergency situations, economies without an economy stockpile may end up being unilateral receivers of support, and thus it is hoped that these economies will also establish an economy stockpile or require a private-sector stockpile that include running stock as a matter of energy security policy.

In recent years, as part of the Saudi Arabia and UAE market strategy in Asia, these economies are implementing a scheme whereby they receive crude oil tanks from Asian economies that they use under normal circumstances as hubs for crude oil sales, but which in emergencies can be used to provide the host economy with a preferential supply of crude oil.

Even in economies without an economy stockpile, schemes such as this one can be implemented alone or jointly among multiple consumer economies as a helpful energy security policy.

### ii) Release of reserves

There are two major reasons economies release a stockpile. One is a global matter and the other is more local.

The global-scale reason that economies release the stockpile is when it becomes impossible for oil-producing economies to export crude oil, causing a global supply shortage. The first oil crisis was caused by the 1973 Yom Kippur War, the second oil crisis was caused by the 1978 Iranian Revolution, and the third by the 1990 Iraqi invasion of Kuwait, all of which had a major impact on global oil supply and demand. However, recent years' destruction of crude oil production facilities by terrorism and attacks by armed groups, among other destabilizing elements, have not had an impact on global oil supplies because of the United States' dramatic increase in shale oil production.

Meanwhile, the more local reason for diminished reserves is natural disaster, such as recent years' increasingly large typhoons, hurricanes, and monsoons attributed in part to global warming, as well as the major earthquakes and volcanic eruptions frequently occurring throughout the world.

Whether the reason is global or local in scale, economies respond by cutting oil demand, changing fuel sources, and imposing restraints on sudden demand increases, cutting into their number of days' worth of reserves for a set period. In the present day, many economies both inside and outside the OECD maintain an oil stockpile. The body that puts a response plan into action in the event of an oil emergency is the IEA for IEA member economies and the ASPA Board of Directors (based on the ASPA, ASEAN Petroleum Security Agreement) for ASEAN economies. However, there are no connections between these implementing organizations, and there are gaps regarding how to respond to economies' releasing their stockpile. Therefore, the two organizations should establish links and become able to cooperate on emergency response.

**iii) Support for petroleum product supply**

There is more to emergency response than just domestic measures. Active overseas support for foreign economies is also possible. This applies particularly to economies that have had their oil supplies cut off locally, as in such cases nearby economies or organization member economies can act to increase crude oil processing for the disaster-stricken areas or directly supply the areas with petroleum products. In one case, after the 2005 U.S. Hurricane Katrina, economies sent out emergency exports of petroleum products to the United States. After the 2011 Tohoku earthquake in Japan, various economies sent Japan aid in the form of real goods and commodities. However, under present conditions, this sort of aid is only delivered to a port, and transport and usage beyond that point must be handled by the disaster-stricken economy itself. After the 2011 Tohoku earthquake, there were great difficulties delivering aid supplies as even standard logistics and distribution channels were lost to damage.

The resolution of these difficulties is the problem of the disaster-stricken economy, and the reality is that it can be difficult to provide relief or rescue even for nearby economies or organization members. However, it is also important to sign special contracts or take other special measures to address these emergency situations.

### 6) Cooperation with producing-economy NOC

#### i) Cooperation between oil-producing and -consuming economies on downstream oil strategy

Chapter 2 discussed refinery construction planned by Asian oil-consuming economies. This section will excerpt from that body of data examples of oil-producing economies collaborating with Asian oil-consuming economies on refinery construction.

**Fig. 3-9: Oil refineries resulting from collaboration between oil-producing economies and Asian oil-consuming economies**

| Company | Partner | Status | Ref Name | Capa.(b/d) | Project |
|---|---|---|---|---|---|
| NORINCO (China) | Saudi Aramco | New | Panjin | na | MOU of Refining, Petrochemical and Retail Project, May 2017, Panjin, Liaoning |
| CNPC (China) | Rosneft | New | Tianjin | 320,000 | 9.1 million b/d ESPO crude oil as feed, FS stage, by end of 2020 |
| Pertamina (Indonesia) | Rosneft | expansion up grade | Tuban | +200,000 | From 100,000 to 300,000b/d, install secondary unit for gasoline, diesel & jet fuel and Petrochemical complex Facilities, under FS, by end of 2021 |
| Pertamina (Indonesia) | Saudi Aramco | expansion up grade | Cilacap | +50,000 | From 350,000 to 400,000b/d, install secondary (FCC, Hydro desulfurizain) unit for gasoline, diesel & jet fuel, below 10ppm, by end of 2021 |
| Pertamina (Indonesia) | under consideration | New | Bontang | 300,000 | below 50ppm for Gasoline and Diesel, by middle of 2023, Oman is one of the candidate |
| Pertamina (Indonesia) | China, Iran, Oman | New | Java or Smatra | 300,000 | rumor as of 2015, Possibility of being duplicated with Bontang's plan |
| Petronas (Malaysia) | Saudi Aramco | New | Pengerang RAPID | 300,000 | 50:50, below 10ppm for Gasoline and Diesel, 70% crude oil supply by Saudi, on going, by end of 2019 |
| PTT (Vietnam) | Saudi Aramco | New | Nhon Hoi | 400,000 | original schedule is end of 2022, but postponement policy by PTT as of Jan 2017 |

Source: Derived from information on company websites and oil industry publications

These projects are the products of collaborations between the national oil companies of oil-producing economies, who sought a larger market share of crude oil sales, and Asian oil-consuming economies with uneasiness and anxieties regarding construction funding, technology, and stable crude oil supplies.

#### ii) Benefits and drawbacks

This section will examine the benefits and drawbacks of these schemes based on the perspectives of both economies.

#### Potential benefits to oil-producing economies

- Secure a stable customer for crude oil by participating in consumer economies' downstream sector;
- Opportunities emerge to gain entry to consumer economies' domestic petroleum products sales networks;
- Oil refining possible closer to the consumer region, improving the speed and flexibility of petroleum product exports; and
- Ultimately, stronger connections can be built up with consumer economies in a variety of areas.

**Potential drawbacks to oil-producing economies**

- If consumer economy oil demand does not line up with forecasts, the investment may be wasted; and

  ⇒ In this case, the refinery can be used for exports to surrounding economies.
- Competes with the economies to which the oil-producing economy exports petroleum products;

  ⇒ In such cases, isolate the two from each other to some degree

**Potential benefits to oil-consuming economies**

- Can secure a stable supply of crude oil;
- Can secure financing or operating technology and skills from the oil-producing economy, in some cases; and
- Even if the local refinery halts operations because of regular repairs or accidents, it is potentially possible to receive preferential access to petroleum product supplies from the oil-producing economy itself.

**Potential drawbacks to oil-consuming economies**

- If the oil-producing economy declares *force majeure* and it becomes impossible to make crude oil imports, refinery operations may be temporarily affected; and

  ⇒ In this case, some procured crude oil could be transferred to another economy;

  ⇒ For this reason, one economy is not to be relied upon for 100% of crude oil supply. Alternative sources of imports must be secured. A certain level of reserves is kept of crude oil and petroleum products.

Viewed in this way, oil-consuming economies clearly face few risks to cooperating with oil-producing economies to construct refineries. However, it is necessary to be very careful not to push forward with an overreliance on Middle Eastern oil-producing economies, only because of their political and religious instability, but also because of the unreliability of their economies and even transport routes. In recent years, non-OPEC oil-producing economies have increased crude production, and they too are seeking to secure destinations for their exports. Thus, while being mindful of relationships with economies such as these, it is important to create well-balanced relationships with oil-producing economy NOCs.

## Chapter 4. Implications

### 4-1. Oil energy situation in each economy

The oil energy situation of each of the 21 APEC member economies is unique. This section will categorize these economies on the basis of proved reserves, crude production, oil products consumption, refinery capacity, TPES self-sufficiency ratio, and oil import ratio.

**Fig.4-1: Oil energy situation of APEC economies**

| | Proved Reserve | | Crude Prod. | Oil Products Consumption | | Refinery Capacity | | TPES self-sufficiency ratio | Oil import ratio |
|---|---|---|---|---|---|---|---|---|---|
| | 2016E | R/P | 2016 | 2015 | 2030(A) | 2015(B) | B-A | | |
| | Bn bbl | Year | Mb/d | Mb/d | Mb/d | Mb/d | Mb/d | | |
| Australia | 4.0 | 30.3 | 0.359 | 0.870 | 1.047 | 0.512 | ▲ 0.535 | 298% | 60% |
| Brunei Darussalam | 1.1 | 24.9 | 0.121 | 0.013 | 0.028 | 0.010 | ▲ 0.018 | 593% | -1269% |
| Canada | 171.5 | 105.1 | 4.460 | 1.957 | 2.268 | 2.008 | ▲ 0.260 | 171% | -178% |
| Chile | 0.2 | | 0.012 | 0.295 | 0.409 | 0.233 | ▲ 0.176 | 35% | 98% |
| China | 25.7 | 17.5 | 3.999 | 10.770 | 16.412 | 10.710 | ▲ 5.702 | 84% | 60% |
| Hong Kong, China | 0.0 | | 0.000 | 0.065 | 0.092 | 0.000 | ▲ 0.092 | na | 100% |
| Indonesia | 3.3 | 10.3 | 0.881 | 1.326 | 2.026 | 1.167 | ▲ 0.859 | 189% | 43% |
| Japan | 0.0 | | 0.136 | 3.227 | 2.940 | 3.917 | 0.977 | 7% | 100% |
| Korea | na | | 0.097 | 2.043 | 1.926 | 2.970 | 1.044 | 18% | 100% |
| Malaysia | 3.6 | 14.0 | 0.705 | 0.564 | 0.912 | 0.527 | ▲ 0.385 | 112% | -8% |
| Mexico | 8.0 | 8.9 | 2.456 | 1.742 | 1.986 | 1.540 | ▲ 0.446 | 98% | -42% |
| New Zealand | 0.0 | | 0.044 | 0.133 | 0.152 | 0.117 | ▲ 0.035 | 78% | 70% |
| Papua New Guinea | 0.2 | | 0.056 | 0.042 | na | 0.032 | na | na | 57% |
| Peru | 1.2 | 24.0 | 0.135 | 0.295 | 0.577 | 0.193 | ▲ 0.384 | 104% | 37% |
| The Philippines | 0.1 | | 0.026 | 0.312 | 0.501 | 0.276 | ▲ 0.225 | 50% | 96% |
| Russia | 109.5 | 26.6 | 11.227 | 3.096 | 4.342 | 5.692 | 1.350 | 188% | -275% |
| Singapore | 0.0 | | 0.000 | 0.299 | 0.496 | 1.345 | 0.849 | 2% | 100% |
| Chinese Taipei | 0.0 | | 0.028 | 0.812 | 0.708 | 1.310 | 0.602 | 11% | 100% |
| Thailand | 0.4 | 2.3 | 0.479 | 1.063 | 1.421 | 1.246 | ▲ 0.175 | 56% | 74% |
| United States | 48.0 | 10.6 | 12.354 | 15.813 | 16.374 | 18.097 | 1.723 | 88% | 40% |
| Viet Nam | 4.4 | 36.2 | 0.333 | 0.373 | 0.466 | 0.148 | ▲ 0.318 | 95% | 11% |
| APEC Total | 381.1 | | 37.908 | 45.110 | 55.083 | 52.050 | ▲ 3.065 | | |

TPES = total primary energy supply

Source: Proved reserves and crude production from BP, *Statistical Review of World Energy 2017;* oil products consumption and refinery capacity converted (kb/d) from APERC data (Mtoe); TPES self-sufficiency ratio and oil import ratio created from IEA, *Energy Balance 2017.*

For example, in the above table, the United States' refinery capacity is satisfying demand; however, its crude production is not. In Canada, meanwhile, crude production outstrips oil demand, and refinery capacity is on par with demand at present but the refinery capacity is seen as being far from sufficient relative to 2030 demand forecasts. On the other hand, Mexico's crude production capacity is high but its refining capacity has been insufficient and is continuing to be insufficient.

In China, while its crude oil production is insufficient against oil demand, the refining capacity is currently well-balanced. However, it is viewed as being far from sufficient relative to 2030 demand forecasts.

Crude productions in Indonesia and Malaysia are insufficient to cover oil demand, and refinery capacities are also lacking. The difference between these two economies is that oil demand exceeds 1.0 million b/d in Indonesia but not in Malaysia.

Refinery capacities in Singapore and Korea are much greater than oil demand, and all crude oils are imported. The difference here, too, is that oil demand exceeds 1.0 million b/d in Korea but not in Singapore.

Oil demand in Viet Nam in recent years has exceeded both crude production and its refinery capacity.

As it is noticeable, the oil energy situation of each of the 21 APEC member economies is unique and very different from that of the others. The following sections will be dedicated to the detailed investigation.

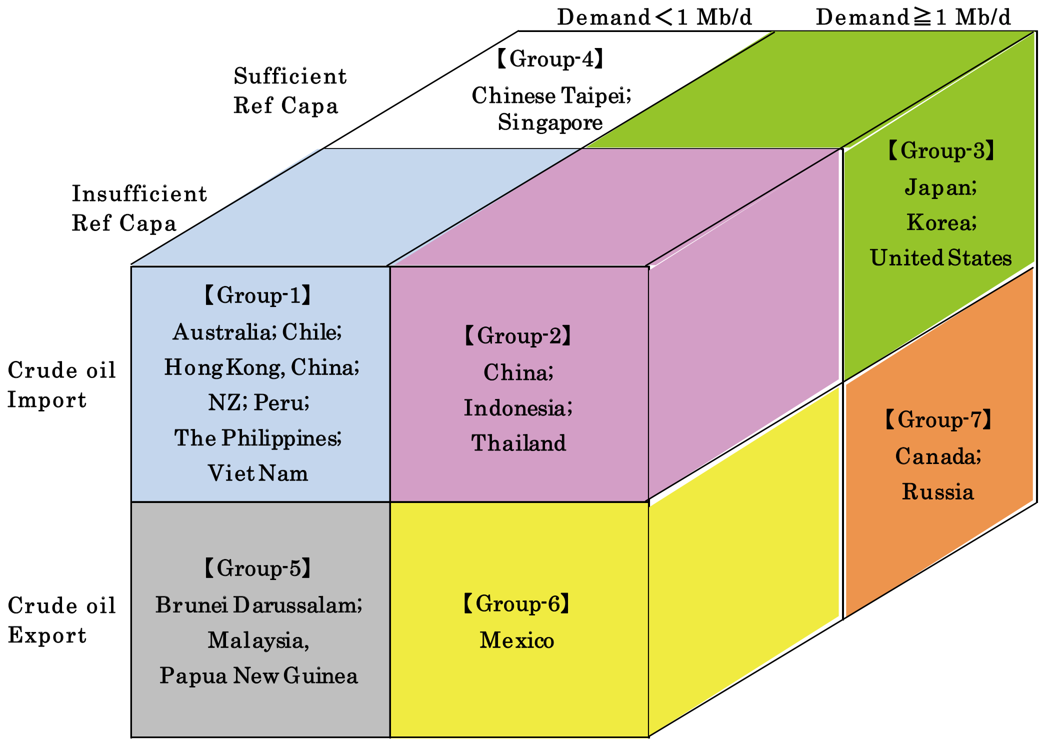
### 4-2. Categorization by energy situation

This section will use the data in the previous section to categorize the 21 APEC member economies in three dimensions.

1) We will first examine supply-demand balance of oil resource by simply comparing whether crude production satisfies oil products demand. That is, if crude production falls below oil products demand, that economy is viewed as being in an "oil importer position." If production exceeds oil products demand, the economy is viewed as being in an "oil exporter position."
2) Next, we will examine the size of oil demand. For convenience, we will simply separate the economies with oil demand exceeding one million b/d from the economies with oil demand less than one million b/d.
3) Finally, economies will be checked whether their current refinery capacity can satisfy domestic demand including future demand in 2030.

Some economy is planning or examining refinery construction in the future, but in order to refer to when making final investment decisions, here is showing based on current oil refining capacities.

Fig. 4-2: APEC member economy categorization diagram




Ref. Capa. = refinery capacity

### 4-3. Basic approach

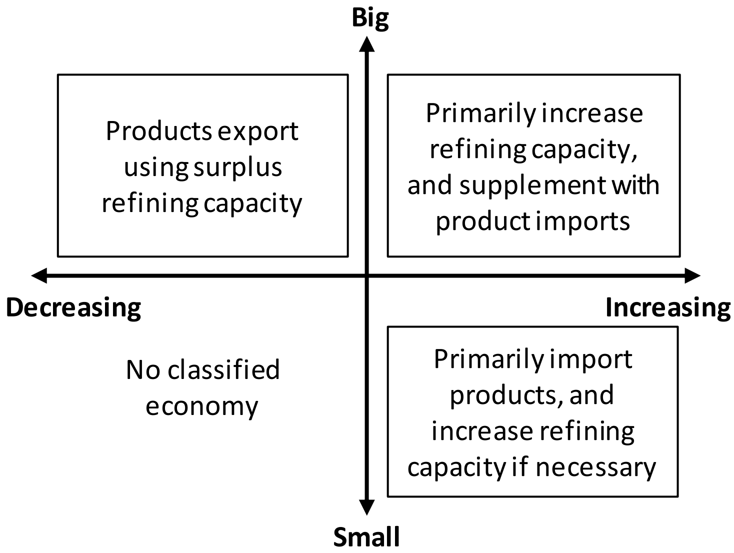
An exporter/importer position on crude oil has a major impact on the energy security policy for each economy. For a net importer position, the point in question is how to acquire crude oil, or how to acquire a supply of petroleum products. On the other hand, for a net exporter position, the policy priority is how to secure an export market for crude oil, or how to increase the value-added of crude oil.

Forecasts on excess or deficiency of refining capacity can create differences in oil security policy. If refining capacity is sufficient or estimated to become a surplus in the future, it becomes important to determine how efficiently the refinery can be operated and how oil products can be exported. If refining capacity is insufficient, the question is how to increase the refining capacity or what strategy to acquire petroleum product imports.

The magnitude of demand (one million b/d is used as a basis for evaluation) has an impact on the economic viability of the investment. If it is assumed that domestic demand of sufficient size will continue to exist for a given period in the future, it becomes easier for refinery construction to be economically viable. If it is not possible to predict that there will be a sufficient domestic demand, it is difficult for refinery construction to become economically viable unless count export demand. In such case, petroleum product import becomes the more viable option.

Building on this, midstream oil security policy can be categorized from the size of demand and future increase/decrease.

**Fig. 4-3: Relationship between the size of demand and future increase/decrease**




Based on this summary, we recommend the following midstream oil security policies that take into account unique circumstances that vary between individual economies. Our recommendations to the region of APEC as a whole, which supports individual economies' various policies, will be described in Section 4-5.

### 4-4. Policy implications for individual economies

*<u>Group 1; Crude oil import - insufficient refining capacity - smaller demand size economies</u>*

G1-1) Chile, Peru

Chile and Peru are in similar energy and economic situations. Crude oil production and refining capacity are smaller than oil demand, and therefore they import petroleum products. Those imports come primarily from the Gulf of Mexico in North America through the Panama Canal. Oil demand for Chile and Peru are forecasted to increase strongly through 2030 (AAGR of 2.2% and 4.6% respectively), and the supply-demand gap with domestic refining capacity will widened.

Based on this, there are two choices on how these two economies will improve their midstream oil security in the future. One option is to increase domestic refining capacity. In this case, the economies must evaluate the all the variables related to the process to expand the facilities, including refinery location and associated facilities, as well as crude oil import sources and routes because both economies are in a crude importer position. In other words, the economies can obviously import for a stable supply, but they must consider the economic viability of such a decision. In case of lager and more economically efficient vessels (VLCC: a capacity of approx. 2.0 million barrels), the evaluation must include the possible routes and the transport lengths. That is the voyage from the Gulf of Mexico or the Middle East and Africa to the coast of the Pacific Ocean via the southern tip of South America. The voyage distance can nevertheless be shortened by passing through the Panama Canal, but this forces the use of the less economically efficient Panamax vessels (capacity of approx. 500,000 barrels)

Taking into consideration of the investment in refinery construction and crude transport costs, the most rational choice for both economies is to adopt a system whereby necessary quantities of oil products can be procured when necessary at cheap prices. This is considered as a second option.

Peru currently relies on imports for 34% of its crude oil, and total primary energy supply import ratio (TPES self-sufficiency ratio) is quite high at 104%. This is due to its high production of natural gas. If Peru were able to shift its domestic energy demand from oil to natural gas, its energy security could be expected to significantly improve. To that end, there is a need to continue working towards building a legal framework and infrastructure that promote natural gas usage.

G1-2) Australia; Hong Kong, China; New Zealand

Australia and New Zealand are in relatively similar situations. Their crude production and refining capacity are less than oil demand, and therefore they import petroleum products primarily from Korea and Singapore.

Australia's approach to oil security has changed over time. Oil demand growth is slow, the import ratio for primary energy as a whole is quite high at 298%, and investment in refining capacity could be risky in light of increasingly strong climate change countermeasures. Under these policies, there is a need to keep an eye on future changes in oil demand, and especially in Australia with its long automobile travel distances, to expand stockpile policies focused on fuels used for transportation, which are difficult to replace.

In New Zealand and Hong Kong, China, refining capacity is only barely insufficient to cover oil demand, and no major growth in oil demand is expected in the future. Refining capacity in New Zealand in 2030 is expected to be just 35,000 b/d short of demand, whereas the gap in Hong Kong, China will be 92,000 b/d. The gap is small in both economies, and especially in Hong Kong, China with its small island area, it is likely more profitable to choose product imports using the petroleum products market rather than to increase refining capacity.

New Zealand has introduced an approach of using "Ticket contracts" that enable preferential purchasing of oil in emergencies, achieving necessary oil security without maintaining any physical stockpile within the economy. This could be a viable option for economies with small demand.

G1-3) The Philippines, Viet Nam

Although the Philippines and Viet Nam are somewhat different in terms of crude oil production, oil demand is expected to grow strongly in the future. However, these economies are facing the problem of refining capacity insufficiency that is expected to become even bigger in the future. Refining capacity shortages in 2030 can be conjectured to exceed 200,000 b/d in the Philippines and to exceed 300,000 b/d in Viet Nam.

This gap between supply and demand is sufficiently large to justify expanding refining capacity and this is considered as an appropriate midstream oil security policy for both economies. However, increasing refining capacity will require several years to accomplish, and in the short term, there is no choice but to rely on product imports. For this reason, it is increasingly important in terms of security policy to expand stockpile of petroleum products.

Viet Nam still has oil resources remaining and its best option is likely to increase domestic crude oil production. Viet Nam already has many projects underway that aim to increase refining capacity, but those projects cannot necessarily be said to be progressing smoothly. Many factors may be impeding their project execution. An option to be considered is for the refinery construction to be pursued together with the governments of oil-producing economies which can be more effective in terms of both financing and crude oil procurement.

Group 2; *Crude oil import - insufficient refining capacity - larger demand size economies*

G2-1) China

Even though China is slowing down, its energy consumption is expected to continue growing along with its economic growth in the future. With tremendous demand, policy in China has the potential to have a major impact on prices and the balance of supply and demand in international market. Therefore, it is rational for China to choose neither crude oil imports alone nor petroleum product imports alone, but rather to skillfully combine crude oil import and petroleum products import instead.

Moreover, there is uncertainty in the assumption that oil demand will continue to grow in the future, and there is a need to build on that uncertainty moving forward. At present, China is actively working to improve energy efficiency and enthusiastically utilizing low-carbon energy sources. For example, China's requirement that a percentage of new vehicles sales be alternative fuel vehicles in 2019 and beyond has the potential to heavily depress the outlook for oil consumption in the transportation sector. Building off on this uncertainty, it might be wise to restrain from adding up refining capacity to provide domestic supply.

Bad for both China and the international market are the excessive crude oil procurement and investment in refinery construction, as well as the domestic and international market turmoil and extreme corrections that would follow such activities. What is needed is leadership by well-balanced supply chain planning and policies that avoid problems such as these.

G2-2) Indonesia, Thailand

Indonesia has proved oil reserves totaling 3.3 billion barrels, but these are on a remarkable decline noticeable from the production volumes decreasing every year. Moreover, although domestic demand is growing, refining capacity cannot cover this demand and around 40% of demand is reliant on petroleum product imports. This insufficiency in refining capacity will become even more prominent in the future with the supply-demand gap predicted to become second only to China in size in the APEC region by 2030 (at approx. 860,000 b/d in 2030).

On the basis of this long-term growth in demand and insufficient refining capacity, it seems that investment in additional refining capacity would be the best midstream oil security policy for Indonesia. Although its proved oil reserves are in decline, there are crude oil resources remaining, and obviously, it would be ideal to continue developing these resources as long as it is economically viable to do so.

Indonesia is already working with several oil-producing economies on joint refinery construction projects which can prove to be an effective choice to acquire both crude oil and capital simultaneously. Due to its rich natural gas and coal resources, Indonesia's TPES self-sufficiency ratio is over 100%, and it is also working to expand its use of alternative energy sources. Indonesia will continue developing its land and economy further into the future, and this means it has a chance to build an economic structure that differs from the path taken by developed economies and does not rely on oil. It is obviously important to improve access to commercial energy, but it is preferable to take a long-term view in selecting energy sources and not to become reliant on oil without careful consideration.

Thailand resembles Indonesia in that its crude oil production is declining and it has a relatively strong oil demand growth. However, Thailand differs from Indonesia in a few points. Although Thailand currently has enough refining capacity to cover domestic demand, it is predicted to be 175,000 b/d shortage by 2030. Considering only domestic demand and factoring in stronger long-term climate change policies in the future, adding refinery capacity might be a high-risk decision. However, if adjacent Cambodia, Laos, Myanmar, and other ASEAN economies are viewed as markets for the additional refinery capacity, the potential for such an investment decision does exist.

Group 3; *Crude oil import - sufficient refining capacity - larger demand size economies*

G3-1) United States of America

The United States' crude oil production volume has shot up due to the increase in shale oil production since 2010. As a result, the USA's oil self-sufficient ratio is the highest it has ever been, and oil security can be considered to have improved. The current administration is on a path of supporting the development of domestic oil resources, and this is a positive from an oil security perspective. However, shale oil production has an uncertain outlook for the future, and it has been pointed out that production volumes may not increase much, depending on the amount of the resource available and market conditions[17].

The U.S. oil demand is expected to grow marginally in the following years leading up to 2030 despite the supply of cheap natural gas and regulations on incorporation ethanol in automobile fuels. Meanwhile, refining capacity in 2030 is expected to exceed demand by 1.7 million b/d, and there is a need to make efficient use of that.

The United States was hit by hurricanes in the Gulf of Mexico in August 2005 and September 2017 and these disasters had an impact on the U.S. oil industry as the industry is concentrated in that region. Stronger countermeasures against severe weather are likely needed.

G3-2) Japan, Korea

The situations of Japan and Korea are extremely similar to one another. Neither has

[17] EIA, *Annual Energy Outlook 2017*

oil resources and both import all of their crudes. Oil demand is on the decline, and there is a surplus of refining capacity relative to domestic petroleum products demand. However, the initial core concept underlying oil refinery construction differs between the two economies: Japan has built up its refining capacity in response to increasing domestic demand, and since domestic demand has begun decreasing, it has excess capacity to capture the margin through export. By contrast, Korea built up its refining capacity from the start with the aim to incorporate processing for export. Therefore, Korea differs from Japan in that Korea's refineries are typically in a state of high utilization.

In terms of domestic midstream oil security, the key issue is likely the revision of petroleum product supply methods to suit shrinking domestic demand. In Japan's case, the question is how long it should maintain refinery capacity to cover supply for all of its shrinking domestic demand. Conventional security policy has been built on a premise of refining for its own consumption. However, maintaining refining capacity for a shrinking market is a risk for private companies, and its aging refineries may lose economic viability compared to imported oil products. If the situation takes place, it is then more rational to do away with the principle of refining for self-supply and gradually increase oil product imports instead.

Like Japan, Korea is also responding to a shrinking domestic market by focusing on improving its competitiveness in international markets. If Korean-made oil products were to lose their competitiveness, Korea's surplus refining capacity is likely to rapidly skyrocket. In this case, the role of its domestic refining capacity in its domestic midstream oil security situation may be up for discussion.

To examine the reverse case of maintaining refining capacity, it would be necessary to improve oil product exports and make efficient use of surplus facilities. Japan and Korea are well-placed geographically to potentially develop Pacific Rim markets for its petroleum product exports, and it might be possible to use the products' quality to differentiate them from competitors. Surplus facilities could potentially be lent out to economies in which demand is expected to grow, similarly to the way that crude oil tanks are already lent out[18] to Middle Eastern oil-producing economies now, or used by other economies as a stockpile.

Group 4; *Crude oil import - sufficient refining capacity - smaller demand size economies*

G4-1) Singapore

Although Singapore has low oil demand, it is already a hub for the petroleum

[18] This will end in Korea at the end of 2017.

products trade in Asia as it is well-located and has large-scale refining and reserve tank capacities. Singapore's refining capacity is around 4.5 times its domestic consumption (as of 2015). From a domestic mid-stream oil security perspective, it needs only to focus on maintaining its crude oil supply for the present, while working to not lose its status as a hub is a key issue in the medium to long-term. If Singapore were to lose its status as a hub, the excessive refining capacity would be a major liability for oil companies, and this may also impact the stability of its domestic supply.

Singapore's role as a trading hub is an essential element to the security of its economy that is an oil product importer. A fluid and transparent product market are essential to economy security that relies on imports for its petroleum product supply. In this sense, Singapore is expected to build the infrastructure so as to support physical trading such as sea routes and harbor facilities, and to continue serving its role as a hub of petroleum products trade.

G4-2) Chinese Taipei

Chinese Taipei is technically classified into the same group as Singapore, but its geographical situation, the anticipated decline in oil demand, TPES self-sufficiency ratio, and dependence on oil imports make it similar to Korea and Japan.

Like Korea and Japan, Chinese Taipei has utilized its surplus refining capacity for petroleum product exports, and in the future it too will need to consider the most effective use of its surplus refining facilities and tanks. In the medium to long term, it is possible that oil demand will decline even further with the strengthening of measures to halt climate change. In such a case, like Japan and Korea, Chinese Taipei may need to re-examine the role of its refining capacity in its oil security.

Group 5; *Crude oil export - insufficient refining capacity - smaller demand size economies*

G5-1) Malaysia

Malaysia is currently in a crude oil exporter position and its refining capacity is approximately equal to demand. However, compared to its predicted demand in 2030, Malaysia would fall into a crude oil importer position with a refining capacity shortage of around 400,000 b/d based on its current capacity. These elements are the same as those of the economies categorized in Group 1.

Taking into account the possibility that Malaysia may suffer a 400,000 b/d oil products supply gap by 2030, adding refining capacity is an option. Even if half of Malaysia's proved oil reserves were marginal oil fields containing less than 100 million barrels, the most rational security policy for Malaysia is likely to cover its own supply by using its remaining crude oil resources and refining at its own refineries. At present, Malaysia is partnering with Saudi Arabia to construct a 300,000 b/d refinery in Pengerang in southern Johor, a state located on Malaysia's peninsula. Also seen elsewhere in East Asia, this investment scheme is an effective framework that enables Malaysia to supply crude oil and funding simultaneously.

Malaysia also has a TPES self-sufficiency ratio of over 100%. Possessing the capacity to supply energy (natural gas) with a high self-sufficient ratio and promoting its use serve to push down oil demand, contributing to an improvement in oil security.

G5-2) Brunei Darussalam; Papua New Guinea

Oil demand in both Brunei Darussalam and Papua New Guinea is below 50,000 b/d, but crude oil production exceeds demand. Although refining capacity is insufficient to cover demand, it is not economically sound to construct new refineries considering the size of demand. Instead, these economies' rational options are to consider small-scale facility expansions, make processing contract to Singapore (providing crude oil and receiving petroleum products), or to import petroleum products in necessary quantities from the market.

Group 6; *Crude oil export - insufficient refining capacity - larger demand size economies*

G6-1) Mexico

Mexico's crude oil production exceeds its demand, putting it in a crude oil exporter position. However, its refining capacity is insufficient to cover demand, and therefore it is in a petroleum products importer position. Mexico has been exporting crude oil to the U.S. and importing petroleum products, but in recent years, Mexico's crude oil exports to the U.S. have declined as American shale oil production has increased. Since American shale oil production is expected to continue on into the future, Mexican oil security requires the development of new crude oil export markets to cover the drop in American imports, and the bolstering of domestic refining capacity in proportion to the estimated growth in Mexican petroleum product demand.

Both Mexico's offshore and onshore crude oil production sites are located in the vicinity of the Gulf of Mexico. Meanwhile, there are refineries in six locations, three around the Gulf of Mexico, two in the central, and another on the Pacific coast. Most of these refineries are located near the crude oil production sites. The production sites and refineries are connected via pipeline. The refinery on the Pacific coast is at Salina Cruz, and oil is sent there via pipeline from the Gulf of Mexico approximately 250 km away.

What if Mexico were to expand the capacity of its crude pipeline running up the

Pacific coast and establish a new refinery or expand the Salina Cruz refinery? There would be several benefits to this. First, all Pacific Rim economies could be considered potential crude oil export markets. Mexico has exported crude oil out of Salina Cruz in the past, but the shipment was very time-consuming due to limitations in the pipeline's capacity and crude oil tank capacity. These problems can be resolved, and the currently insufficient domestic petroleum products supply can be supplemented with newly built or expanded refining facilities, with Pacific Rim economies as potential export markets for surplus oil products.

Group 7; *Crude oil export - sufficient refining capacity - larger demand size economies*

G7-1) Canada

In Canada, too, crude oil production outstrips demand, then, Canada is in a crude oil exporter position. Current refining capacity is even with oil demand but it will be insufficient to cover forecasted 2030 demand by 260,000 b/d. The midwestern Canadian province of Alberta accounts for around 80% of Canada's crude oil production with most of it from oil sands. The crude is sent primarily to America's midwestern region (PADD 2). Due to the growing production of light shale oil in the United States, there is increasing American demand for heavy oil to blend with the shale oil, hence the growing imports of Canadian crude. In June 2017, the Canadian Association of Petroleum Produces (CAPP) predicted that Canadian crude oil production would grow 33% on current levels by 2030 to 5.12 million b/d[19]. It is good news for Canada that construction of the Keystone XL pipeline in the United States has seen progress, but it is difficult for the U.S. alone to absorb all growth in crude oil production, and thus there will be a need to develop new export markets, potentially including Pacific Rim economies.

Canada has refineries in 17 locations, but around half of these are located in the provinces of Alberta and Ontario. There are just two small refineries in British Columbia, a Canadian province located on the Pacific Ocean, and as the expansion of refineries becomes necessary for the future, it is important for Canada—just as necessary for Mexico—to give consideration to such locations. However, one shall remind of the issue of pipeline transportation from producing site in the mid to Pacific coast.

G7-2) Russia

Russia has plenty of crude oil production and refining capacity to cover predicted petroleum product demand through 2030. Moreover, its TPES self-sufficiency ratio is extremely high. For these reasons, Russia is currently a prime supplier of crude oil in

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19 *Canadian Press,* June 13, 2017 edition

the market. However, the key to whether Russia can maintain its crude oil production volumes depends on whether it can make up for reduced production in western Siberia with new oil field development in eastern Siberia or the Far East. What becomes important is to what extent Russia can develop the difficult offshore oil drilling zones of the Arctic Ocean or the tight oil of western Siberia. Moreover, although Russia has refining capacity, most of its refineries are aged and deteriorating with their facilities in need of an upgrade. Finally, Russia's exports tend to go disproportionately to European markets, and it needs to diversify in this respect.

Russia is dependent on revenues from oil and natural gas exports, and key issues for its oil security include securing export markets by stably producing crude oil and petroleum products, as well as acquiring methods of overcoming geographical and weather conditions to enable exports.

### 4-5. Policy implications for the APEC region

#### 1) Add refining capacity in the Pacific coast and utilize surplus capacity

The above sections discussed implications on an economy-by-economy basis. Many economies are in crude oil import position and forecasts show that over half of the economies will face refining capacity shortages. Across APEC as a whole, the amount of crude oil required is expected to grow in the future, and there is no way to proceed ahead without increasing refinery capacity. The shortage of refinery capacity affects the Pacific region, and particularly South America and Southeast Asia, where there is a need to increase supply. On the other hand, there are a few economies that are exporters and are expected to have surpluses of refining capacity in the future. The utilization of this surplus capacity has the potential to be more economically efficient than constructing new facilities, and much is expected from seeking and utilizing such opportunities.

#### 2) Create a highly liquid and transparent petroleum product market

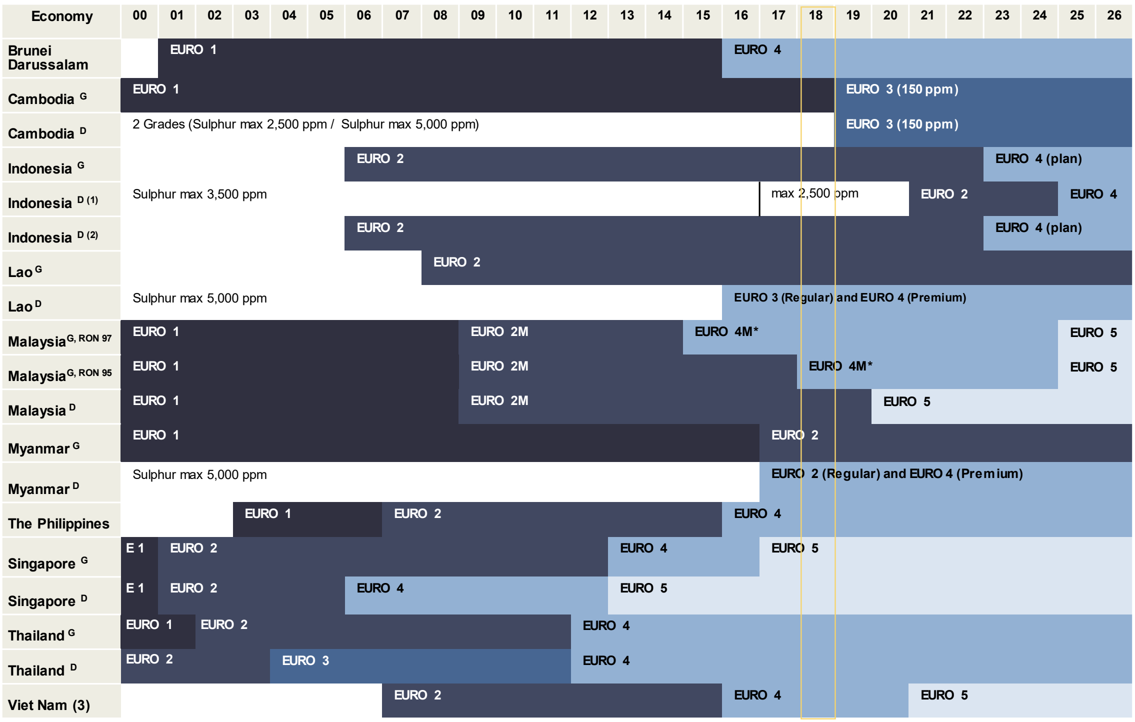
The stable supply of oil products is a matter of life and death in economies for which it is not economically viable to have domestic refineries. Highly fluid petroleum product markets with transparent transactions and price formation processes are useful in securing this sort of stable supply. To this end, there is a need to further develop the petroleum products trade that has been continuing to expand in recent years. We offer the following two recommendations to achieve this goal.

## Integration of quality standards for petroleum products

Our first recommendation is the integration of quality standards for petroleum products. For instance, there are two standard values for sulfur content in automobile gasoline: 50 ppm and 10 ppm among Asian economies. In addition to this, the octane number at which gasoline is divided into regular and high-octane gasoline is 90 or 95 for the most economies, but this too differs from economy to economy. Not only automobile gasoline but also diesel fuel has different sulfur content and cetane numbers in different economies.

If specifications such as these were to be standardized throughout APEC, member economies would easily be able to procure petroleum products from any other members, and this could reduce both transport costs and transaction costs. It would also be easier to lend one another petroleum products in emergencies.

**Fig. 4-4: Quality standards of transportation fuels in ASEAN**




Note: G = Gasoline, D = Diesel; (1) PSO: Public Service Obligation (2) Non-PSO: Non-Public Service Obligation (3) Motorcycle uses EURO 3 from Jan 2017,

EURO4M* => Sulphur 50 ppm, Benzene < 3.5%, RVP < 65 kPa

Source: Petroleum Institute of Thailand (2018)

**Abolish subsidies for petroleum products**

Our second recommendation is price transparency. Proper price signals are essential to developing a market. For example, if supply is tight relative to demand, prices will rise (price signal). This will suppress demand and increase supply, achieving a market balance. This market mechanism must function properly, and if this function is lost, excessive price variations and imbalances in supply and demand may interrupt the stable supply of petroleum products to the market.

There are two kinds of prices: international and domestic. Prices on the futures market and the spot market are used as indexes for international prices. Such indexes are determined by various players performing an infinite number of transactions, giving international prices a certain transparency. Meanwhile, among domestic prices, there are examples of prices kept low through subsidies from social or industrial policy in some economies. Although the intent of policies aimed at protecting low-income individuals and industries exposed to international competition is understandable, it is preferable for these policies to be ended due to their market-distorting side effects. We propose separating energy prices from subsidy policy and transitioning from "energy subsidies" to "direct subsidies for the protected parties."

**3) Review the strategic stockpile**

The general intent behind stockpile was for any economy to store crude oil and petroleum products within its own territory in case of supply interruptions from crude oil production sites. Later, considerations included not only production sites but transport-related risks along with other supply routes such as the Strait of Hormuz and etc. At this stage of the development, only the economies that were in net oil importers position needed to evaluate their stockpile.

However, there may be a need in recent years to extend the usage strategy of the stockpile to include natural disasters and incidents; for example, natural disasters sometimes affect crude oil production or refining operation. Hurricanes in the United States, despite being short-lived, have caused oil supplies to come to a halt for a given period. Additionally, the Tohoku earthquake in Japan caused damage to refineries, oil tanks, and transportation, causing oil supplies to come to a halt.

These sorts of natural disasters and incidents can happen in any place, and therefore not only net importers but net exporters also require a certain level of a stockpile. Additionally, it is not sufficient merely to own the stockpile. Their role must be defined as being a package of "holding" and "release" actions, with the question being the methodology to release the stockpile in emergency situations (i.e. whether to ship petroleum products to disaster-affected areas). Therefore, it is also important to review the stockpile balance between crude oil and petroleum products.

Traditional security policies are still needed and viable. However, economies are suggested to respond to new fundamental and market reality, and combine the traditional with new security policies that best suit to respective economies and to the region.

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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 Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org



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