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Cooperation Framework for Oil Stockpiling and Emergency Response System

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FOREWORD

Energy demand in Association of Southeast Asian Nations (ASEAN) countries has been rapidly expanding in the last decades. While the total energy demand in ASEAN countries has grown by almost 2.5 times from 1990 to 2011, its oil demand in particular has shown the largest increase, by more than 120 million tons of oil equivalent. Because domestic oil production has been either stagnant or shrinking in most ASEAN countries, oil demand growth has automatically resulted in increasing oil imports, which has made ASEAN countries more vulnerable to external supply disruptions or highly volatile international oil prices.

In recognition of this, this study has developed two scenarios to draw a picture of what will happen if an unexpected severe oil supply disruption happens in the absence of oil stockpiling. The particular focus of this report is on the ASEAN region because it has highest necessity to promptly initiate stockpiling development actions in East Asia. The report then considers what kind of oil stockpiling options are available for ASEAN countries that have not yet developed their stockpiling systems, and how government and industry relationships can help to promote stockpiling development.

It is my hope that the outcomes of this study will serve as a point of reference for policymakers in East Asian countries and contribute to the improvement of energy security in the region as a whole.

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LIST OF ABBREVIATIONS

APSA	= ASEAN Petroleum Security Agreement
ASEAN	= Association of Southeast Asian Nations
b/d	= barrels per day
bcm	= billion cubic metre
CBM	= coalbed methane
CIS	= Commonwealth of Independent States
CO_2	= carbon dioxide
EAS	= East Asia Summit
EIA	= Energy Information Administration
ECTF	= Energy Cooperation Task Force
ERIA	= Economic Research Institute for ASEAN and East Asia
GDP	= gross domestic product
HOA	= Heads of Agreement
IEA	= International Energy Agency
IEEJ	= The Institute of Energy Economics, Japan
LNG	= liquefied natural gas
LPG	= liquefied petroleum gas
MJ/litre	= mega joule per litre
MMBtu	= million British thermal unit
MMscfd	= million standard cubic feet per day
MMscmd	= million standard cubic metre per day
MT	= million tonnes
Mtoe	= million tonnes of oil equivalent
NESA	= National Emergency Supply Agency
NESO	= National Emergency Strategy Organization
OECD	= Organisation for Economic Co-operation and Development
SAGESS	= Société Anonyme de Gestion de Stocks de Sécurité
SS	= service station
Tcf	= trillion cubic feet
Tcm	= trillion cubic metre

UAE	= United Arab Emirates
UK	= United Kingdom
US	= United States
WG	= working group

Executive Summary

As ASEAN's oil imports continue to grow, oil supply security has become an acute issue for sound economic growth. The development of stockpiling, in particular, will play a central role in energy security policy. This is because oil is a commodity that is used for a variety of purposes and is difficult to substitute with another commodity. Oil therefore has a strategic importance that other commodities do not have, and a certain volume of oil should be separately stored to prepare for an unexpected supply problem. Stockpiling is in fact an established oil supply security measure in Organisation for Economic Co-operation and Development (OECD) countries, which have proved its effectiveness against sudden and unexpected supply disruptions in the past.

An oil supply disruption can occur for a range of reasons, from an unprecedented natural disaster to successive accidents in the oil supply chain. It can therefore happen at any time and will not wait until sufficient stockpiling is developed in ASEAN. A disruption can cause significant malfunctions in a country's economic activities and affect energy demand in multiple sectors, from the transportation, residential, and industrial sectors through to power generation. It may even lead to political uncertainty if the disruption is prolonged and causes discontent between the public and the government.

In developing oil stockpiling, the usual practice undertaken by many OECD countries is to build a permanent stockpiling base. There are four major types of oil stockpiling base in the OECD, namely onshore tank stockpiling, underground cavern stockpiling, salt cavern stockpiling, and floating stockpiling. Each stockpiling base has its own benefits and drawbacks. An ASEAN country intending to build a permanent stockpiling base may choose one of the types in accordance with the country's unique conditions, such as site availability, geological conditions, budgetary requirements, and resilience against natural disasters.

Some smaller ASEAN countries, however, may not have sufficient demand to justify developing a permanent stockpiling base, or may not be financially capable of funding the development of a stockpiling base. For such countries, lower cost options may be able to mitigate the effects of an unexpected supply disruption. There are five types of such lower-cost option: ticket stockpiling, upgrading commercial inventory to strategic stockpiling, joint stockpiling with a third party, regional stockpiling, and multilateral arrangements. Some small European countries prefer ticket stockpiling, but it cannot be a long-term solution for stockpiling development, especially for ASEAN countries, whose oil demand is likely to increase in the future. Upgrading commercial inventory may be a more viable option for ASEAN countries if cooperation from the oil industry can be obtained. Regional oil stockpiling can also be an effective option as benefits from economies of scale can allow even a smaller country to have a stockpiling base. A combination of ticket stockpiling arrangements may facilitate regional stockpiling.

In developing oil stockpiling, a successful relationship between the government and the oil industry will help greatly. Collaboration with industry brings industrial expertise on oil storage operations as well as the efficient management of oil supply logistics and financial and human resources. Examination of the history and management of oil stockpiling in OECD countries highlights several factors that are important and necessary for achieving a successful relationship between governments and the oil industry: 1) legal provisions that identify the roles and responsibilities of relevant players and mobilise domestic financial and human resources to proceed with stockpiling development; 2) international agreements and cooperation that provide external pressures to accelerate stockpiling development and ensure levelled competitive conditions across borders; and 3) close communication with the oil industry to understand the real intentions of the industry and create opportunities for economic benefits by the industry for developing stockpiling. The creation of economic incentives, where possible, will encourage the industry to join the stockpiling development efforts. Finally, government support in financing stockpiling development or regulatory arrangements to promote stockpiling development will also help to form a successful government-industry relationship.

ASEAN countries will follow the following steps as a template for an oil stockpiling development road map:

(1) Providing principles and legislation
(2) Founding a specialised organisation
(3) Financing
(4) Selecting an oil stockpiling option
(5) Securing a site and carrying out construction and operations

Providing principles is the first task to be undertaken in identifying the purpose of stockpiling and the specific target of stockpiling development. Oil stockpiling law will help to determine the roles and responsibilities of relevant players. The founding of a specialised organisation will be the next step, as the organisation will play a key role in developing stockpiling through coordination with the related agencies as well as foreign countries or organisations. The organisation will be a permanent one to accumulate expertise and information on stockpiling operations. The third step is securing finance. This can be achieved through government financing or private bank loans, subject to each country's political and economic conditions. Financing sources may also differ depending on the stage of stockpiling development. Selecting an oil stockpiling option is the next step. The chosen type of stockpiling can be based on each country's unique conditions. A lower cost and quicker option, such as ticket stockpiling, may be chosen first, then followed by a higher cost and more complex option, such as the upgrading of commercial inventory or regional stockpiling. Securing a site and carrying out construction is the final step. If a technically difficult option is chosen, assistance from foreign companies may be considered.

It is never easy to develop oil stockpiling. However, with increased uncertainty of current international oil demand and supply, and greater dependence on oil imports in the ASEAN region, its importance the importance of oil stockpiling is increasing day by day. To protect the domestic economies and populations from unexpected supply disruptions, oil stockpiling must be improved step by step, starting from where is most feasible.

CHAPTER 1

Crisis Scenarios

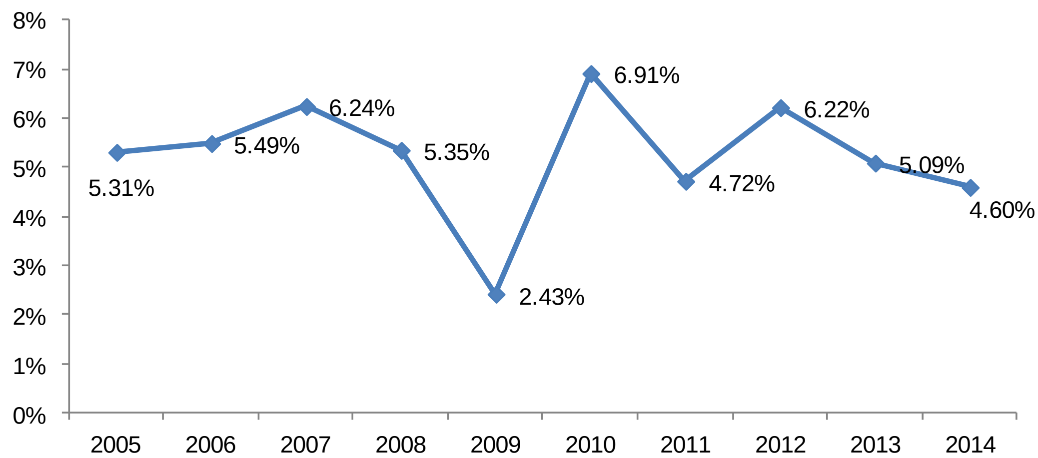
This chapter provides two potential crisis scenarios related to oil supply disruption, with a particular focus on ASEAN countries.[1] The scenarios aim to describe what would happen if an unexpected oil supply disruption were to occur in a country with no official stockpiling system.

1-1 Scenario of a Domestic Natural Disaster (The Case of Large Earthquake)

1-1-1 Assumptions of the scenario

Country A is a hypothetical country in Southeast Asia. The country was seriously hit by the Asian Economic Crisis that occurred in the late 1990s. Since then, however, the country's economy has grown at an annual average rate of 5 percent or higher through the steady development of various manufacturing industries, particularly boosted by its abundant natural resources. The country is leading other countries in the ASEAN region due to the recently booming Asian markets (Figure 1-1).

Figure 1-1. Economic Growth Rates of Five Major ASEAN Countries



Note: The five major ASEAN countries are Indonesia, Malaysia, the Philippines, Singapore, and Thailand.
Source: International Monetary Fund, World Economic Outlook Database.

[1] As mentioned in the Foreword, this report mainly deals with stockpiling development

While its economy continues growing at a rapid pace, Country A has seen its domestic energy demand increase at the same time. Over the past 10 years from 2005 to 2014, the country's energy demand has increased at an average annual growth rate of nearly 4 percent. While managing to meet the demand with coal and natural gas, the country has been a net oil importer since the 2000s.

With respect to oil supply and demand conditions, Country A is an oil-producing country, pumping as much as 800,000 barrels per day (b/d) of crude oil, most of which is exported without being refined domestically. This is because the crude oil produced in the country is of high quality with a low sulphur content, and is traded at high prices in the Asian markets as fuel for power generation and gasoline feedstocks. Instead, Country A imports high-sulphur crude oil from the Middle East, which is refined at its local refineries. The locally produced oil products are supplied to its domestic market. However, with the continuing depletion of its oil fields, the country's crude oil output has been decreasing each year. For this reason, while domestic oil demand increases, the demand for imported oil outpaces the increase of domestic oil demand.

Country A's government has a 100 percent national-owned oil company that plays a significant role in its oil industry. The company operates its upstream sector by inviting Western and other Asian companies for the purpose of introducing their advanced technologies and capital investments. But the national oil company almost completely monopolises oil refining, logistics, and distribution businesses, and foreign companies are not allowed to be involved, with very few exceptions.

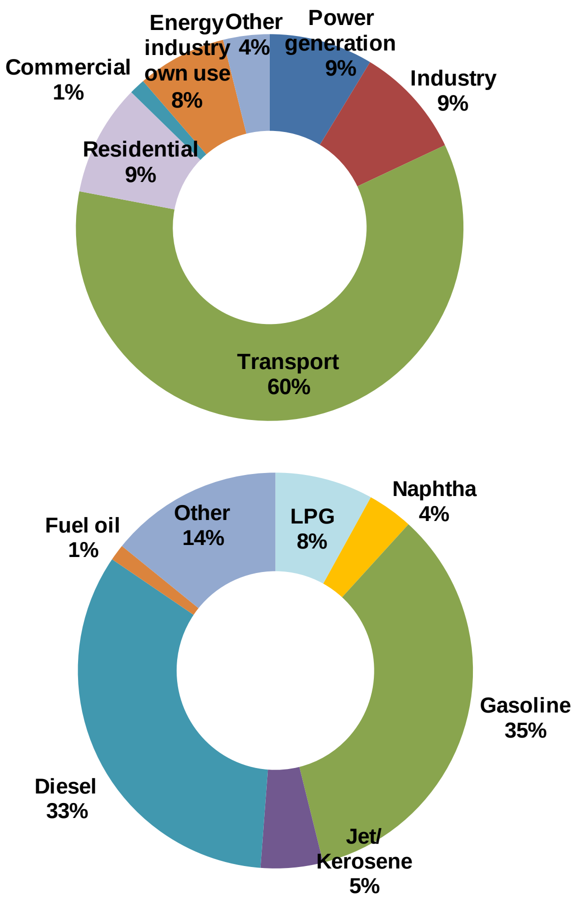
While domestic demand for oil has been increasing, the construction of domestic refineries to satisfy the rising demand has been put on the back-burner. As a natural consequence, imports of oil products have continued to increase. The country's newest refinery was built in the mid-1990s, and despite an almost doubling of domestic demand for oil, no new refinery has been built since then. It is widely known that international crude oil prices are extremely volatile, but international oil product prices are even more volatile than crude oil prices. Country A, which is increasing its imports of oil products, rather than imports of crude oil, is exposed to far more oil price volatility than other countries. For this reason, in addition to securing physical oil supplies, Country A will have to solve the problem of how to manage violent price volatility as major challenges for its oil policy.

To support the market, Country A has subsidised domestic oil product prices for many years so that price volatility in the international market is not directly reflected in domestic market prices. With such a subsidy system in place, the country's national oil company, which is a main product importer and a product supplier to the domestic market, has been absorbing price volatility in the international market. This is one of the reasons why no new refineries have been built over the past 20 years. The government subsidy helped to keep domestic oil product prices low and the construction of new refineries was not economically justifiable.

Country A is known for its large number of islands, and the majority of oil products are hauled to domestic consumption areas mainly via naval transportation. On the main islands, where refineries are operating, oil products are delivered domestically to local oil depots by coastal tankers, barges, railroads, tank lorries, etc., and to filling stations and end user locations by tankers. On the other hand, on the small islands, where there are no refineries, oil products are hauled from refineries mainly by coastal tankers. Restricted by such complicated geographic conditions, domestic pipelines for oil products have not been well developed.

In Country A's oil demand mix by application, transportation accounts for the largest share (60%) of the total oil demand. Transportation is followed by industry, power generation, and residential use, each with a share of 9 percent. In Country A's oil demand mix by product, the percentages of gasoline and diesel oil are increasing. Country A has also been converting kerosene to liquefied petroleum gas (LPG) as part of its domestic program to cut subsidies for oil products.

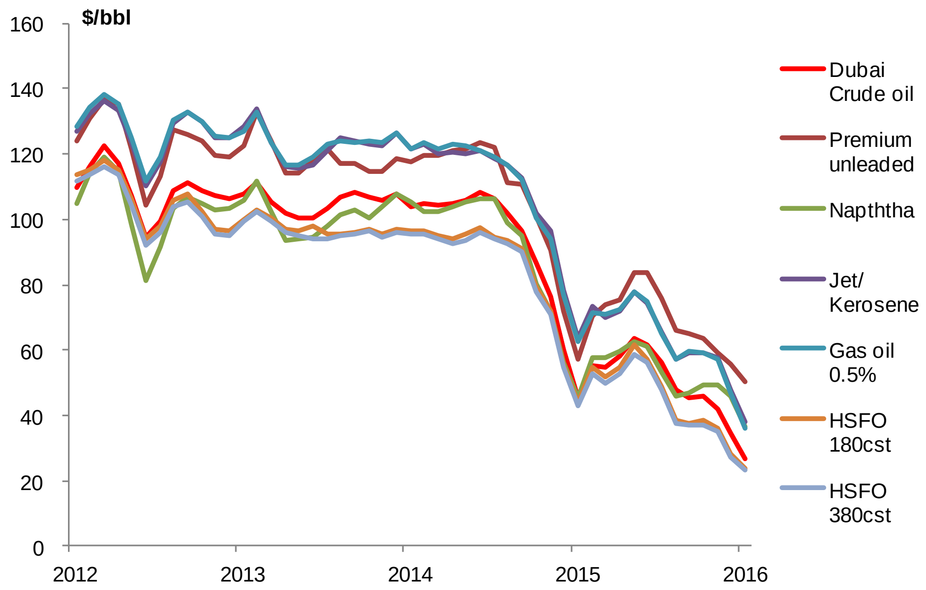
Figure 1-2. Oil Demand Mix in Southeast Asia (top: by application; bottom: by product)



LPG = liquefied petroleum gas.
Source: International Energy Agency, Energy Balances of non-OECD Countries 2015 edition.

From the standpoint of energy security, Country A has been raising concerns about the increase in domestic oil demand and the rise in oil product imports. To address these concerns, the country has discussed the development of national oil stockpiling as well as the expansion of domestic oil refining capacity. While oil refining is positioned as part of oil business, oil stockpiling itself requires only operational costs, with no profit produced. Furthermore, constructing oil stockpiling facilities would require a huge amount of money for building oil storage tanks and procuring oil to be stored. Although the government of Country A and its national oil company are fully aware of the need to stockpile oil, they have not taken any concrete action toward the development of oil stockpiling facilities. Rapid economic growth has been continuing, but the development of not only oil but all forms of social infrastructure, such as electric power supply, roads, and telecommunications, has not been able to catch up with the pace of Country A's expanding domestic economic activities. In allocating its limited national budget and domestic resources, the country has tended to put slow-acting programs, such as the development of oil stockpiling, on the back-burner. Additionally, falling crude oil prices and the moderated supply-demand balance of oil products in the Asian market since 2014 (Figure 1-3) have somewhat decreased Country A's awareness of the importance of oil products, which is one of the reasons why the development of oil stockpiling has been delayed.

Figure 1-3. Prices of Crude Oil and Major Oil Products in the Asian Market



Source: International Energy Agency. *Oil Market Report*. Various editions.

Under such circumstances, emergency oil stockpiling has not existed in Country A. The only oil stock that existed in the country was the commercial stock held by the national company, at a volume of only around 3 weeks' worth. As only its domestic oil demand was increasing, the country did not construct additional refineries or oil tank sites and as a consequence, the country's domestic oil storage capacity did not increase. While domestic oil demand was increasing, inventory days, the volume of domestically stocked oil divided by the country's daily consumption, were gradually declining. However, the country could not make the necessary investments to expand the storage capacity of the domestic oil tank sites. As a result, oil products were supplied to their distribution infrastructures at higher turnover rates than ever before.

1-1-2 Development of the scenario

In the summer of 201X, a massive magnitude-eight earthquake occurred off the coast of Country A. The violent shaking from the huge earthquake caused considerable damage to the country. At the same time, subsequent large-scale tsunamis had devastating impacts on the coastal areas of the country.

The disaster occurred at the worst time in terms of the oil supply and demand of Country A. Domestic oil demand peaks in the summer, so the impact of the oil supply disruption was greater than it would have been in any other season. As mentioned, Country A uses large quantities of oil for electric power generation, and its electricity demand peaks in the summer, too. The supply disruption of an oil product impairs the operation of oil-fired thermal power generation and has a direct impact on the electricity supply, which is a major energy source for people's lives. Furthermore, the demand for automotive air conditioning is also higher in the summer than any other season. As such, unfortunately, the disaster happened when the domestic oil supply–demand balance was the tightest in the year.

The earthquake and the subsequent tsunamis devastated the country's oil-related infrastructure, including refineries and oil tank sites in the coastal areas. Immediately after the earthquake occurred, refining operations had to be shut down at three refineries with a combined capacity of 500,000 b/d, equivalent to more than half the country's total domestic oil refining capacity of 800,000 b/d. The disaster-stricken refineries were located near the metropolitan area, where oil demand is concentrated. The actual impact of the supply disruption was larger than could have been assumed from the capacity.

Many refineries were forced to stop operations because their processing plants were damaged by the earthquake. Some refineries had to stop operations when continuous strong shaking caused oil products to leak from floating roof tanks and some product tanks even caught fire. At many refineries, the tsunamis damaged the loading arms, which load and unload products for ocean transportation. As a result, these refineries were unable to unload crude oil and semi-products from incoming tankers, or load their end products onto outgoing tankers.

The national oil company, which single-handedly operated all the oil refining businesses in the country, made the following official statements: 1) three refineries had to be shut down immediately after the earthquake, with a combined oil refining capacity of half the country's total; 2) one refinery, with a refining capacity equivalent to a quarter of the country's total, could be back in operation in a week; 3) repairing one of the two other refineries would take a month; and 4) the last refinery was damaged by a serious fire incident and would take more than a year to restart operations.

As with the oil refineries, the country's crude oil and natural gas production facilities were also affected by the natural disasters. Fortunately, the impact of the earthquake and tsunami on these upstream oil assets was found to be relatively limited. The national oil company said that it would take between one week and one month for the production outputs at each facility to return to their pre-earthquake levels.

The tsunami caused by the earthquake affected not only the assets of refineries but also other assets in the oil supply chain. The tsunamis washed away many of the tank trucks used to transport oil products from refineries and oil tank sites. To make the matters worse, the strong shaking of the earthquake and the tsunami also damaged trunk roads and railroads in the coastal areas, making land transportation means very difficult.

Table 1-1. Impacts of the Damage

Item	Impact	Time Required to Restore
Oil production	100,000 b/d of production is stopped	1 week to 1 month
Refining	500,000 b/d of refining capacity is stopped	1 week for 150,000 b/d 1 month for 150,000 b/d 1 year for 200,000 b/d
Distribution	10% of total tank trucks are lost Railroads and highways for transporting oil products are damaged	

b/d = barrels per day.
Source: Authors.

1-1-3 Possible oil supply problems

As a result of the unprecedented natural disaster, Country A is now challenged by serious problems in every aspect of its economy and society. In the wake of the earthquake, Country A's capability of supplying oil products decreased significantly. If adequate levels of oil product stockpiles had existed and been released to the market immediately, the country might have been able to minimise the negative impact of such a natural disaster. As demonstrated in recent examples, such as the Great East Japan Earthquake in 2011 and Hurricane Sandy, which hit the East Coast of the United States (US) in 2012, it is possible to secure adequate levels of oil product supplies by releasing domestically stocked products to the market in a timely manner, even under situations where the area is hit by a natural disaster and the supply of oil products is disrupted.

But what kinds of problems happened in Country A without such emergency stockpiles?

(a) Decreased oil product supplies in the event of refinery shutdowns

Immediately after the earthquake occurred, operations were stopped at some domestic refineries, with a combined refining capacity of 500,000 b/d. As a result, there were significant shortages of domestically produced oil products. A shortage of domestic oil refining capacity had already existed, and Country A was importing oil products to balance the supply and demand. In the wake of the earthquake, the country had to reduce the quantity of domestically produced oil products even further. Under these conditions, the national oil company, which monopolised the supply of oil products in Country A, had no option other than to satisfy its immediate supply needs by increasing imports of oil products (which will be described later). At the same time, the company had to reduce the volume of its commercial stock held at its refineries and oil tank sites as much as possible. The company held a total of only 3 weeks' worth of commercial oil stock, and the level of the stock of gasoline, which has peak demand in the summer, was undoubtedly less than that.

(b) Panic buying at filling stations

The earthquake and tsunamis had a strong impact on domestic economic activities, disrupting the country's entire logistics functions. As a result, there were serious shortages of daily commodities in some areas of the country. People panicked and rushed to stores to buy food, consumables, medicines, drinking water, and other basic daily supplies. These supplies disappeared from store shelves almost instantly.

This was also the case with oil products. People waited in long lines to buy gasoline at every filling station. Not only regular drivers but also consumers who drove only on weekends and even elderly people who seldom drove long distances all scrambled to panic-buy gasoline in the worry of short-term supply shortages. Many people were misinformed that the country had only 2 weeks' worth of oil product stockpiles, and that the government would have to start rationing oil products in a few days. Such information spread across the country through the Internet and social media, fuelling the panic buying.

Panic buying such as this tends to create another round of panic buying, eventually leading to a vicious cycle. Many consumers rushed to filling stations in towns, forming long lines in front of gas pumps. Seeing this caused consumers who would not even regularly drive to feel anxious and to want to emulate the same behaviour. Filling stations that were unable to receive additional supplies after the earthquake and tsunami ran out of gasoline in a short time. Again, seeing this reinforced the perception among consumers that the risk of an oil supply disruption was real. The reality was that the country's existing commercial stock had simply been transferred temporarily to consumers' gas tanks, but the consumption behaviour of many people made consumers feel as though the gasoline supply had suddenly tightened.

(c) Impacts on industrial activities

Automobile fuels were not the only products that faced such supply shortages. Oil was widely used in Country A as a fuel for industrial and power generation, and its shortage caused many problems for industrial plants and electric power stations. In the wake of the earthquake, many plants could not continue operating due to the damage to their facilities. Because of the fuel supply disruptions, even inland industrial facilities and power stations that were not hit by the tsunami were also forced to stop operations. The fuel supply shortage occurred in the summer, when the demand for air conditioning was particularly high and oil-fired thermal power stations were operating at their highest utilisation rates of the year. The timing of the disasters added to the severity of these problems. The main fuel used for these applications was fuel oil, but because fuel oil was produced less than gasoline or diesel oil, the quantity of its commercial stock held at refineries and oil tank sites was limited. This fact worsened the fuel supply shortage problem at industrial plants and electric power stations.

In addition, the earthquake and tsunami disrupted the supply of oil products used for transporting supplies, such as food and other daily necessities. As a result, while there were stocks of these supplies in the country, they could not be transported to the areas where they were needed, causing shortages of daily commodities in various locations.

(d) Problems at refineries

In the wake of the earthquake, refineries with a combined refining capacity of nearly half the country’s total had to be shut down. In order to compensate for the lost capacity of oil products, Country A began to take various measures but encountered some problems. The country chose some domestic refineries that were operating at relatively low utilisation rates and tried to increase the supply of oil products by raising their utilisation rates as much as possible. During the state of emergency, each of the refineries raised their utilisation rates to levels close to the limit. However, in the process, equipment was overused to an extent seldom seen under normal circumstances, causing some parts of the plant to break down and stop operating. The extreme conditions also placed heavier burdens on the operators working to respond to the emergency situation. This resulted in an increase of problems due to human error.

(e) Lack of ability to deal with product import-related services

Because of the significant drop in its domestic production capacity of oil products, Country A was forced to import many more oil products than before. However, the national oil company that would have to deal with the increased quantities of imported oil products did not have a sufficient number of staff members. As a result, the shortage of such staff members capable of doing the required jobs became a serious issue. The oil products import department of the national oil company had a minimum number of staff members required to handle product import-related services at ordinary times. For this reason, the company was not fully prepared to deal with the sharp increase in the demand for imported oil products in the wake of the earthquake and tsunami. Product import-related services are professional services that require not only a minimum level of foreign language ability but also familiarity with transaction forms and business practices for oil product trading. For this reason, there were only a limited number of human resources who could take on such professional services, even in the country's national oil company. The company was unable to allocate a sufficient number of people in response to the surge in workload after the earthquake.

Even though the country secured imports of oil products, it was not able to receive them because its unloading facilities were damaged by the tsunami. Partly because of oil product supply and demand information not being fully shared among the concerned parties amid the post-earthquake chaos, the unloading facilities had not been restored before the emergency import of oil products arrived. As a result, the tankers loaded with oil products were kept waiting off the coast for a long period of time.

(f) Identified limiting factors in logistics

Even when the imported oil products were unloaded at the country's refineries, other problems still existed. The trunk roads along the coastline of the country were damaged by the tsunami and some were completely shut down. In areas where the trunk roads were physically severed, some consumption markets were isolated due to inaccessible land. These markets relied on air transportation, such as helicopters, for the delivery of daily commodities. Where it was difficult to deliver oil products to such areas via air, coastal shipping was also used. As a result of using different logistics operations to those used under ordinary circumstances, operations on the front line were confused by conflicting information, which led to many other problems.

(g) Impact of LPG supply shortages on people's lives

In Country A, there were serious disruptions to the supply of LPG, the most widely used energy source by the public and the main source of energy for daily cooking.

The country has two supply sources of LPG. At one source, LPG is produced through fractional distillation from natural gas from domestic gas fields. At the other source, LPG is produced as a by-product when crude oil is refined at domestic refineries. The earthquake and tsunami seriously damaged both the domestic LPG supply sources, causing substantial shortages in the domestic market. Although there were LPG import facilities in Country A, the capacity of these facilities was not more than 10 percent of the country's total LPG demand. Compared with other regular oil products, LPG is an oil product that is used by a wide range of people in the country. As a consequence of the earthquake and tsunami, the country faced severe LPG supply disruptions that were greater than those of regular oil products.

(h) Inadequate response procedures, information gathering, and emergency decision-making mechanisms

What became clear amid the post-earthquake chaos was the reality that Country A could not properly decide who should allocate the temporarily limited supply of oil products in an optimal manner, the procedures for doing so, or how to set the order of priority. The earthquake extraordinarily affected the supply of oil products in Country A, but not all oil product supplies were lost. There was a certain level of commercial stock in the country, some refineries still continued operating, and there was room to increase the imports of oil products. The real problem was the lack of a mechanism to allocate the oil product stocks, however limited they were. This also highlights the importance of being prepared for a crisis, when there may not be sufficient time to think about such issues.

The country should have been prepared to collect information on the quantities and locations of oil products stocks in the event of an emergency. At the same time, the country should have been able to estimate in a timely manner how much of them would be available in the short term. Based on that information, the country should have determined the areas to preferentially receive the stocked oil products in the short term and allocated a minimum level of oil supply. In reality, Country A could not take such actions because the government did not have enough data on the stocked oil products. The country had difficulty in estimating the quantity of stocked oil products that could be supplied in the short term, and there was no mechanism to decide the order of priority of who should receive them during the emergency. As a result, sufficient quantities of stocked oil products were not supplied to the medical vehicles, police vehicles, firefighting vehicles, or public vehicles that should have received them on a preferential basis, causing interference with the progress of the post-earthquake restoration work. Meanwhile, politicians and other influential figures representing the disaster-hit areas scrambled to ask the national oil company to supply fuel to their home bases. This also prevented stocked oil products from being allocated in an optimal manner. In either case, the problem occurred due to the lack of adequate preparation, a detailed emergency response manual, systematic organisation, and an information gathering mechanism in the country's emergency oil product supply system, particularly relating to the required statistics.

(i) Discontent of society with the fuel shortages and anti-government demonstrations

Lastly, because the shortage of oil product supplies had a great impact on people's lives and raised consumer fears, social uncertainties in Country A increased after the earthquake. Gasoline panic buying became a serious social phenomenon in the country, which caused many problems among the population. For example, at filling stations where stocks ran out, people waiting in line were frequently seen fighting with each other. There also were cases where riots occurred at filling stations. People who wanted to get gasoline swarmed around tankers heading for filling stations, causing the tankers to come to a standstill on the road. In order to prevent the recurrence of such a problem, the country had to take countermeasures by having these tankers protected by the police.[2] Furthermore, because of serious supply disruptions of LPG, an important oil product in the people's lives, people rebelled against the government because of its inability to take effective action. As a result, many demonstrations against government organisations broke out, increasing the country's social uncertainties.

1-1-4 How can this emergency situation be resolved?

As described, the natural disasters seriously disrupted Country A. The country took various countermeasures to manage and restore the supply of oil products that had been severed by the disasters.

(a) Oil supply cuts (introduction of oil product rationing)

In the wake of the disasters, the national oil company introduced supply cuts as a countermeasure to the depletion of its commercial stock. The company proposed the measure, which was approved by the government for implementation. Specifically, the national oil company cut the quantities it supplied through its distribution network at ordinary times by 20 percent across the board. However, official procedures for the country to authorise such supply cuts were not originally in place. Also, there was no established procedure for who should make the decisions or on what information the decisions should be based. That is why it took some time before the supply cut was actually authorised and implemented. At the same time, the rate of the supply cut was politically decided without objective evidence, and the government's unfounded decision caused unnecessary confusion among the public.

[2] Similar events in fact happened following the Great East Japan Earthquake in 2011.

(b) Increased imports of oil products

The country tried to solve the shortage of domestic oil product supplies through supply cuts by the national oil company as an internal measure, and by increasing the import of oil products as an external measure. In this scenario, the largest supply source was Singapore, its neighbouring country. Singapore had the world's leading oil storage facilities, and for that reason, major oil companies were operating there for oil product trading. Country A was fortunate that Singapore was located right next door.

In the wake of the earthquake, Country A imported a variety of oil products, not only from refineries in Singapore but also from many oil tank terminals located in the surrounding area. In addition to Singapore, Country A imported oil products from the Republic of Korea (henceforth, Korea), India, and even as far as from refineries in Middle Eastern countries. Furthermore, attracted by relatively higher market prices in Asia, oil products began to flow from countries in Europe and the US into the region. This movement helped ease the tight oil product supply-demand situation throughout Asia. Based on market mechanisms, price signals played the role of inviting oil product supplies from around the world.

(c) International humanitarian support

In the wake of the earthquake and the severe shortages of daily commodities, including oil products, Country A tried to solve the shortages by requesting support from other countries. However, while Country A needed oil products, other Asian countries had oil stockpiles, largely in the form of crude oil. With the oil product supply-demand balance in the entire Asian region becoming increasingly tight, only a few countries were able to supply Country A with large quantities of oil products. Another problem was that because the country's oil receiving infrastructure was damaged, it took longer than usual to receive the required oil products.

However, several countries with excess oil refining capacity supplied oil products to Country A as humanitarian assistance. The governments of the countries encouraged their oil companies to operate at full capacity in order to produce enough oil products for Country A. In ordinary circumstances, excess capacity is seen as a burden for oil companies, but in this emergency situation, it played a significant role in supporting Country A.

(d) Dysfunctional multilateral oil coordination framework

For the purpose of international cooperation, Country A had agreed an emergency oil coordination framework with its neighbouring countries. Under the framework, if the shortage of oil in a member country were to exceed a predetermined threshold, the other member countries were supposed to use their oil supplies to support the relevant country in a cooperative manner. During Country A's oil supply disruption, however, the country was unsuccessful in actually receiving any products through the framework, despite exploring the possible ways for doing so.

One reason why the arrangement did not work properly was that the actual shortage of oil did not reach the threshold set by the framework to trigger the oil arrangement. The threshold was defined by the condition that the shortage of domestic oil exceed 10 percent of the country's demand for 30 consecutive days. Country A had already encountered many problems before reaching the 30th day, and the option of waiting until oil swapping was triggered was not realistic. Before reaching the threshold, the country could have asked the other member countries to supply oil on a voluntary basis. However, the organisation managing the framework was not influential enough to have a permanent head office, and its temporary office operated on a small budget with only a limited number of staff. Even if Country A had asked the organisation for voluntary support, the office would not have had the required authority or capacity. None of the countries covered by the framework had sufficient stockpiles of oil, so even if Country A had asked them, the physically available stocked oil products would have been limited to only small quantities.

1-1-5 Implications of the scenario

What can we learn from the above development of this scenario? The following implications can be derived from the scenario and are helpful in studying how to respond to future emergency situations, including the development of oil stockpiling.

(a) Natural disasters will not wait until an oil stockpiling system is put in place. What does it take to develop an effective oil stockpiling system as quickly as possible?

In Country A, where the import of oil products was growing at a rapid pace, the need to introduce an oil stockpiling system had originally been discussed. But the country put off the decision for various reasons, such as a lack of financial resources and the urgent need to develop other forms of infrastructure. In reality, however, natural disasters will occur regardless of the progress of such a stockpiling system. If the stable supply of oil products is questioned, the problem should be solved, or the measures to minimise the impacts should be taken as quickly as possible.

Needless to say, in the event of an oil supply disruption, the first thing we should do is to immediately secure alternative supply sources to make up for the lost supply of oil products. In other words, if we can secure appropriate alternative supply sources, we will not necessarily need to build a large-scale oil stockpiling terminal within the country, although it is desirable to have one in the long term. In this case, we will need to figure out the kinds of options available as alternative supply sources that can be developed in a more effective, expeditious manner. This point will be discussed in the next chapter in more detail.

(b) Unlike in ordinary circumstances, a different set of regulations may be required in emergency situations. What regulations should be relaxed in such emergency situations?

The recovery of the oil supply should be prioritised in an emergency situation. In doing so, if the existing set of regulations during ordinary times hinders us from taking immediate countermeasures, it is meaningful to consider making an exception to relax part of these regulations. For example, when Hurricane Sandy hit the US in 2012, the US government temporarily relaxed the Jones Act, which allows only US-flagged vessels to transport domestic oil products. At the same time, the US government temporarily relaxed another regulation on the quality standards for oil products. These two regulations play important roles in ensuring national security and environmental protection during normal circumstances. However, the US emergency response systems are based on the notion that the limited relaxation of regulations is acceptable only for a short period of time in the event of an emergency situation, like a hurricane. In a more severe emergency where more stringent demand-side management is needed, the government will need larger authority to ensure such countermeasures, such as demand rationing.

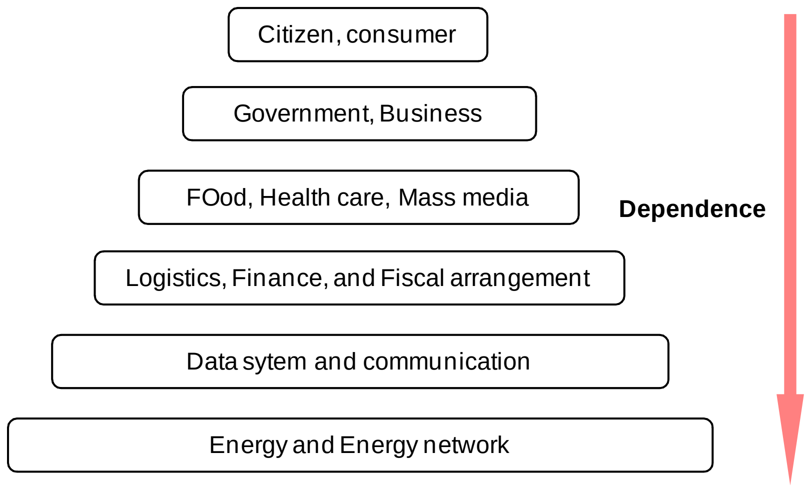
The importance of preparation cannot be overemphasised because the occurrence of an emergency situation is unavoidable. We should not simply ignore it, thinking it is unlikely to happen. Instead, we should make sufficient preparations so that we will be able to respond when such an emergency actually happens. In particular, we should be clear on which regulations could be limiting factors in existing regulatory systems should an emergency situation happen. We should also determine who should make the decisions to relax regulations, and the procedures and criteria for doing so. As such, we need to consider whether the relevant administrative agencies should be granted additional authority in an emergency situation. If they should, we must discuss the extent to which their authority should be strengthened.

(c) What are the differences between oil and other products? Why is oil stockpiling particularly important?

Oil is a very versatile product that is used not only for transportation but also for many uses in the industrial, power generation, and consumer sectors. In addition, oil cannot be easily replaced with other sources of energy in the transportation sector. This is another reason why a certain volume of oil needs to be stockpiled to prepare for an emergency, as the impact of an oil disruption would spread over a very wide area in the industry. Especially in emergency situations, oil plays an important role as a fuel to power private electric generators at medical and other socially important institutions, and also as a transportation fuel for the delivery of necessary rescue teams and relief supplies to the disaster-stricken areas.

From the standpoint of the effective use of limited resources in an emergency, many social functions, such as information/telecommunications and finance, should be restored on a priority basis. In the same way, there should be an order of priority for which energy sources, including oil, should be restored in the event of an emergency.

Figure 1-4. Order of Priority of the Emergency Response System of Finland



Source: Morita (2012).

In ASEAN countries, which use large quantities of oil not only for transportation and industrial purposes but also for power generation and residential use, securing the stable supply of oil products is very important for recovering activities in the energy sector. By keeping a certain level of oil stockpiling in preparation for such an unexpected situation, countries should be able to act in a more effective manner when recovering from various kinds of disruptions, not only in energy supply but also in social and economic functions.

(d) In the event of an emergency, we must have an excess capacity that is different from the excess capacity needed in ordinary circumstances. Who should store such excess capacity for emergencies?

Excess capacity during ordinary circumstances has an extremely important role in emergency situations, although the degree of excess capacity is determined by market balance and not by energy security policy itself. For example, in the wake of the Great East Japan Earthquake in 2011, Japan was able to make up for the shortage of domestic refining capacity immediately after the earthquake by taking full advantage of the excess refining capacity that existed in the country. Conversely, if a certain supply system is kept in operation at its full capacity, and if another supply system encounters a problem, the capacity to supply additional oil is very low.

With its domestic oil production decreasing, unlike Middle Eastern oil producers like Saudi Arabia, Country A cannot afford a certain level of excess production capacity during ordinary times. As an alternative, it is desirable to stockpile oil before an emergency happens, although the immense challenge of who should bear the cost will have to be addressed. As will be discussed in Chapter 3 in more detail, there are many patterns of ownership for oil stockpiling facilities. Among the developed countries with oil stockpiling systems, such facilities are owned by governments, private companies, and oil stockpiling agencies representing multiple private companies. In some cases, a country's emergency stock is stored in another country's facilities based on government-to-government agreements. The pattern is chosen depending on various factors, such as the financial condition of the country that develops the oil stockpiling, and the relationships between companies and the government. For this reason, it is not easy to suggest which pattern is best. As described above, from the viewpoint of securing an oil stockpiling system in a more expeditious, effective manner, we need to explore the available kinds of patterns in greater detail.

(e) How should we prioritise oil product supplies in an emergency?

In this scenario, panicked people engaged in so-called panic buying when the supply of oil and other products was disrupted. As the physical supply of products stopped, the demand soared much higher than expected. The difference between supply and demand widened suddenly. This behaviour is typical in the event of a product disruption of any kind. Therefore, we need to decide in advance who should receive a limited supply of products on a priority basis when such an event actually occurs. In other words, we must make the difficult decision of whom the products will not be delivered to. This concept is similar to that of 'triage' in emergency first aid treatment. Although such prioritisation depends heavily on the situation and scale of a specific supply disruption, it may be possible to decide the order of priority beforehand as a guideline. It is generally believed that the supply of oil products should be used first for military and policing to maintain security, and then for medical use to save human lives. Next, the supply should be for the demand for oil products in power generation and consumer use. It is important to clarify the details of such prioritisation.

Needless to say, when distributing the supply of oil products on a priority basis, we must collect information in a timely manner on the quantities and locations of oil product stocks. The management and operation of such oil product stock information are equally important. Moreover, it is desirable to have more detailed information on the demand that can be expected from each of the prioritised fields. Securing such information requires the collection and use of supply and demand data from ordinary times, and also requires the accumulation of knowledge on actual consumption based on the data. Information technology may be used to help for this. Spain, for example, has a publicly accessible information database where the operation of each retail station can be found. Such information services can help greatly in minimising confusion and panic in emergencies.

(f) It is impossible to stockpile every oil product. At what ratio should we stockpile crude oil and oil products? In doing so, what are the points we should keep in mind?

Lastly, in this scenario, some countries received emergency oil supplies from overseas. Many of those countries that provided emergency oil supplies however stockpiled oil in the form of crude oil and did not have ample oil product stockpile. How to stock crude oil and oil products is another important point in developing an oil stockpiling program. From a stockpiling cost standpoint, crude oil is more economical because it does not deteriorate in quality when stocked over an extended period of time and it can be stocked in bulk in large-scale tanks. However, it is not crude oil but oil products that are consumed immediately after an emergency happens. It can be said that stockpiled oil in the form of oil products will have more immediate effects in the event of an actual emergency. On the other hand, oil products deteriorate in quality and must be replaced with new ones every few years. Storing many different oil products obviously costs more than storing crude oil, which can be stored as a single product.

Additionally, the decision to stock crude oil or oil products will be influenced by other factors, such as the capacity of domestic oil refining and the types of crises to be considered. If the country has an adequate level of domestic refining capacity, then stockpiling crude oil will be justified. If not, stockpiling oil products would be desirable. For example, if we assume a crude oil supply disruption stemming from the political situation in Middle East, then we may want to stockpile crude oil instead of oil products.

As will be described in Chapter 3, IEA member nations are stocking different types of oil products depending on each country's situation and energy security policies[3]. The decision to stockpile crude oil or oil products should be made in a comprehensive manner, based on stockpiling costs, domestic refining capacity, and the expected crisis scenarios.

[3] As of October 2015, the stockpiling ratio of crude oil to oil products was 59:41 (1,332.1 million bbl: 930 million bbl) in the North American OECD region, 38:62 (548.7 million bbl: 880.8 million bbl) in the European OECD region, and 68:32 (582.3 million bbl: 269.4 bbl) in the Asian and Oceania OECD region. (All the numbers include commercial oil stock.) European Union member countries of IEA also have an obligation to stockpile a minimum of one-third of their stockpiling as oil products.

1-2 Scenario of Oil Product Supply Disruptions from Overseas (The Case of a Complete Supply Disruption from Singapore)

1-2-1 Assumptions of the scenario

Country B is a relatively small hypothetical country in the ASEAN region, with a population of approximately 15 million. With the recent strong economic growth in the entire ASEAN region, Country B has grown in the past 10 years at an annual average economic growth rate of as high as around 6 percent. Although the country's gross domestic product (GDP) per capita is still low at US$1,000, living standards have been noticeably improving. As a result, the demand for energy is increasing at a faster pace.

Oil accounts for only about a quarter of the country's primary energy supply mix and the share of traditional biomass energy sources, such as wood and coal, is still high. On the other hand, the percentage of oil-fired thermal power in the electricity generation mix is as high as 40 percent, as is the case with the transportation sector, making it an energy consuming sector highly dependent on oil. In the country's oil demand mix by product, the percentage of diesel oil is very high, accounting for half of the total domestic oil demand. Diesel oil is used mainly for transportation and power generation. The country's domestic generation capacity is smaller than its demand, which is why power outages occur frequently. The demand for diesel oil is high for powering private generation systems at plants and other large facilities. In addition, as the country's economy has grown, income has also increased. As a result, the number of automobiles has increased and the share of gasoline in the oil demand mix is gradually rising.

Country B produces no oil, and all the domestic demand for oil is supplied by imports. Since there are no refineries in the country, oil is imported in the form of oil products. Many of the oil products imported from overseas countries are transported by barges from primary import terminals located in the southern coastal area all the way to oil tank sites spotted along the rivers running through the country. From there, the oil products are hauled by tank trucks to local filling stations. Although the country has plans for building an oil refinery, there has been no clear road map toward the realisation of the plans as domestic oil demand has not yet grown to a level that can justify construction and because the country has difficulty raising the necessary funds.

As it has no stockpiling system in place, Country B has oil stock only in the form of commercial stock, as is the case with Country A. Country B's main oil storage facilities are at the oil import terminals located in the southern coastal areas and the oil tank sites in inland areas. The oil stock in the country is the commercial stock held by oil companies. As Country B does not keep adequate statistics on its oil stock, there is no way of accurately knowing the quantities of oil products that exist. However, it is believed that the quantity of oil stock in the country is no more than 21 days' worth of domestic oil consumption.

The oil market in Country B is liberalised, which is unusual among ASEAN member nations. In Country B, which has no refineries, the country's national oil company, national oil companies in other ASEAN member nations, and European oil majors are involved in the import and distribution of oil products. Domestic oil selling prices are also liberalised, and are basically linked to the international oil trading product prices in Singapore.

In Country B, accurate statistics of domestic oil stock are not available. Among the difficulties in recording the oil supply and demand conditions in Country B is the existence of smuggling. In Country B, oil products are distributed at higher prices than those in neighbouring countries because the oil selling prices are liberalised. Smugglers procure oil products in neighbouring countries at subsidised prices and bring them into Country B for resale to profit from the high margins there. The exact quantities and original locations of the smuggled oil products are not known. The existence of this type of smuggling makes it difficult to accurately determine the oil supply and demand conditions and the quantities of stocked oil products. The smuggling also prevents us from forecasting the future oil demand in the country.

1-2-2 Importance of Singapore in the Asian market

Singapore supplies most of the oil products required by Country B. Many of the products Country B imports from Thailand and Viet Nam were originally refined or blended in Singapore. Singapore is the only country that has oil refining capability in Southeast Asia. The following table lists the country's oil refineries.

Table 1-2. Oil refineries in Singapore

Operating Company	Location	Crude oil distillation capacity ('000 b/d)
ExxonMobil	Jurong/Pulau Ayer Chawan	593
Shell	Pulau Bukom	462
Singapore Petroleum (SPC)	Pulau Merlimau	290

Source: The Institute of Energy Economics, Japan.

Singapore is the centre of oil product trading in Asia, and oil product prices in Singapore are referenced extensively as target prices in the entire Asian region. In particular, Platts releases oil product prices on a daily basis referenced as target prices in each Asian country and has an extraordinary influence over Asian oil markets. This is why all well-known oil majors and traders have offices in Singapore to collect market information around the clock and trade oil products in the midst of the market. In Southeast Asia, there are many countries like Country B where refining capacity falls short of domestic demand, and Singapore acts as a hub to supply oil products to these countries. In the vicinity of Singapore, there are many oil tank terminals as well as oil refineries. Many oil products are imported from all around the world to these oil tank terminals, then exported from the terminals. In the past, many of these oil tank terminals were constructed within Singapore, but recently they are also being built in nearby countries, such as Malaysia and Indonesia. At present, the total oil storage capacity in the vicinity of Singapore is estimated to exceed 9 million cubic metres or more (Table 3-1).

Table1-3. Storage Capacity in Singapore

Operator	**Terminal**	**Capacity** (cm)
Vopak	Banyan, Jurong Island	1,363,375
Vopak	Sebarok Island	1,263,079
Vopak	Jurong Rock Caverns	480,000
Oiltanking	Seraya, Jurong Island	1,265,000
Oiltanking (Helios)	Jurong Island	503,000
Hin Leong	Jurong Island	2,360,000
Horizon Singapore	Jurong Island	1,252,184
Kuo	Busing Island	1,200,000
Total		9,686,638

cm = cubic metres.
Source: *Petroleum Economist*. December 2014/January 2015: 11.

The Strait of Malacca off the coast of Singapore is known as a so-called transit chokepoint, a strategic point of ocean transportation. As much as 15 million barrels of crude oil and oil products transit through the Strait of Malacca every day and it is regarded as the world's second most critical ocean route, next to the Strait of Hormuz. The Strait of Malacca is used to transport many products including oil to not only neighbouring Southeast Asian countries but also Northeast Asian countries, like Japan and China. Because of this, the Strait of Malacca is known as the main artery of the Asian economy.

Table 1-4. Oil Transit in the Strait of Malacca

million barrels per day	**2009**	**2010**	**2011**	**2012**	**2013**
Total oil flows through Strait of Malacca	13.5	14.5	14.6	15.1	15.2
Crude oil	11.9	12.8	12.9	13.3	13.4
Refined products	1.6	1.7	1.7	1.8	1.8
LNG (Tcf per year)	1.6	1.9	2.5	3.2	4.2

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Refined producs	1.6	1.7	1.7	1.8	1.8
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Source: Energy Information Administration (2014).

1-2-3 Events

In 201X, a very large crude carrier navigating the Strait of Malacca, loaded with 2 million barrels of Middle Eastern crude oil, accidentally collided with a product tanker in the same strait that was loaded with 400,000 barrels of fuel oil. After the accident, both tankers burst into flames, and the fire lasted for a week. To make matters worse, huge quantities of the crude oil and fuel oil loaded on both tankers spilled into the sea immediately after the collision. As a result of the tanker accident, the Strait of Malacca had to be shut down. Regulatory agencies allowed vessels navigating the strait when the accident occurred to continue, but vessels that entered after the accident were required to bypass the troubled strait.

If the loads that spilled into the sea had been light oil products, such as gasoline, they would have evaporated after a certain period of time and would not have remained on the sea surface for long. However, this accident involved crude oil, especially Middle Eastern crude oil with a high specific gravity. The fuel oil loaded on the product tankers also had a low pour point. For this reason, the huge quantities of oil spill stayed floating on the sea for a prolonged period of time.

In order to extinguish the fire on the tankers and clean up the oil spill, the Strait of Malacca was shut down for about 3 weeks. The oil spill from the tanker accident drifted down to the vicinity of the refineries and oil tank sites in Singapore, which forced the country to completely stop its imports of crude oil and exports of oil products during the 3-week period.

Table 1-5. Impacts of the Scenario

Item	Impact	Time Required to Recover
Navigation in the Strait of Malacca	Interrupted	3 weeks
Operation of refineries in Singapore	No impact (there was a limit to the volume of crude oil stock)	n/a
Imports of oil to Singapore	Interrupted	3 weeks
Exports of oil from Singapore	Interrupted	3 weeks

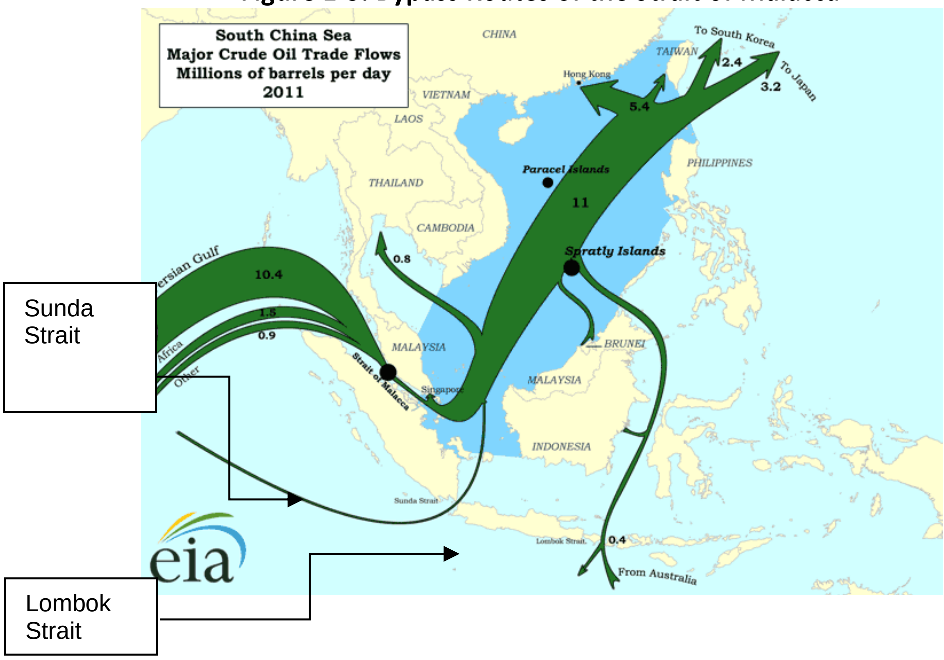
Source: Authors.

1-2-3 Possible oil supply problems

(a) Shutdown of the Strait of Malacca as a critical ocean route

One of the immediate impacts of the tanker accident was on the oil transit of as much as 15 million b/d of oil in the Strait of Malacca. The oil transit had to bypass the strait, taking tankers around an additional three days. The possible bypass routes were either the Sunda Strait or the Lombok Strait (Figure 1-5), but both routes were known as transit chokepoints, with the potential for crowding of vessels in their vicinity. However, for Japanese and Korean oil companies importing oil via tankers navigating through the Strait of Malacca, the impact of the strait shutdown was only a 3-day delay in oil arrival to their home market. This level of delay was able to be easily absorbed by regular oil stockpiling. On the other hand, developing countries like Country B faced extremely serious consequences from the incident, as their levels of domestic oil stock were lower than that of developed countries, and their dependence on product imports from Singapore is high. f

Figure 1-5. Bypass Routes of the Strait of Malacca



Source: United States Energy Information Administration website.

(b) Disruptions of crude oil supply to refineries in Singapore

The disruption of crude oil supply to refineries in Singapore was another problem that affected the supply of oil products in Asian oil markets and Country B. Since the government of Singapore did not have the required official statistics, it was necessary to estimate the level of oil stock held at refineries in the country. In Singapore, only electric power companies have a legal obligation to meet 30 days' worth of fuel oil stockpiling requirements, and even oil companies do not have an obligation for oil stockpiling. Many of the refineries in Singapore are owned by major international oil companies, and their cost management is considered to be very thorough. For this reason, we believe that the refineries are operated at the lowest possible level of oil stockpiling. We estimate that their oil inventory days are lower than those of the IEA policy target (90 days' worth), and that their commercial oil stock is set at a level of about 3 weeks' worth. Therefore, all the refineries in Singapore were forced to ramp up their operation in the wake of the tanker accident. The supply of oil products plummeted accordingly.

(c) Interrupted oil product shipments in the vicinity of Singapore

Despite the severity of the situation, refineries in the vicinity of Singapore were able to continue operations using the existing, although limited, crude oil stock. A much more serious consequence of the tanker accident was that the navigation of tankers in the Strait of Malacca was interrupted for three weeks, shutting out oil product shipments from Singapore. This prevented oil products from being shipped from the refineries and oil tank terminals in the country or its vicinity. Singapore acts as an oil blending terminal for the Asian market, and also functions as an end product shipment terminal for each Asian country's oil product market. In the wake of the tanker accident, this contributed to the worsening of the supply and demand conditions of oil products. There were in fact adequate quantities of oil product stock within the Asian region to satisfy domestic demand, but after the tanker accident, the inability of Singapore to ship oil products to other Asian countries suddenly tightened the supply and demand conditions of oil products.

(d) Price hikes in Asian oil product markets

The tightening of the supply and demand conditions of oil products caused the prices of oil products to rise sharply. The interruption of oil product supplies from Singapore, a major oil product supply hub in the Asian market, had an immense impact on international oil markets. The prices of gasoline, kerosene, diesel oil, fuel oil, and all other oil products increased sharply by about 20–30 percent. As a result of these price hikes, corresponding oil consumer prices went up, even in countries such as Japan and Korea, because their domestic prices were linked to Singapore's market prices. In countries such as Viet Nam and Myanmar, which were constantly importing oil products from Singapore, the tanker accident inflated their import prices substantially. The accident brought about significant negative impacts on the economies of both developed and developing countries.

The impact of the tanker accident on market prices in Asia reached not just the oil product market but also the entire crude oil market. The reduction in crude oil throughput in Singapore decreased the demand for crude oil and loosened the overall supply and demand conditions of Middle Eastern crude oil. Ironically, the increase in oil product prices pushed up refinery margins in Asia. Because these oil products are produced from crude oil, the appraisal value of crude oil itself increased in the market as well. Furthermore, the increase in such refinery margins helped improve the utilisation rates of refineries in other countries, and crude oil prices rose with the increasing oil product prices.

As described above, because of the longer crude oil haul distances due to the closure of the Malacca Strait, the tanker supply and demand conditions tightened suddenly. As a result of the tight supply and demand conditions for tanker space, the freight cost of crude oil jumped by US$1/bbl to US$2/bbl.

(e) Decreased imports in Country B

In Country B, where oil product prices were liberalised, the tight supply and demand conditions and the price hikes initially began to be reflected directly in the domestic market, and the country saw its oil prices increase sharply. While it had sufficient amounts of foreign currency from the recent strong exports of other manufactured products, Country B had to cut the import volume of oil products by 10 percent since the import amounts were substantially exceeding the initial budget.

Since it had no local refineries, Country B had no other option but to import oil products. If the country had had a domestic refinery, and had held a sufficient level of crude oil stock to survive the impact of the oil supply disruption, the country could have minimised the impact of a complete oil product disruption from Singapore. As for crude oil sources, if the country had had trouble getting crude oil from the Middle East, then it should have been able to switch the source to another country in Southeast Asia or Russia. The main reasons why Country B was enormously affected by the supply disruption include: i) Country B had no option than to import oil products from overseas, and ii) Country B depended mostly on Singapore for its supply of oil products.

(f) Uncertain and low domestic oil stock levels

In Country B, domestic oil product inventory levels had originally been very low and oil smuggling was widespread. This made it difficult to determine the levels of domestic oil product stocks and contributed to a worsening of the situation in the country after the tanker accident. As previously mentioned, partly because oil products were distributed at international market prices in Country B, smugglers regularly brought in oil products procured in neighbouring countries at subsidised prices. For this reason, the country had difficulties in monitoring the quantity of the oil product stock in the country and the distribution channels of the illegal products. After the imports of oil products began to decrease, the national oil company's domestic stock plummeted suddenly (based on the only data the government had). At the same time, in anticipation of the increasingly rising oil product prices in Country B, oil smuggling became even more widespread. This was how the country experienced increasing problems for its oil product distribution.

Moreover, knowing that even the government of Country B did not accurately know the level of its domestic oil stock, market concerns heightened to maximum levels, leading to panic buying among consumers. The lack of transparency in oil stock statistics created additional and detrimental product demand.

(g) Heightened public dissatisfaction

As oil distribution became increasingly problematic and uncertain, public dissatisfaction of the government's oil policy also began to grow. As mentioned, oil accounted for only about a quarter of the country's primary energy supply mix, and oil was consumed by only a limited number of people in certain social classes. For this reason, the reduction in oil imports had a direct impact only on a limited number of people. However, the reduced availability of oil caused the country's overall energy prices to rise. This meant that people of lower social classes, who typically used traditional biomass energy sources, were forced to deal with indirect supply constraints and price increases.

Most of the oil consumption in Country B was of diesel oil. Because diesel oil was used mainly in the logistics field, the distribution of daily necessities, clothing, and medical supplies was partly disrupted, having a significant impact on people's lives. Many consumers stood in long lines at gas pumps and the shortage of diesel oil interfered significantly with traffic in urban areas. This was because i) in Country B, the use of oil had not spread to people's lives as widely as it had in Country A; ii) in Country B, oil products had originally been distributed at international market prices and the people had experienced considerable price changes when crude oil prices fluctuated the past; and iii) the scale of Country B is relatively smaller, and oil rationing associated with the reduced oil imports (as described earlier) was implemented in a relatively effective manner.

Furthermore, the shortage of jet fuel led to a restriction of airline services in Country B. As a result, the country's flight arrival and departure schedules had to be revised, which also affected people's lives. Tourism was one of the country's major industries, and the reduced numbers of flights and tourists visiting popular sightseeing spots caused a serious setback to the tourism industry.

1-2-4 How was the situation resolved?

Because of the time taken to clean up the spilled oil after the tanker accident off the coast of Singapore, the shutdown of the Strait of Malacca lasted as long as 3 weeks. After that time, the oil product supplies gradually recovered to their pre-accident levels. In addition, Country B took the following measures to accelerate the recovery.

(a) Introduction of oil product rationing

The country first introduced oil product rationing. As imports of oil products decreased by about 20 percent, the supply of such products in the country also dropped by the same percentage. Under the government's intervention, the national oil company decided the order of priority on how to allocate its oil products to major consumers. As Country A did, Country B tried to prioritise the supply of oil products to help the public and for administrative functions. Not having accumulated enough information on oil product stocks and distribution conditions during ordinary circumstances led to Country B sometimes mistakenly supplying oil products to locations that in fact were not prioritised, or not supplying products to locations that should have been prioritised.

(b) Functions of market mechanisms

As well as the measures described above, market mechanisms and price signals played major roles in the recovery process. In Country B, the domestic oil product market was liberalised, and oil products were distributed at selling prices linked to international oil markets. After the tanker accident, overall oil product prices in Asia went up. With the aim to make a profit through arbitrage, traders imported oil products to the Asian market from all around the world. Many countries in the ASEAN region had subsidy systems in place for domestic oil products and could not afford to import such high-priced products. On the other hand, while its ability to import oil products was limited, Country B was somewhat receptive to the inflow of additional oil products into Asia because the levels of its domestic selling prices had originally been high. This pricing structure helped Country B in securing its required oil products.

Fortunately, many foreign companies were operating in Country B because of the liberalised oil market. Many of the multinational companies were able to secure the necessary products under their international supply networks with each oil company. These companies tried to secure the necessary products by taking advantage of their own unique product supply routes. As a result, the efforts of the companies contributed significantly to Country B securing oil product supplies after the tanker accident.

(c) Internationally supported oil product supply

Despite the oil product supply disruption from Singapore, Country B was able to receive oil products under a bilateral agreement concerning emergency response with Country C. Country C supplied oil products to Country B mainly from government-held national stockpiling. As part of the agreement, Country C's private companies supplied the necessary products to support Country B. There were differences between the two countries in the quality standards for some of these products, but the government of Country B solved the problem by temporarily relaxing their quality standards. Country C had excess refining capacity even during ordinary times. Setting aside the overall price hikes of crude oil and oil products, the impacts that Country C suffered from the tanker accident in Singapore were only slight delays in crude oil arrival. Because there was almost no physical shortage in its domestic oil product supply, Country C had the capacity to help Country B.

1-2-5 Implications of the scenario

This scenario is quite different from the scenario of Country A in both the cause of the supply disruption and the country's scale and oil consumption mix. The implications that can be derived from this scenario have some similarities with those for Country A, but at the same time some of the implications are quite different. Setting aside the overlapping parts of the two scenarios as much as possible, this section looks at some of the implications that come to mind.

(a) When securing the oil supply in an emergency, what problems will the lack of domestic refineries cause?

As mentioned in the scenario, dependence on imports of oil products for the domestic product supply, particularly from specific oil companies and countries, inevitably limits the scope of options in an emergency. Because of the large costs, the construction of a refinery is not always justifiable. Despite the existence of excess refining capacity in neighbouring countries, building a new domestic refinery could worsen the existing oversupply problem in the Asian market. For this reason, the purpose of the project should be studied thoroughly before building a refinery. If the country decides not to have a refinery, the necessary precautions should be taken against the resulting vulnerability of the country's oil product supply.

(b) What implications does a liberalised domestic market have from the standpoint of the emergency oil product supply?

The scenario for Country B showed that a liberalised domestic oil market would offer the following advantages: i) oil products can be secured at international market prices more easily; ii) people can cope with price fluctuations in a flexible manner; and iii) the domestic market can access international trading networks through the foreign companies operating in the country. Of course, in the event of such an emergency, the government is expected to have an extremely important role, including determining the supply and demand conditions throughout the country, prioritising the supply of oil products, and making detailed policy decisions when a rationing system is introduced. On the other hand, it is true that a liberalised domestic oil market offers various advantages that other countries are unable to enjoy. An example of this case is Hurricane Katrina, which struck the US in 2005, resulting in a reduction in the country's domestic refining capacity and causing gasoline prices to soar. Many countries that had not exported oil products to the US during ordinary circumstances supplied the necessary oil products to the disaster-stricken country and helped it recover earlier than expected. It is impossible to respond to emergency situations by relying solely on market mechanisms, but such market mechanisms should be proactively pursued when they are expected to work effectively. Determining the respective roles of the government and the market is an important part of an effective emergency response.

(c) What kinds of methods or incentives should be granted to private companies and foreign companies to hold them accountable for oil stockpiling?

In a sense, the lack of appropriate oil stockpiling worsened the impact of the crisis in Country B. In Country B, where private and foreign companies supply most of the oil product supply, if the country imposed oil stockpiling obligations on companies, the country would undoubtedly see more problems than it would impose it on the national oil company. The act of oil stockpiling is synonymous with holding larger quantities of oil stock, a significant disadvantage for private companies whose mission is to maximise their profit. For this reason, if a country with an industrial structure like Country B is going to implement an oil stockpiling system, the country should take the necessary measures to reduce the burden on oil companies as much as possible, or conversely, the country should consider other approaches that would advantage these companies.

(d) When the status of the oil stock is unknown, how can we collect the necessary information to make appropriate decisions?

Due to the problem of smuggling, Country B was unable to collect accurate information on its domestic oil product stock in a timely manner. In the event of an unexpected, large-scale supply disruption as indicated in this scenario, the absence of such information can cause huge problems. Needless to say, it is important to record such statistics during ordinary circumstances, but it can take a long time to develop such measures. The government and oil companies need to maintain a network during ordinary times in preparation for emergency situations. When an emergency actually happens, an appropriate system should be set up with the help of such networks so that the concerned parties can share information on each company's oil stock status and formulate procurement plans in a timely manner. To ensure the effectiveness of the network, the country should conduct training during ordinary times as often as possible.

CHAPTER 2

Stockpiling Options

In the crisis scenarios in Chapter 1, we saw that the oil supply could be stopped by sudden and unexpected events, causing not only economic impacts but also political and social instability. ASEAN countries use oil for a number of purposes and a disruption in the oil supply can have far-reaching consequences.

Oil stockpiling is a measure to minimise the impact of the disruption of the oil supply. Storing certain amounts of oil that are controllable in an emergency and near areas of demand could minimise the economic and social effects in the case of an oil supply disruption by allowing the immediate release of oil. This could also provide more time before necessary, more severe countermeasures (such as the introduction of a rationing system or fuel conversion) are taken.

This chapter discusses the various options for developing oil stockpiling, with the above-mentioned advantages. Section 2-1 introduces the traditional styles of oil stockpiling and explains their advantages, disadvantages, and development costs. Section 2-2 discusses the next best, lower cost options for oil stockpiling for cases where the development of full-scale oil stockpiling facilities cannot be built.

2-1 Traditional Oil Stockpiling Base Styles

2-1-1 Onshore tank base

The most typical type of oil stockpiling base is the onshore tank type. If land of a sufficient area is available, an onshore tank base is the easiest type of oil stockpiling base to develop, technologically and economically. The actual development cost depends largely on the land reclamation cost or land development cost. In a cost evaluation by Mitsubishi Research Institute for a ground tank base in Viet Nam in 2012, the cost was estimated to be US$397 per cubic metre, with a construction period of 5–6 years (Mitsubishi Research Institute, 2012). The operating expense is higher than that of other types of stockpiling facilities since an on-shore tank base requires operations such as regular inspections and stirring of the stored oil. The IEA estimates the typical annual operating expense to be US$13–US$19 per cubic metre (Stelter and Nishida, 2013).

Figure 2-1 is an aerial photograph of the Tomakomai Higashi Oil Stockpiling Base in Japan, a typical ground tank type oil stockpiling base. In many cases, onshore tank bases are constructed with many tanks in a large area, storing not petroleum products but crude oil.

Figure 2-1. Typical Ground Stockpiling Facility

Source: JOGMEC website.

An advantage of the ground tank base type of facility is that construction and operation are relatively easy. In comparison with underground storage facilities, the lower relative initial cost of construction is another advantage. In addition, since the storage facilities are placed on the ground, periodical maintenance is easy and responding to any operation troubles can easily be carried out. If the base can be constructed and operated next to a tank base of an existing refinery or oil terminal, the construction cost can be 10–20 percent lower than the construction cost of a new tank base and operation costs can be also be lower by 30–50 percent (Stelter and Nishida, 2013).

The largest disadvantage of the ground tank base is that a large area of land is necessary to construct many tanks. Local communities may also oppose the construction of an oil stockpiling base due to concerns about the scenery or perceived danger. If the land covers farmland, compensation to farmers may be necessary. An oil stockpiling base should be constructed near to a city that consumes a lot of oil so that oil can be released immediately to the city in an emergency. However, it is extremely difficult to secure land large enough to construct an onshore, tank type oil stockpiling base. It may be necessary to ask people living on the land to move to other places or to compensate them, and hence the necessary costs before construction can be high.

There is another disadvantage in that the stockpiling base is exposed to the air. This is an environmental issue. Unlike a refinery, a oil stockpiling base simply stores oil. Since there is no constant flow of oil or a high-temperature, high-pressure processing plant, the possibility of a severe accident is extremely low. However, stored oil itself is a highly combustible, dangerous material. An accident can have an extremely large impact on the neighbouring environment and local communities. Also, in the case of an oil leakage from a tank, there could be long-term, negative impacts on the surrounding nature and ecology.

High operation costs are also a disadvantage. Large stockpiling bases require regular inspection. Daily safety inspections can be costly, and the costs for electricity and heat supply are higher than for underground stockpiling bases. In some countries, safety and/or environment regulations can be strict. In these cases, the costs of complying with regulations can be high.

2-1-2 Underground stockpiling

Underground stockpiling is an oil stockpiling method to drill a solid rock bed, construct stockpiling facilities, and store oil. A typical underground stockpiling method uses a water-sealing underground tank, which confines oil using groundwater pressure. Unlike the salt cavern type of stockpiling facility, this underground stockpiling facility requires drilling of a solid rock bed, and thus requires high initial costs. The initial construction cost estimated by Mitsubishi Research Institute is US$466 per cubic metre, about 20 percent higher than that of the ground tank type. However once constructed, an underground stockpiling base requires less costs for inspection, utility, and insurance than the ground tank type, and total operation costs are lower. The annual operation cost of an ordinary underground stockpiling base was estimated by IEA to be less than US$5 per cubic metre.[4]

Figure 2-2 shows a photograph of Kikuma Stockpiling Base in Japan. This base was constructed next to a private company's refinery, whose ground tanks can be seen in the picture. The stockpiling facilities are indicated in purple and crude oil is stored in the large tunnel-like stockpiling facilities.

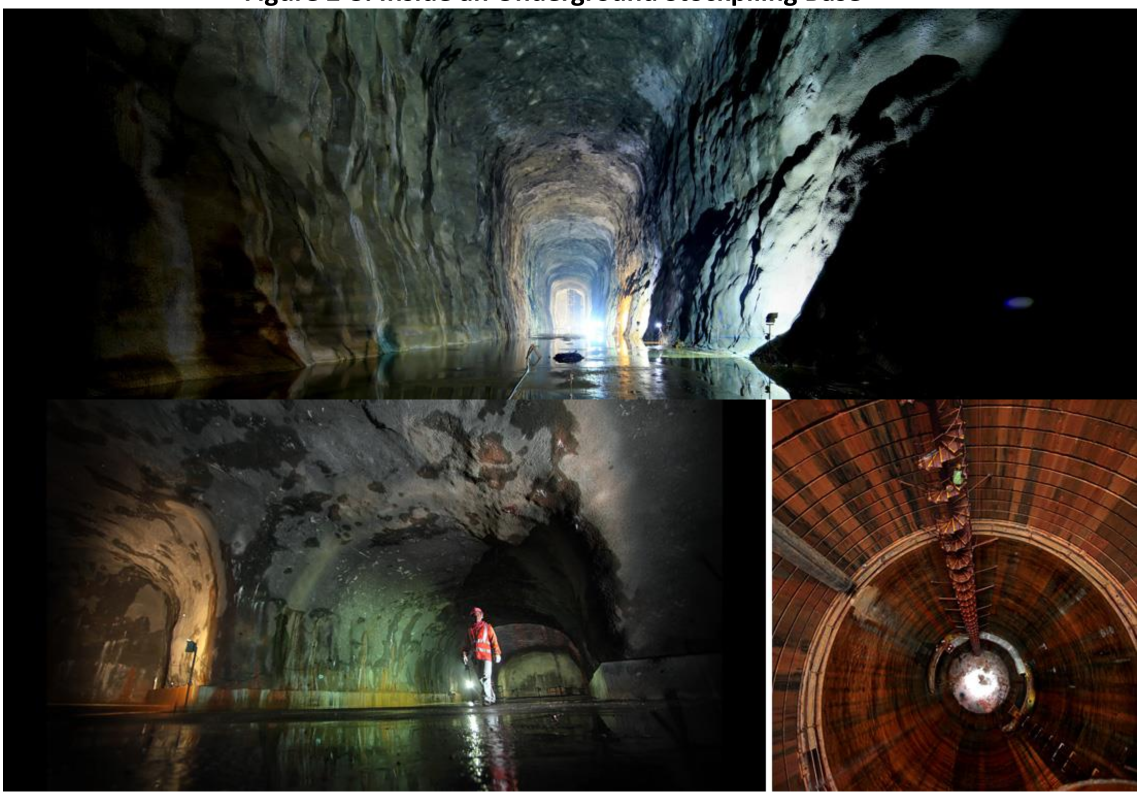
[4] Mitsubishi Research Institute Inc., Mitsubishi Heavy Industries, Ltd., JGC Plant Solutions Co., Ltd., Japan Marine Science Inc., Study on the Project for Development of National Strategic Oil Stockpiling Mega-Floating System in Vietnam (Tokyo, Japan, Oil, Gas, and Metals National Corporation: February 2012).

Figure 2-2. Image of an Underground Stockpiling Base

Note: The underground crude oil stockpiling facilities are shown in purple.
Source: JOGMEC website.

Figure 2-3 shows the inside of an underground stockpiling base in Jurong Island, Singapore, which began operations in 2014. Crude oil is stored in the tunnel-like space.

Figure 2-3. Inside an Underground Stockpiling Base



Source: JTC website.

A typical method used for underground stockpiling is water-sealing underground stockpiling. In this type of stockpiling base, a rock bed below the groundwater level is drilled to make a cavern, which then stores crude oil without having to line the cavern wall with steel or cement. Oil can be stored in the cavern because the groundwater pressure in the rock bed forms a natural wall preventing crude oil from leaking from the cavern.

Safety is an advantage of underground stockpiling facilities. The stockpiling facilities are located below the groundwater and hence crude oil stored in the cavern is confined by the pressure of the groundwater and does not leak out. Since the stockpiling facilities themselves are made of rock bed and the space above the facilities is filled with inactive gas, there is no possibility of fires or explosions. Since tanks are in the underground solid rock bed, they are also less affected by earthquakes than onshore tank bases.

There is also an advantage in terms of environmental conservation as most of the facilities are underground and hence do not ruin the natural scenery. Securing land for the underground facilities is easier than securing land for a ground tank base. This is a social advantage as people living nearby are likely to be less opposed to the base. Moreover, the operation cost of an underground stockpiling base is lower than that of a ground tank base and the rock collected from the drilling work can be used for landfilling in seaside areas. This is an economic advantage (Mitsubishi Research Institute, 2012).

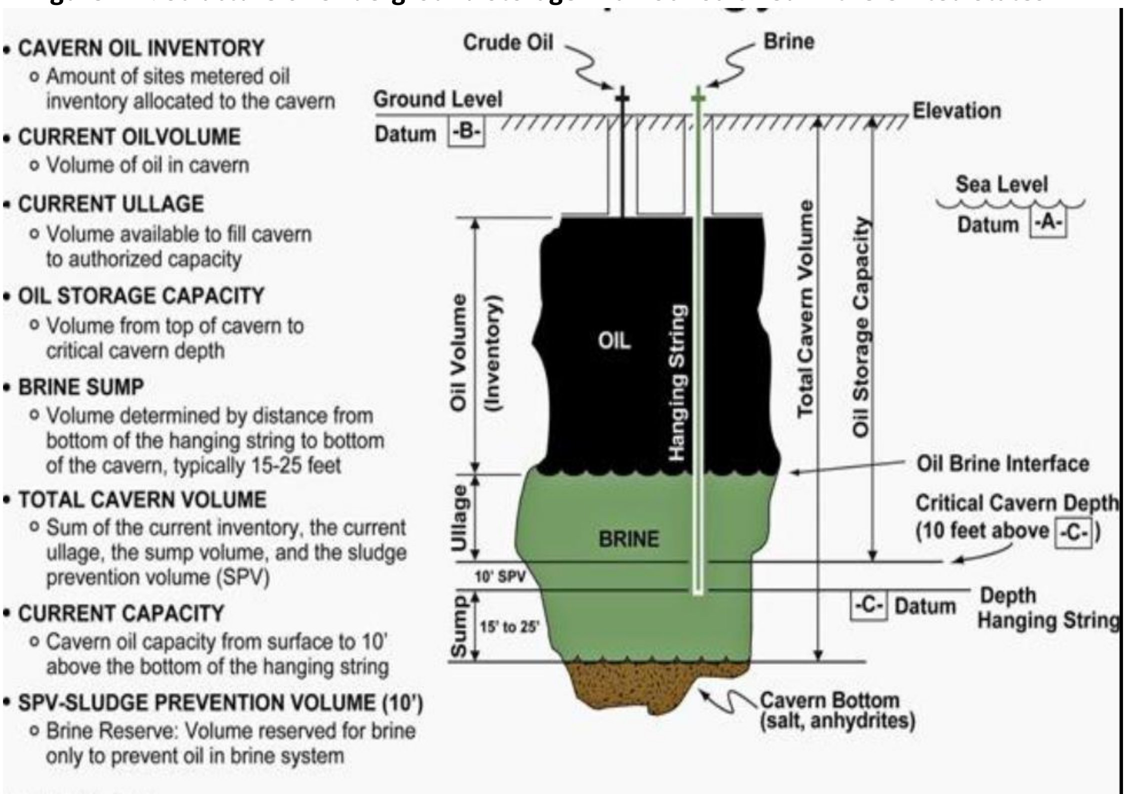
A disadvantage is that the underground facilities cannot be constructed if no appropriate rock bed is found and so the base site depends largely on geological conditions. For some geological conditions, initial costs of construction may be high. For example, Kikuma base in Japan was constructed 65 metres under the sea and the Jurong Island underground stockpiling facilities were constructed 150 metres under the sea. Their construction costs were therefore high. In order to construct water-sealing underground stockpiling facilities, which store oil by utilising groundwater streams, it is necessary to determine the location of appropriate groundwater for the facilities. If no appropriate groundwater can be found, the groundwater needs to be artificially controlled, which requires high operational costs. Compared to the ground tank type, construction of an underground stockpiling base is more difficult. Therefore, to construct an underground stockpiling base in an ASEAN country, the country may need help from a foreign company for construction. Also compared to the onshore tank type, replacement of oil stock in the underground stockpiling base is not easy, and hence bases are used mainly for the storage of crude oil, not petroleum products.

2-1-3. Stock facilities in rock salt beds

In the US, stockpiling facilities constructed in underground rock salt beds are widely used as underground oil stockpiling bases. Since rock salt beds have dense structures with extremely low porosity, the possibility of leakage of stored crude oil is extremely low. Therefore, stockpiling facilities in rock salt beds are appropriate for preventing environmental problems such as soil contamination and water pollution.

For the actual construction of storage chambers in a rock salt bed, a method called solution mining is employed. In this method, the rock salt bed is first drilled, then a large amount of water is supplied into the drilled hole to dissolve the rock salt bed and create a storage cavern. The salt water, generated when the rock salt bed is dissolved, is pressed back in the ground or discharged to the sea.

Figure 2-4. Structure of Underground Storage in a Rock Salt Bed in the United States



Source: United States Energy Information Administration website.

The greatest advantage of oil stockpiling bases in rock salt beds is the low construction costs and operation costs. As mentioned above, the stockpiling facilities are constructed not only by drilling the salt bed but also by dissolving it. Therefore the construction cost is much lower than the construction cost of simply drilling a solid bed. According to an evaluation by IEA, the construction cost is about US$75 per cubic metre, which is much lower than the costs of other types of stockpiling base. The IEA also evaluates the operation cost to be US$2.5 or less per cubic metre, which is lower than ordinary underground stockpiling bases.

Another advantage is safety. Rock salt beds are made of highly pure salt, which does not chemically react with crude oil. As such, rock salt beds are expected to work the same as steel tanks placed on the ground. There are also environmental advantages. Since crude oil is stored 600–1,200 metres deep under ground, even if a crack occurs in the rock salt bed, the underground pressure prevents the crude oil from leaking through the crack. Also, the temperature differs from place to place inside the storage cavern in the rock salt bed. It is therefore expected that the stored crude oil rotates inside the stockpiling facilities. This natural stirring effect keeps the crude oil properties in a stable state. Since periodic oil stirring is not necessary, unlike for onshore tank bases, the operation costs can be reduced.

There are few disadvantages of oil stockpiling bases in rock salt beds, but this method cannot be employed if no appropriate bed can be found. In the US, appropriate rock salt beds for oil stockpiling exist near the coast of the Gulf of Mexico, where many refineries are located. In Europe, there are also many appropriate rock salt beds for oil stockpiling. However in ASEAN countries, rock salt beds appropriate for oil stockpiling have not been found and construction of oil stockpiling bases of this type would be difficult.

2-1-4 Floating stockpiling base

Floating stockpiling bases store oil in floating tanks on the water, on the sea in many cases. Examples of the floating stockpiling bases are Kamigoto base and Shirashima base in Japan. Figure 2-5 shows an aerial view of Kamigoto base.

Figure 2-5. View of a Floating Stockpiling Base

Source: JOGMEC website.

The floating facilities can be constructed as a so-called 'mega-float' structure at a shipbuilding yard. This structure can be built only in a ship yard where a very large vessel can be built. Therefore the initial construction cost is about US$395 per cubic metre, as high as that of onshore tank bases. Since the floating base requires inspection works and management of the office building, the annual operation cost is also as high as around US$11 per cubic metre.

The largest advantage of the floating oil stockpiling base is that it is relatively easy to find a base site if the hydrographic conditions are met. If land large enough for ground tank facilities cannot be secured, a floating stockpiling base is a likely option. In particular, ASEAN countries have many islands and there are many quiet ocean areas where waves from the outer sea can be blocked. These areas are suitable for floating stockpiling bases. ASEAN countries thus have a topographical advantage. Before constructing a floating stockpiling base, it is necessary to take the appropriate measures to prevent any negative effects on local fisheries or ecological systems in the surrounding area.

Extending or moving a floating stockpiling base, if necessary for some reason, is relatively easy compared to extending or moving a ground tank base or underground stockpiling base. A disadvantage, however, is the high operation costs. In particular, if a floating base is constructed far from the coast, operation costs after the completion of the construction for operational office facilities and transportation, such as ships to go to the facilities, tends to be high. This is the largest disadvantage.

Floating stockpiling bases have to be constructed in places with appropriate hydrographic conditions. To prevent adverse weather from destroying the stockpiling facilities and causing oil leakages, the topographical conditions for the construction of a floating base have to be closely examined.

From an environmental viewpoint, a floating stockpiling base has to be constructed in a place with calm hydrographic conditions. If the stored crude oil leaks out for some reason, there could be potentially profound effects on the surrounding environment. (In Japan, to minimise this danger, protective measures with quadruple structures are taken for the bases.) From a safety viewpoint, floating stockpiling bases are weaker than underground stockpiling bases, which is another disadvantage of floating bases.

2-1-5 Summary

Table 2-1 summarises the characteristics of the four stockpiling base types. Costs to secure land change largely depend on the topographical conditions of the land. For any type of stockpiling base, preventive measures against oil leakage are assumed, but if an accident does occur, it can have significant, detrimental impacts.

Table 2-1. Comparison of Major Stockpiling Systems

	Above ground tank	Underground tank	Salt cavern	Floating tank
Characteristics	Large storage tanks above ground Globally adopted means to store crude oil Sometimes adjacent to refinery	Crude oil is sealed in the underground storage Impact to surrounding environment and scenary are limited. Conditions where sufficient underground water pressure can be maintained	Construction and maintenance cost is low. Widely adopted in US or Europe Not many locations in Asia have suitable salt layer	Facility is relatively easy to expand Large floating storage tanks offshore location
Location	Close to sea coast where tanker can moor Large flat area	Close to sea coast where tanker can moor Suffient amount of underground water to maintain crude oil in the storage	Salt dome	Calm wade and tide condition Sufficient water depth
Benefits	Easy to operate and maintenance Relatively small initial investments	Safety Environmentally friendly No need to secure wide surface land	Low initial investment and operating expenses	No need to find a wide surface land Easy to transport
Drawbacks	Difficulty to find suitable land Relatively high OPEX	High initial investment Difficult to find suitable geological condition	Dificult to find suitable geological condition	High operating expenses Risk of oil spill
Requried land area	Large	Middle	Small	Small
Environment impact	Big	Middle	Small	Small
Construction period	5-6 years	7-10 years	7-10 years	3-4 years
Construction unit cost	USD 397 / m3	USD 466 / m3	USD 75 / m3	USD 395 / m3

Note: Because cost estimates of each type refer to different sources, the basis assumptions may be different across types. The costs shown in the table are the construction costs only and do not include operational expenses or procurement of stockpiled oil.

Source: Mitsubishi Research Institute, International Energy Agency, complied by IEEJ.

2-2 Lower-Cost Options

For securing the oil security of a nation, the final goal is to develop oil storage within the country. However, many of the ASEAN countries are still undergoing economic development and do not have the required financial resources to construct oil stockpiling bases on a significant scale. Therefore, while aiming for the long-term development of oil stockpiling bases as described in the previous sections, these countries may choose lower-cost stockpiling options to enhance oil security as much as possible until the future development of stockpiling bases is completed. The following section examines the options for low-cost oil stockpiling.

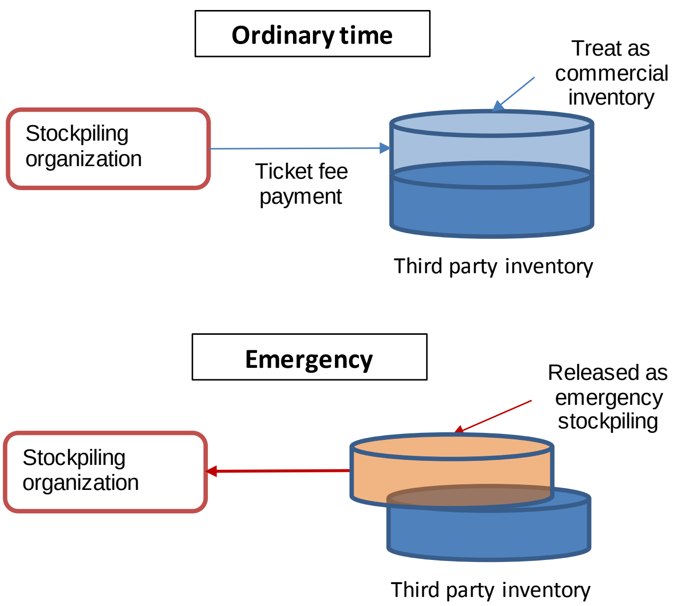
2-2-1 Ticket stockpiling

(1) Outline

One low-cost option of oil stockpiling is stockpiling by ticket, which is most commonly used in Europe. Ticket stockpiling is a system in which a country's agency in charge of oil stockpiling pays a ticket fee (charge for oil stockpiling) to count oil stock held by other agencies as emergency oil stock. 'Other agencies' include domestic oil companies, domestic oil stockpiling agencies, and foreign entities. In this system, the agency paying the ticket fee does not have actual oil stock but entrusts oil stockpiling to other agencies. If the ticket stockpiling is entrusted to an oil company, the company receiving the ticket fee has to store the designated inventory of oil during ordinary times. The company can use the oil for business in ordinary times but needs to release the oil in the event of an emergency.

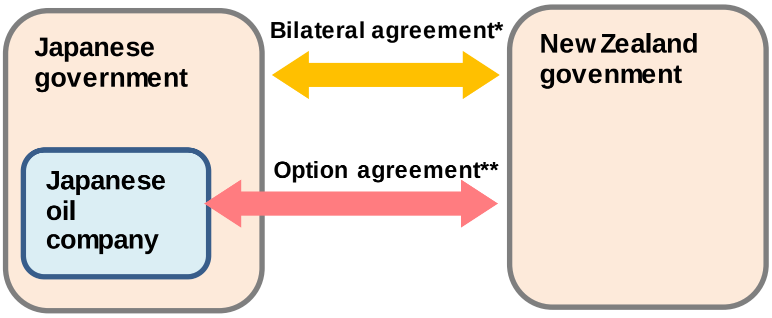
If the ticket stockpiling is conducted between two countries, both governments make an agreement on the stockpiling of a specific amount of oil before agencies in the two countries actually make a contract. For example, for ticket stockpiling between Japan and New Zealand, the governments of the two countries first made an agreement, and then a Japanese oil company and the New Zealand government made a ticket contract that New Zealand would pay a ticket fee and the Japanese oil companies would promise to supply petroleum products to New Zealand in the case of an emergency.

Figure 2-6. Forms of Ticket Stockpiling



Source: The Institute of Energy Economics, Japan.

Figure 2-7. The Ticket Stockpiling System between Japan and New Zealand



***Bilateral agreement**
- Inventory for option contract is counted as stockpiling volume of New Zealand.
- When New Zealand exercises its option contract, Japan does not obstruct transportation of the stockpiling volume.

****Option agreement**
- New Zealand government purchases option to buy oil from Japanese oil company through option fee payment.

Source: The Institute of Energy Economics, Japan.

The ticket stockpiling system has been widely used in Europe. In East Asia, New Zealand has already introduced the system. Many countries have set the upper limit of the ticket stockpiling to be 10 percent of the total required oil stock for security reasons.

(1) Advantages

The largest advantage of the ticket stockpiling system is that actual storage of oil is not necessary. For energy security, it is important to construct oil stockpiling bases, but construction costs are extremely high. Therefore, ticket stockpiling can minimise the costs for the development of oil stockpiling facilities. By having an external oil stock as a ticket, one does not have to store oil or conduct the operational work necessary for the stored oil. The system also has the advantage that the security and safety risks of having oil stock can be avoided.

Another advantage is the economic rationality. In stockpiling oil, it is rational to store the oil where storage costs are lowest. For ticket stockpiling, the agency in charge of oil stockpiling in the country that is buying the ticket calls for bids on oil stockpiling to determine agencies selling the ticket. Through this process, the agency in charge can entrust stockpiling and operations of oil to the most cost-competitive agency.

The third advantage is high flexibility. Once oil stockpiling bases are constructed in a country, the number of bases cannot be easily changed depending on the balance between oil demand and the oil market. However, the amount of oil stored by the ticket stockpiling system can be relatively easily changed at the end of the contract. If the domestic demand is expected to change considerably in a short period of time or if parallel development of multiple oil stockpiling bases is expected, the ticket stockpiling is an effective choice because the oil stock amount can be changed. However, this flexibility also has a disadvantage. In order to be able to buy a ticket at an arbitrary time, there needs to be excess stockpiling facilities or excess stock somewhere in external agencies. If only a small capacity of oil storage is available, there is a risk of an increase in the ticket price.

Table 2-2. Major Countries that have Introduced Ticket Stockpiling Systems

Country	Domestic tickets		Tickets abroad	
	Allowances	Usage	Allowances	Usage
Australia	Not applicable		Not applicable	
Austria	Not allowed		Not allowed	
Belgium	Allowed	Yes	30% of public stocks	Yes
Canada	Not applicable		Not applicable	
Czech Republic	Not allowed		Not allowed	
Denmark	Allowed	Yes	30% of obligated industry stocks and 5% for FDO	Yes
Finland	Allowed	*	20% of obligated industry stocks	No
France	Allowed	Yes	Allowed	No
Germany	10% of EBV's stockholding obligation maximum	Yes	10% of EBV's stockholding obligation maximum	No
Greece	Not allowed		Not allowed	
Hungary	Not allowed		Not allowed	
Ireland	Allowed	No	Allowed	Yes
Italy	Allowed	Yes	Allowed	Yes
Japan	Not allowed		Not allowed	
Korea	Not allowed		Not allowed	
Luxembourg	Allowed	No	Allowed	Yes
Netherlands	Allowed	Yes	Allowed	Yes
New Zealand	Allowed	No	Allowed	Yes
Norway	Not allowed		Not allowed	
Poland	Allowed	*	5% of obligated industry stocks, not allowed for ARM	No
Portugal	Allowed	*	Allowed	No
Slovak Republic	Not allowed		Not allowed	
Spain	Allowed	Yes	Allowed	No
Sweden	Allowed	Yes	20% of obligated industry stocks	Yes
Switzerland	Not allowed		Not allowed	
Turkey	Not allowed		Not allowed	
United Kingdom	Allowed	Yes	Allowed	Yes
United States	Not applicable		Not applicable	

Note: * Information on the use of domestic tickets in Finland, Poland and Portugal was not available at the time this paper was drafted.

Source: International Energy Agency, 'Focus on Energy Security'.

(2) Challenges

A challenge in the promotion of the ticket stockpiling system is the incentive of a country to store oil. All the countries employing the ticket stockpiling system, shown in Table 2-2, are IEA member countries and possess an obligation of 90 days' worth oil stockpiling. IEA member countries have a duty to have oil stockpiling, no matter what oil type is stored or where or how it is stored among the member countries. Therefore, if a similar arrangement were introduced in ASEAN, it would be preferable for ASEAN to have a similar obligatory framework in place to stockpile oil.

Another challenge is the geographical distance to the stockpiling base of a ticket. In Europe, even when a stockpiling base owned by a ticket is located outside the ticket holder's country, the country often has a pipeline to the base and the line is often not very long. Therefore, when the country needs the stored oil in an emergency, it can secure the oil in a reasonably short period of time. In ASEAN, on the other hand, if a country buys a ticket from another country, the distance to the oil stockpiling base may be very long and in many cases the oil may need to be transported by tankers, depending on the relevant countries. Therefore, mobility of oil is a large problem for effective stockpiling by tickets.

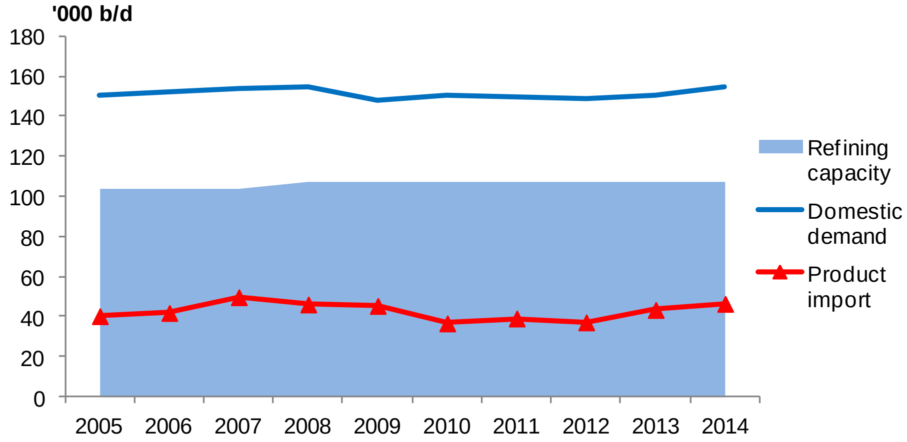
Accurate and transparent data is also an important issue because a ticket holder needs to ensure that the ticketed volume is readily available. This requires strong trust been ticket holders and ticket issuers in such arrangements.

For oil stockpiling by ticket, it is necessary in many cases to find an oil company that owns stock facilities of a sufficient size that can afford to lend part of their facilities. When there is a loose supply-demand balance, and in particular when contango is observed in the futures market, oil companies carry a lot of stock and can easily provide some of the stock for ticket stockpiling. However, in the case of a tight supply-demand balance, it can be difficult to find an oil company possessing the necessary oil stock. In general, private oil companies have an incentive to hold as little commercial oil stock as possible. Therefore, the ticket price has to be high enough to encourage the companies to hold more oil stock and supply oil from their stockpiling facilities. Hence, the ticket price or available volume may change largely depending on the status of oil stock in the market.

(3) Case study of New Zealand

New Zealand is the only country in the Asia-Pacific region that uses the ticket stockpiling system. The domestic oil demand, refining capacity, and oil product imports in New Zealand are shown in Figure 2-8. Domestic oil demand increased continually after 1980, but reached a peak in 2005, staying at around 150,000 b/d.

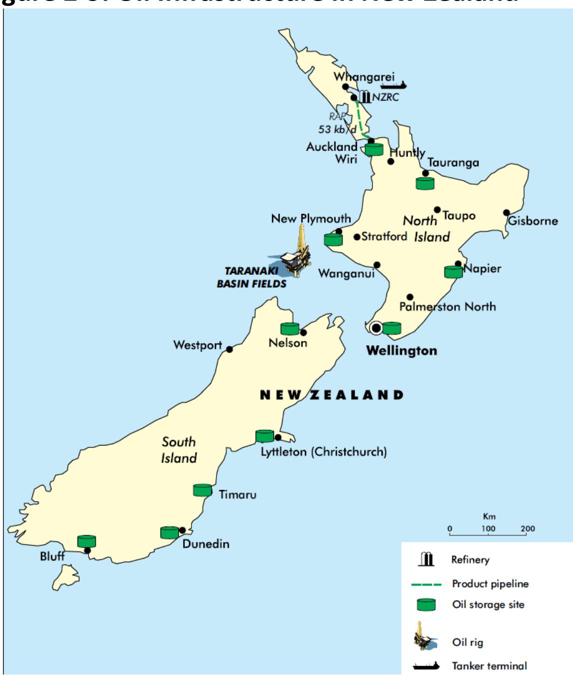
Figure 2-8. Domestic Oil Demand, Refining Capacity, and Oil Product Imports in New Zealand



Source: BP (2015); IEA Energy Balances of OECD Countries.

Oil production in New Zealand is around 35,000 b/d (as of 2013) and most of the oil is produced in the Taranaki Basin, offshore and to the west of the North Island. The crude oil produced in this oil field is light, low sulphur crude oil, which can be sold at a high price in the international market. Most of the oil produced is exported.

Figure 2-9. Oil Infrastructure in New Zealand

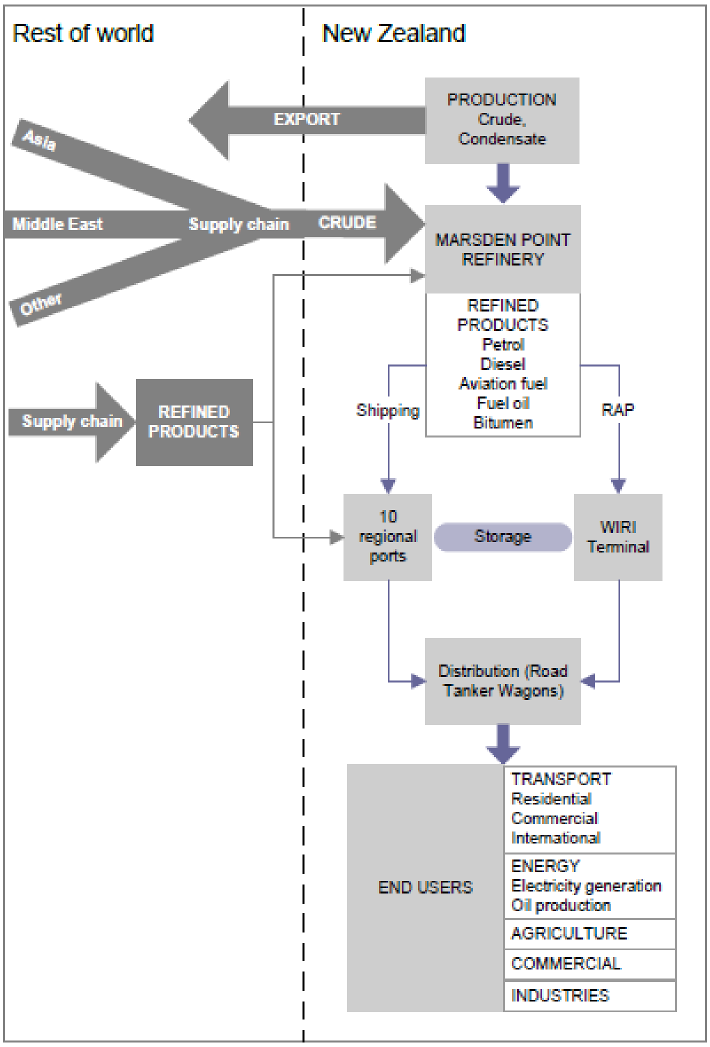


Source: International Energy Agency (2014).

New Zealand has only one refinery, located in Whangarei in the northeast of the country. Its refining capacity was 107,000 b/d as of 1 January 2016. The refinery supplies 80 percent of the petroleum products in New Zealand. Petroleum products are also imported from Singapore and Korea, with imports from the two countries accounting for almost 90 percent of all imports. Forty percent of the crude oil refined in the Whangarei refinery comes from Middle Eastern counties, especially from Saudi Arabia and Qatar. The rest comes from Asian countries, such as Malaysia and Brunei Darussalam.

Figure 2-9 shows the oil supply structure in New Zealand. Most of the crude oil produced in the country is exported and crude oil is imported from the Middle East and Asia to the refinery, which produces 80 percent of the petroleum products supplied in the country. The produced products and imported products are supplied to filling stations (SS) in various places through petroleum product pipelines and the domestic logistics network.

Figure 2-9. Oil Flow in New Zealand



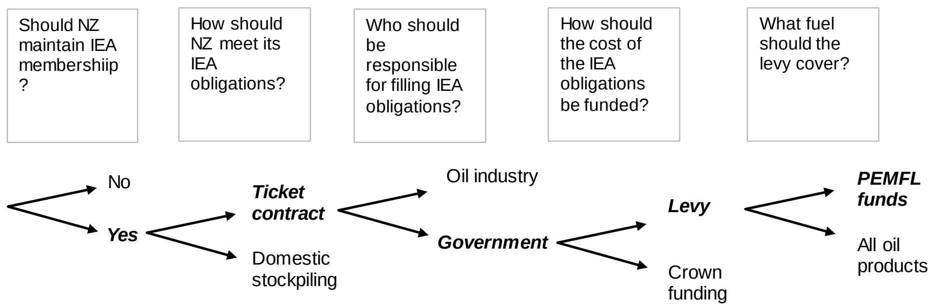
Source: Ministry of Business, Innovation, and Employment (2012).

Since New Zealand is an oil-producing country, it used to be able to meet the IEA's 90-day target from only the commercial oil stocks of private oil companies. However from the mid-2000s onward, demand has increased and domestic production has reduced, so the country was no longer able meet the target using only commercial stock. New Zealand therefore began oil stockpiling by ticket on 1 January 2007 to achieve the IEA target. It accepts international bidding to secure oil stock every year and buys ticket contracts to purchase stored crude oil or petroleum products from foreign countries, such as the Netherlands, the United Kingdom (UK), and Japan. Based on the ticket contracts to purchase oil, New Zealand can require the ticket-issuing countries to release some, or all, of the ticketed stockpiled oil in the event of an IEA collective action. The release, however, is not automatically done when the IEA decides collective action. The ticketed volume is released only when New Zealand requires the ticket issuing countries to do so.

New Zealand has had a high interest in oil security for several reasons: the crude oil produced in the country has not been enough to meet domestic demand; most of the produced crude oil is exported and most of the oil supplied to the country is imported oil; and the country is located far from other countries so it is not easy for New Zealand to rely on other countries for receiving oil supplies in an emergency.

Based on such heightened interest in oil supply security, the Ministry of Economic Development of New Zealand issued a report on oil security in 2005[5]. In this report, option analysis was conducted to reach the conclusion that ticket stockpiling based on government funds is the best option for New Zealand. This report first asks whether New Zealand should maintain its IEA membership, as that is its biggest motivation for developing stockpiling. The report explains that the country should maintain the membership as it brings numerous benefits, such as information sharing about oil markets, technological expertise in the use of other forms of energy, as well as opportunities for exchange on various issues of energy policy with other advanced countries.

Figure 2-10. Option Analysis for Stockpile Holdings



IEA = International Energy Agency, NZ = New Zealand, PEMFL = Petroleum or Engine Fuel Monitoring Levy.
Source: Ministry of Business, Innovation, and Employment (2012).

[5] Covec and Hale and Twomey Limited, *Oil Security* (Wellington, Report prepared for Ministry of Economic Development), 2005

The report then asks whether New Zealand should construct a stockpiling base or adopt ticket stockpiling. It claims that the country should choose the ticket stockpiling option, as it is more economical than building a stockpiling base. The cost-benefit analysis on the construction of an oil stockpiling base and oil stockpiling by ticket was conducted in another report entitled *New Zealand Oil Security Assessment Update*, published in 2012. The report shows that the construction cost of a new oil stockpiling base would be US$10.88–US$14.25 tonnes per month and the cost of ticket stockpiling, estimated from past examples, would be US$0.79–US$1.86 tonnes per month. The report therefore notes that the construction of a new stockpiling base is not an economically appropriate option. The report also explains that stockpiling should be developed by the government, as industry does not have the sufficient capability to pursue such high-cost investment. The report concludes that the cost of the stockpiling arrangement should be levied on oil consumers, as oil users should bear the cost of stockpiling, too.

Based on the findings, New Zealand made intergovernmental agreements with the UK, the Netherlands, Spain, Japan, and Denmark, and has been bought tickets from the Netherlands, Spain, and Denmark, as of March 2016. Although the ticket prices have not been disclosed, volatility has been extremely high and prices fell to one-sixth over the period from 2009 to 2016. The New Zealand government has secured NZ$3 million on average every year, which has not enough in some years (Ministry of Business, Innovation, and Energy, 2015). The government raised its Petroleum or Engine Fuel Monitoring Levy (PEFML) of 0.045 cents per litre imposed on major petroleum products, such as gasoline and diesel oil, by 0.2 cents to secure the required financial resources.

New Zealand, as shown above, decided that ticket stockpiling is the best option for the country's stockpiling based on thorough examination of the various options and rigorous cost-benefit analysis. The country's approach will be a good reference for ASEAN countries in considering how to develop their own stockpiling systems.

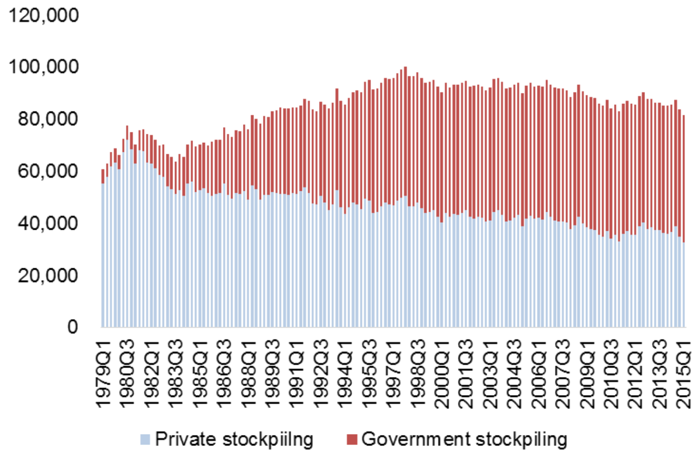
2-2-2 Upgrading of commercial stock to stockpiling

(1) Outline

Another lower-cost option is to upgrade the existing commercial stock to stockpiling by setting obligations. As this would simply impose a minimum inventory on existing players, it is the easiest option from an administrative standpoint. Of course, since many oil companies keep their stock as low as possible for business efficiency, they would have to construct additional storage facilities in addition to those used for storing the minimum necessary amount of oil for business. The government would need to create a legally binding regulation for oil companies to stockpile a certain amount of oil. In many ASEAN countries, national oil companies manage the domestic oil business. Therefore, it would be relatively easy to require an increase in oil stock from those companies than private companies.

Japan is one of the countries that have increased oil stockpiling in this way. After experiencing the oil crisis in 1970s, the Japanese government began to develop oil stockpiling for emergencies. First, the government obliged domestic oil companies to consider a part of their stock as stockpiling for emergencies and keep a certain level of oil stockpiling. As national oil stockpiling bases were constructed and completed, the obligations by companies were gradually loosened. (Figure 2-11). Since this new regulation imposed a heavy burden on private companies, the Japanese government needed to financially support the companies to increase stockpiling. The details are described in Chapter 3.

Figure 2-11. Amount of Stockpiled Oil in Japan



Source: Institute of Energy Economics, Japan.

Obligations for government-run or private domestic oil companies to stockpile commercial oil have been gradually promoted in ASEAN countries. Table 2-3 shows these activities. These existing obligations will be a good start for further expanding the obligatory volumes.

Table 2-3. Stockpiling Obligations in ASEAN

Country	Stockpiling Obligation
Singapore	Power plants and fuel suppliers are obliged to respectively have 60 and 30 days' worth of fuel oil stockpiling for electricity
Thailand	Oil companies are obliged to have 25 days' worth of oil stockpiling
Philippines	Refining agents, bulk marketers, and liquefied natural gas importing companies are obliged to respectively have 30, 15, and 7 days' worth of oil stockpiling

Source: Institute of Energy Economics, Japan.

(2) Advantages

Upgrading of the existing commercial stock to stockpiling has many advantages. Since there is already existing infrastructure, such as tanks, facilities for lifting and loading cargo, and pipelines for oil supply, the cost to construct additional storage facilities is very low. Cargo handling facilities for commercial use during ordinary times can also be used for releasing stockpiled oil, which would be efficient and effective for the oil release. When releasing oil from independent, government-run stockpiling facilities, handling facilities that are not used in ordinary times would need to be used and hence require some preparation. However, if existing facilities are extended to hold stockpiling, oil release in an emergency can be made at an appropriate time because the facilities usually used for commercial operation can be used for the oil release, and the released oil can be transported through the usual oil transport paths.

Also, existing facilities and workers can be efficiently used for operations. Since electric power and heat from the existing facilities can be used, use of the existing facilities has a large advantage compared to construction of new stockpiling facilities. There is also a large advantage from the viewpoint of facility security control and environmental conservation as workers at a refinery or import base can be used for cargo work and safety inspections of stock facilities.

In addition, operators with knowledge of the existing facilities can assist in procuring oil and materials for construction of the facilities. Additional oil stockpiling requires the procurement of oil at a competitive price. Such procurement can be conducted based on the knowledge accumulated by the operators through their experience and knowledge of ordinary commercial trade.

(3) Challenges

The biggest challenge is encouraging the oil industry, which owns the stock infrastructure, to expand its facilities. Establishing a relationship with the oil industry for oil stockpiling is therefore an important issue, which will be discussed in detail in Chapter 3. Problems must be solved, such as how to introduce legal obligations, or what incentives should be developed for taxation or financial support from the government.

Another challenge is ensuring the arrangement works properly. Development of an accurate and timely statistical data collection system is necessary for checking that the required minimum inventory is maintained. Detailed procedures on releasing stockpiles must also be agreed upon to determine who decides when and what volume of oil will be released. If the number of stockpiling inventory holders becomes large, the procedures will become more complex.

2-2-3 Third-party leasing stockpiling

(1) Outline

Third-party leasing stockpiling is an arrangement where a third party lends storage capacity and uses it for commercial purposes in ordinary times; but the capacity owner (in many cases the host government) can claim prioritised access to the inventory in the storage as a part of stockpiling. Since the possibility of the occurrence of an emergency requiring oil release is extremely low in reality, the fee for leasing the facilities as commercial oil stock facilities can compensate the cost of developing the facility and its operation in ordinary times.

Japan utilises this method as its third type of stockpiling, together with national stockpiling and private stockpiling and conducts the arrangements with major oil producing countries. Saudi Aramco, Saudi Arabia's national oil company, and Abu Dhabi National Oil Company, Abu Dhabi's national oil company borrow stockpiling facilities in Okinawa and Kagoshima prefectures, respectively, for crude oil sales in the Asian market. The Japanese government and the governments of the two countries agreed that the oil companies in the two Arabian countries could use the stockpiling facilities for business in ordinary times and the stockpiled oil would be released to the Japanese market on a priority basis in emergencies.

(2) Advantages

An advantage of this method is that the country possessing the stockpiling facilities can recover some of its operating expenses by receiving a leasing fee. In principle, oil for stockpiling is just stored and does not produce a profit by itself. However, revenue can be acquired by leasing the oil stockpiling facilities to a third party with an obligation to release the stockpiled oil in an emergency.

Since the stockpiled oil is used for business, the oil is not simply 'stockpiled' but 'flows.' Therefore, the quality of the stockpiled oil can be maintained in this flowing stockpile. Although the quality of crude oil does not degrade during long-term storage, the quality of petroleum products tends to degrade after several years. By increasing the flowing stockpile through collaborative stockpiling, the oil is regularly replaced and its quality can be maintained.

Also, as in Japan, collaborative stockpiling with major oil supply countries can strengthen the relationship between countries. For Japan, Saudi Arabia and the United Arab Emirates are the largest and second-largest oil supplying countries. Therefore, even in the case of an emergency, crude oil from these countries can be processed at domestic refineries without worrying about the quality of the oil.

(3) Challenges

One problem of collaborative stockpiling with a third-party country is that the capacity of the facilities has to be large enough for the third party to use. Construction of a stockpiling facility requires a large amount of capital, and thus any firm agreement for such third-party leasing has to be agreed before constructing the facility. Therefore, private companies may be wary in investing in such facilities and the government needs to play an important role in their construction.

For collaborative oil storage, such as that conducted by Japan and Saudi Arabia or the UAE, the commercial advantage of storing crude oil is a key issue. For example, the facilities in Japan are geographically close to China and Korea, i.e., large markets for Saudi Arabia and the UAE, which is an incentive for oil-producing countries to store oil in Japan for commercial purposes. In order for the oil-producing countries to store oil in ASEAN countries, the countries have to be attractive as an oil market for the oil-producing countries.

Also, it must to be made clear in advance on what standard the stockpiled oil is released in. This is because stockpiled oil is not actually released unless the third party that owns the stockpiled oil agrees on the conditions of the release.

2-2-4 Regional stockpiling

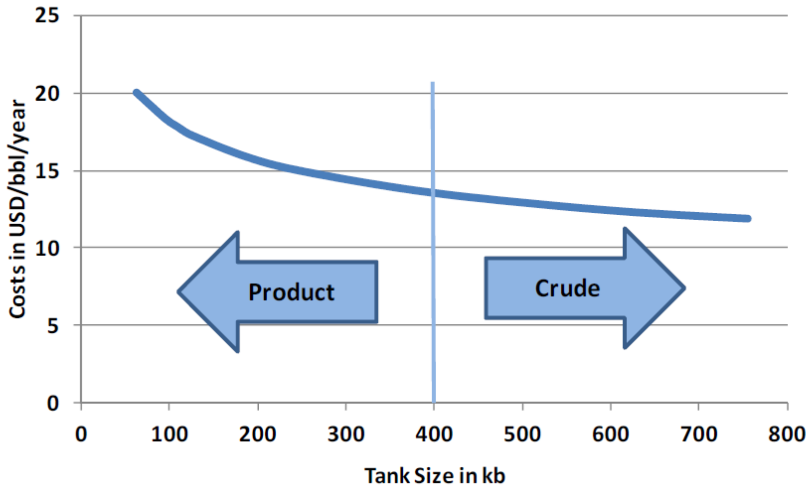
(1) Outline

Regional stockpiling is oil stockpiling based in a specific location that countries in the region can access in an emergency. Constructing such a regional collaborative stockpiling base would be beneficial for the ASEAN region. Stockpiling would be held and operated under the control of a specialised organisation, supported by investment from ASEAN member countries.

(2) Advantages

The greatest advantage of regional collaborative stockpiling is that it can benefit from economies of scale. According to an evaluation by the IEA, a 0.1 million-barrel tank of and a 0.4 million-barrel tank have a cost difference of at least 25 percent (Figure 2-12). Therefore, it is economically rational to build an oil stockpiling base together in a certain location rather than to build small bases in multiple countries with small oil demand.

Figure 2-12. Size and Construction Costs of Oil Storage Tanks



Source: International Energy Agency, 'Focus on Energy Security'.

Regional stockpiling also has the advantage that the various resources of the countries in the region can be pooled and shared for effective and efficient operation of the oil stockpiling. If each country invests money to establish a stockpiling facility, it needs to establish a specialised organisation with permanent staff and operate the facility by itself. If countries can establish a common organisation for stockpiling, they can pool their staff and financial budgets, and utilise them in a more efficient manner. Analysis of oil supply and demand, for example, can be done more efficiently by gathering human and information resources in a single place.

Some ASEAN countries may not have the capacity to develop and operate their own stockpiling bases, but by forming a regional organisation and stockpiling facility, they may have access to stockpiling by becoming partial investors.

The most suitable place for this type of stockpiling in ASEAN would be Singapore. As seen in Chapter 1, Singapore is a trade hub in the Asian oil market, possessing stock facilities of a capacity of 9 million kilolitres. It is also located in the centre of ASEAN. From Singapore, oil can be transported to any ASEAN country within a week. It is also easy in Singapore to find tankers for the transport of petroleum products in an emergency and the country politically and economically stable.

(3) Challenges

The first large challenge for advancing this type of oil stockpiling is that from a security viewpoint, some countries may not agree on stockpiling their oil in another country's territory. It can be expected that many countries consider oil stockpiling to be an important aspect of oil supply security, and would therefore want their stockpiled oil to be located in their own countries. To advance this regional stockpiling, strong relationships and mutual trust among the countries has to be built.

Even if an agreement on regional stockpiling were to be made, the location of the stock would be another issue. Singapore seems to be the most appropriate in terms of stockpiling infrastructure among the ASEAN countries. However, it is far from the Philippines, which may not be able to use the stored oil immediately in an emergency. This issue may also raise a free-rider problem. If a country's facility is identified as a regional stockpiling facility and the burden of its operation and maintenance is taken on by the country, it may feel that the other countries are free-riders of the stockpiling system, making the agreement unsustainable.

The details of the organisation must also be decided, such as the ratio of investment, the organisation's decision-making process, how to secure oil, who operates the stockpiling base, and the form of oil stockpiling. Administrative procedures will also be complicated, as detailed operational rules, such as the definition of an emergency and decision-making procedures, need to be developed.

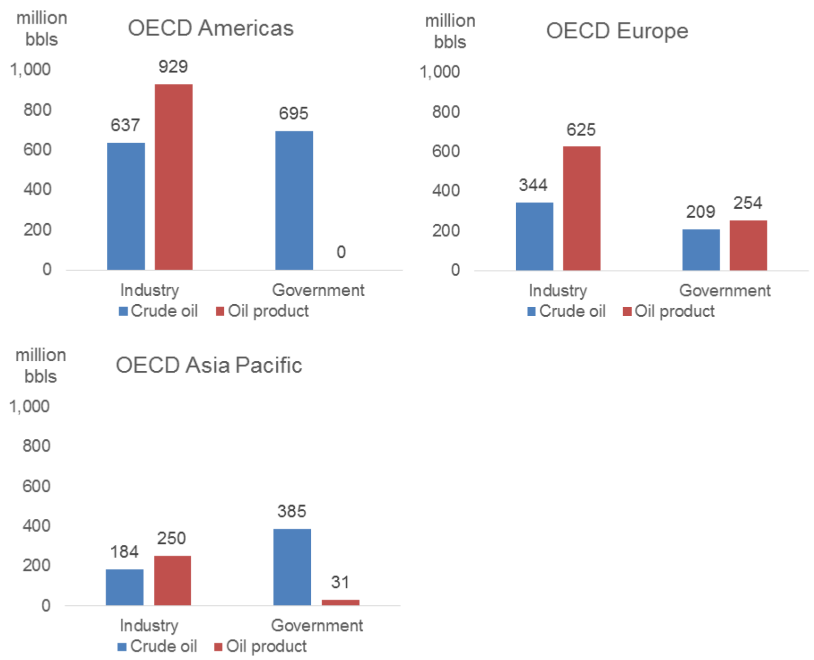
Another problem is the quality of the stockpiled oil or petroleum products. Refineries in the ASEAN area refine crude oil from different oil-producing countries and hence have to stockpile various types of crude oil. Also, many ASEAN countries employ the Euro Standard of petroleum product quality, but standards vary among countries. Coordination of the quality differences must therefore be conducted.

2-2-5 Multilateral arrangement system

(1) Outline

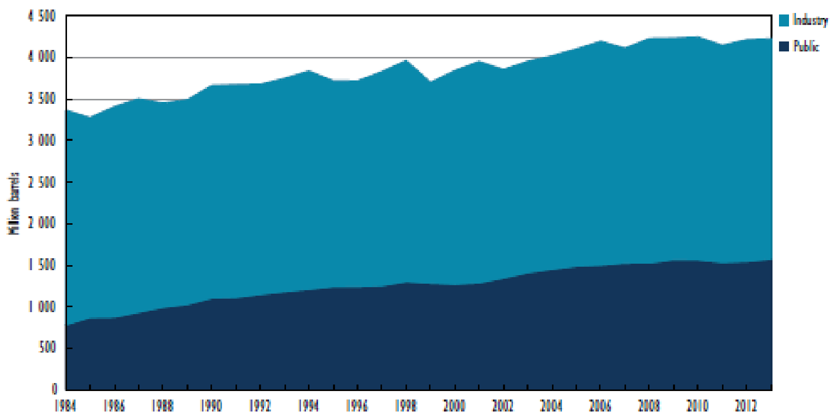
A multilateral arrangement system is a cooperative framework where multiple countries agree to share their oil with each other if a serious oil disruption occurs. When oil supply termination occurs at a certain level in one of the member countries, the other countries must collaboratively supply oil to the affected country. A precondition for the operation of this oil sharing system is that a certain number of member countries must have developed oil storing infrastructure and hold enough oil stockpiling to respond to a certain level of supply change. Also, the countries need to have infrastructure for not only domestic oil supply but also for exporting to foreign countries.

Figure 2-13. Oil Stock of International Energy Agency in Different Regions (as of October 2015)



Source: International Energy Agency, Oil Market Report.

Figure 2-14. Oil Stock of the International Energy Agency



Source: International Energy Agency (2014).

As an example, ASEAN countries agreed to the ASEAN Petroleum Security Agreement (APSA) in 2009, however it is yet to be exercised.

(2) Advantages

An advantage of a multilateral framework is in minimising the impact of a disruption by pooling the stockpiling of the member countries. Oil supply disruptions can occur for various reasons.

If the Hormuz Strait were to be closed, many oil importing countries would be affected and the multilateral sharing system may not work. However, for oil supply disruptions that largely affect a specific area, such a hurricane in the US or the supply termination of Libyan crude oil, which is exported mostly to Europe, additional supply from areas that are not affected would be extremely effective. Therefore, a multilateral sharing system is more effective with a larger number of member countries.

Another advantage of the multilateral framework is information sharing. For example, the IEA regularly releases the latest information on the demand-supply situation in the current oil market, expectations of the future demand-supply balance, the risks in the current oil market, and measures necessary to minimise the influence of the risks. It also regularly reviews the oil supply security policies and other energy policies of individual countries to find problems and promote sharing of the best practices of the countries. Therefore, an advantage of the multilateral framework is to provide a system for information sharing and the formation of collaborative relationships among regions on the energy security and energy policies based on the system.

(3) Challenges

A challenge in developing such framework in ASEAN is that ASEAN, unlike the IEA, has countries with largely differences in their stages of economic development, oil demand-supply situations, and views on oil security. Therefore, the greatest problem in the development of a multilateral sharing system is to unify countries with a variety of attributes and policies in a single framework.

First, it is necessary to set up a permanent secretariat for the development of a multilateral sharing system, like the IEA. This is because an organisation for coordination among member countries and market analysis is necessary before taking actual, coordinated action. For market analysis, specialists who can regularly analyse trends in the oil market and personnel to collect and analyse statistical data and price data are also needed. For this coordination and analysis work, a permanent organisation is necessary, giving rise to the problem of who must pay for the costs. A large challenge in the execution phase may be in determining the cost sharing among member countries.

For ASEAN countries, the existence of APSA is an important asset for future development of a multilateral framework. Currently, ERIA is examining the operation of the system with expectations of practical achievement.

2-3 Summary

This chapter summarised the advantages and challenges of various options for oil stockpiling. In practice, the best type is often determined by eliminating the inappropriate options based on a country's limitations (budget restrictions, topographical and geological conditions, securing of land, etc.) and political priorities (emphasis on higher security or economy, accepting or rejecting foreign capital, etc.) For the early development of an oil stockpiling base, the restrictions must be solved one by one.

The construction costs, advantages, and disadvantages of each stockpiling base type explained in this chapter are the most common ones. In the actual development of a base in an ASEAN country, there may be further costs, advantages, and disadvantages specific to the country.

The five low-cost options may also be combined in actual applications. For example, regional stockpiling may be combined with a ticket stockpiling arrangement. This would be a practical choice, because in many cases, ASEAN countries lack the sufficient land and financial capabilities for building their own stockpiling bases, and this would allow them to enjoy the benefits of economies of scale and the accumulation of market information and operational expertise.

Table 2-4. Comparison of Lower-cost Stockpiling Options

	Ticket	**Upgrading commercial inventory**	**Third party leasing**	**Regional stockpilnig**	**Multilateral arrangement framework**
Characteristics	Stockpiling arrangement where an entity that is responsible for stockpiling pays a fee (or purchase a ticket) to another entity to claim a certain volume of oil as its stockpiling. Ticket can be purchased from both domestic and international entities An entity that receives the ticket fee has to provide the ticketed volume if requested by the ticket holder.	Setting an easier target to the existing commercial inventory holders and gradually raising the target preferably with the government's support	Stockpiling storage leased to a third party for commercial use in ordinary times; but the storage owner can claim the prioritized access to the inventory in the storage in case of emergency.	Multiple countries agree to have a single stockpiling base and store their oil in the base. Each country can claim the stored inventory in case of emergency.	Multiple countries agree to arrange and coordinate their inventory in case of emergency. Combining obligation of stockpiling development with the arrangement will be more effective.
Benefits	- No need to hold physical inventory - No capital expenditure for stockpiling facility and no operational expenses for stockpiling - No risk of accident that may occur at stockpiling facilities - Higher flexibilities, particularly grade and volume of stockpiling	- Capital expenditures and operational expenses can be saved by utilizing an existing infrastructures. - Actual release of stockpiled oil can be smoothly done because the release will use the current operating infrastructure and staffs. - Expertise of commercial operators can be utilized.	- Operation costs of stockpiling can be made up with additional revenues - Stored inventory is usually used for commercial operations: it can avoid quality degradation of by storing oil for a long time.	- Economies of scale Concentrate various resources and utilize them in an effective and efficient manner. - Countries with different development stage and economic background can have a stockpiling by joining efforts with other countries.	- An established and operational example exist (IEA's arrangement) - Pooling inventory and arranging each other in case of emergency can enhance supply security and resilience. - Information sharing helps the member countries to promote stockpiling development.
Challenges	- Geographical distance from stockpiling base may be a serious problem - Availability of appropriate ticket issuers has to be ensured. - Ticket price may be volatile. - Security concern for not holding physical inventory	- Incentivizing the commercial operator is not easy. - Government's support may be needed. - Acquisition of additional land for such stockpiling facilities may be difficult	- Finding an appropriate partner for joint stockpiling is sometimes difficult. - Monitoring and ensuring a certain level of inventory is difficult. - Need to clarify the conditions of the release in advance.	- No existing arrangement - Security concern to have a stockpiling outside the country - Selecting the location may be politically complex. - Administrative cost is large.	- Making agreement among countries with very difference economic development stage, oil market size, and the level of inventory, is not easy. - Permanent secretariat needs to be set up.
Remarks	- Extensively utilized in Europe - Ticket price as of year 2015 is less than USD1.0/ton/month	- Easiest way to build stockpiling from the government standpoint - Government may ensure that the inventory passes the incremental cost to the final selling price.	- Japan and Saudi Arabia and UAE have this type of stockpiling arrangement.	- Combining with ticket stockpiling can be an effective arrangement.	- APSA will be the appropriate platform if this type of stockpiling aims to be realized

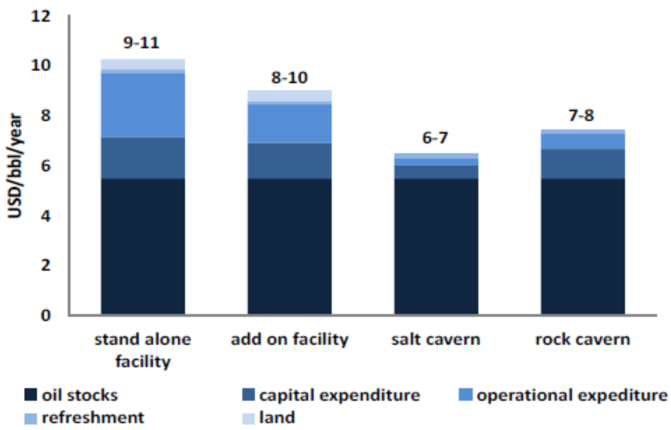
Source: Institute of Energy Economics, Japan.

Addendum: Economics of Stockpiling

Stockpiling brings numerous benefits to stockholding countries. The benefits, however, vary significantly depending on factors such as the oil intensity of GDP, the share of oil in the total energy mix, the degree of import dependence, and GDP per capita. This report does not provide economic analysis on specific countries, but introduces the recent analysis conducted by the IEA in 2013 on the *global net benefits* of stockpiling.[6] The following is a brief summary of the analysis.

The costs of representative stockpiling options are shown in Figure 2-15, based on the IEA's analysis. The range is roughly US$7–US$10/bbl, depending on the option.

Figure 2-15. Cost of Stockpiling Development



Source: IEA, Focus on Energy Security.

The benefits of stockpiling are composed of the amount of avoided GDP loss resulting from stockpiling and the reduced import bill by utilising domestic stockpiling. The IEA member countries' stockpiling system is estimated to have generated US$3.5 trillion in benefits from the past release activities. The IEA used a simulation model developed by Oak Ridge National Laboratory and calculated the expected benefits. The schematic of the simulation is shown in Figure 2-16. It assumes an unexpected supply disruption on a random basis, based on the past 30-year history of the international oil market. In the estimate, the model uses the following reference data:

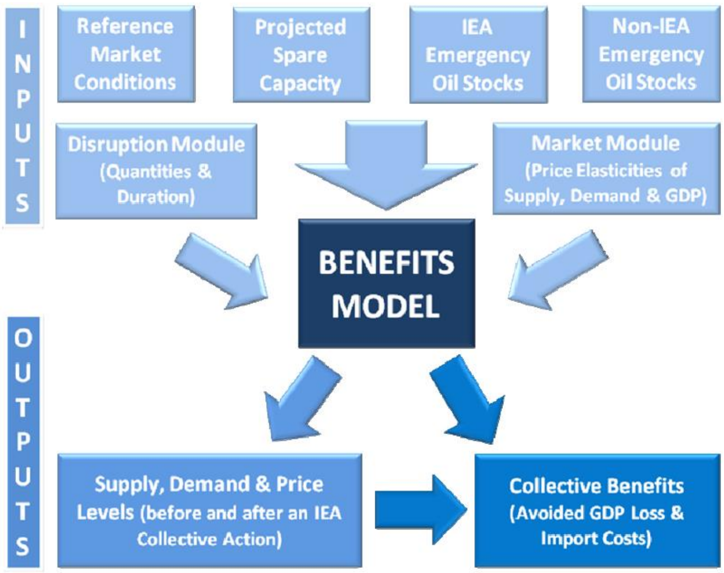
- Market conditions (demand and supply balance)
- Spare oil production capacity
- IEA emergency stock capabilities

[6] International Energy Agency, Focus on Energy Security (Paris: International Energy Agency, 2013).

- Non-IEA emergency stock capabilities
- Oil supply disruption probabilities
- Market responsiveness (price elasticity of supply and demand) and macroeconomic sensitivity to shocks (GDP elasticity toward the oil price)

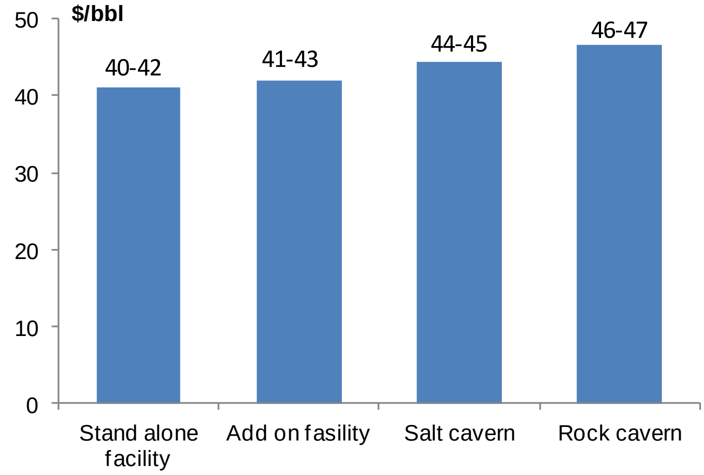
The simulation analysis estimates the global benefits of stockpiling at approximately US$3,546 billion for 30 years, equivalent to US$51/bbl. The avoided import costs amount to US$23/bbl the avoided GDP losses are US$27/bbl. Combining the cost estimates of each stockpiling type, the net benefits of stockpiling are summarised in Figure 2-17.

Figure 2-16. Cost of Stockpiling Development



Source: IEA, Focus on Energy Security.

Figure 2-16. Net Benefits of Stockpiling



Source: IEEJ based on IEA, Focus on Energy Security.

It should be noted that this is the global net benefit, and further analysis is needed to assess the net benefit for each specific country. Individual countries face additional costs that are unique to their own stockpiling development, but incremental benefits from stockpiling. However, the IEA's analysis clearly shows a significant benefit from stockpiling (US$51/bbl) and this amount is large enough to mobilise domestic resources to prompt development of stockpiling systems in ASEAN countries.

CHAPTER 3

Successful Government and Industry Relationships for Stockpiling Development

3-1 Why are Government-Industry Relationships Key to Oil Stockpiling?

This chapter addresses government and industry (G-I) relationships with respect to oil stockpiling in ASEAN. As discussed in previous sections, a successful G-I relationship is the cornerstone of a country's stockpiling development and operations. This section discusses why G-I relationships are so important and how these relationships can be built with reference to the experiences of IEA member countries.

3-1-1 Capitalising on industry knowledge

Firstly, cooperation with the oil industry provides practical knowledge for oil stockpiling. Crude oil and petroleum products are highly flammable and dangerous, and their handling (loading, unloading, storage, transport, etc.) requires specialist expertise and special facilities. In addition, they should be managed by organisations or personnel that specialise in safety and environmental issues to prevent any leakages or a release of oil into the surrounding environment. Cooperation with the oil industry, specialising in the operational handling of crude oil and petroleum products, is key to capitalising on its knowledge and expertise.

In principle, governments are expected to allocate a budget for human resources, expertise development, and accumulation of knowledge in order to stockpile oil, which is essential for national energy security. As discussed in Chapter 1, oil imports to ASEAN countries are increasing rapidly, making it urgent to develop practical stockpiling systems. It is therefore beneficial to make use of the knowledge of the domestic industry available in each country for stockpiling oil.

3-1-2 Securing efficiency

Cooperation with the oil industry, which engages in the commercial handling of oil and petroleum products, can improve stockpiling systems and efficiency. The industry's decision-making systems and handling procedures for supplying oil to the market should be fully utilised in a country's stockpiling operations. Developing stockpiling systems requires significant investment and resources, and efficiency is essential. As such, governments should make the most of the oil industry's knowledge and expertise for efficient business operations, for example in forming practical organisations and decision-making processes, determining effective staff allocation, and implementing cost-effective maintenance.

Cooperation with the oil industry is also essential in building stockpiling stations. In particular, a close G-I relationship is key to optimising stockpile management, from designing to constructing and operating new stockpiling facilities.

3-1-3 Government resource constraints

The third aspect is in a way the most critical: government resource constraints. While most ASEAN countries have growing infrastructure needs, such as for road construction, power supply, and telecommunication systems, their infrastructure systems have yet to be developed and they have limited financial and human resources available for social infrastructure development, including oil stockpiling. In recent years, major countries have conducted various cost-benefit analyses with respect to oil stockpiling, which is raising awareness of its economic benefits.[7] That being said, its effectiveness may look still less tangible for many policy planners and policy makers compared to other infrastructure, such as railroads and telecommunication systems. Thus, a practical solution is to make the most of the industry's financial and human resources, which requires incentives to encourage cooperation in oil stockpiling.

The recent trend worldwide has been for governments to opt for private finance initiatives to ramp up investment in social infrastructure. In the UK, which has taken the lead in adopting private finance initiatives, businesses with the following conditions are considered suitable for the initiatives (HM Treasury, 2008)：

- The businesses require significant capital investment for the construction and maintenance of facilities.
- The needs can be considered as services by the public, output to the private sector, and defined as such in the contract accordingly, with the risks clearly shared between the public and private sectors.
- The life cycle costs of the construction of facilities and the provision of services can

[7] For example, the following analysis was conducted:
International Energy Agency, 'Focus on Energy Security
Costs, Benefits and Financing of Holding Emergency Oil Stocks,' (2013), NZIER Report to Ministry of Economic Development, 'New Zealand Oil Security Assessment Update,' (2012), Department of Energy & Climate Change, 'Future Management of the Compulsory Stockpiling Obligation in the UK,' (2013), Hale & Twomey, 'National Energy Security Assessment Identified Issues: Australia's International Oil Obligation,' (2012)

be defined, with the risks clearly identified and quantified.

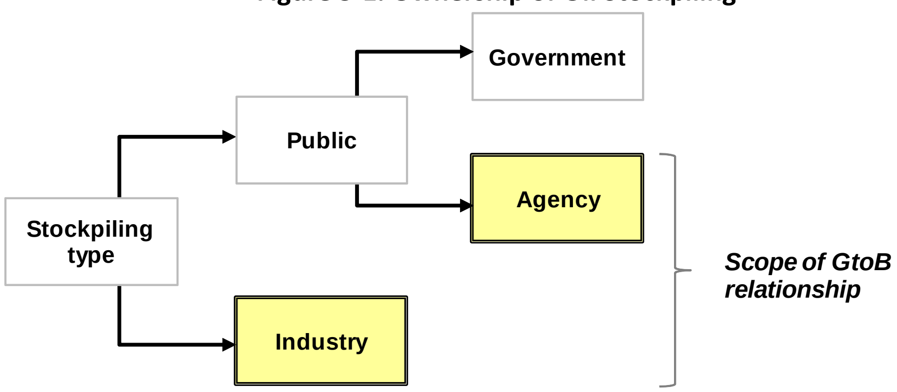
- Significant capital expenditures are required for the construction and maintenance of facilities.
- Significant changes, such as rapid technological innovation and political about-face, are not anticipated.
- The resulting public services will be ensured and provided for a long period of time.

As oil stockpiling meets most of these conditions, it is important to capitalise on industry resources, including private funds.

3-2 Scope of the Government-to-Business Relationship for Oil Stockpiling

By ownership, oil stockpiling can be classified into public stockpiling and private stockpiling. The former consists of government stockpiling and agency stockpiling. In most cases, agency stockpiling is funded and managed by private companies that belong to the agency. Stockpiling types that require industry involvement, therefore, consist of private stockpiling and agency stockpiling, which are operated by private funds.

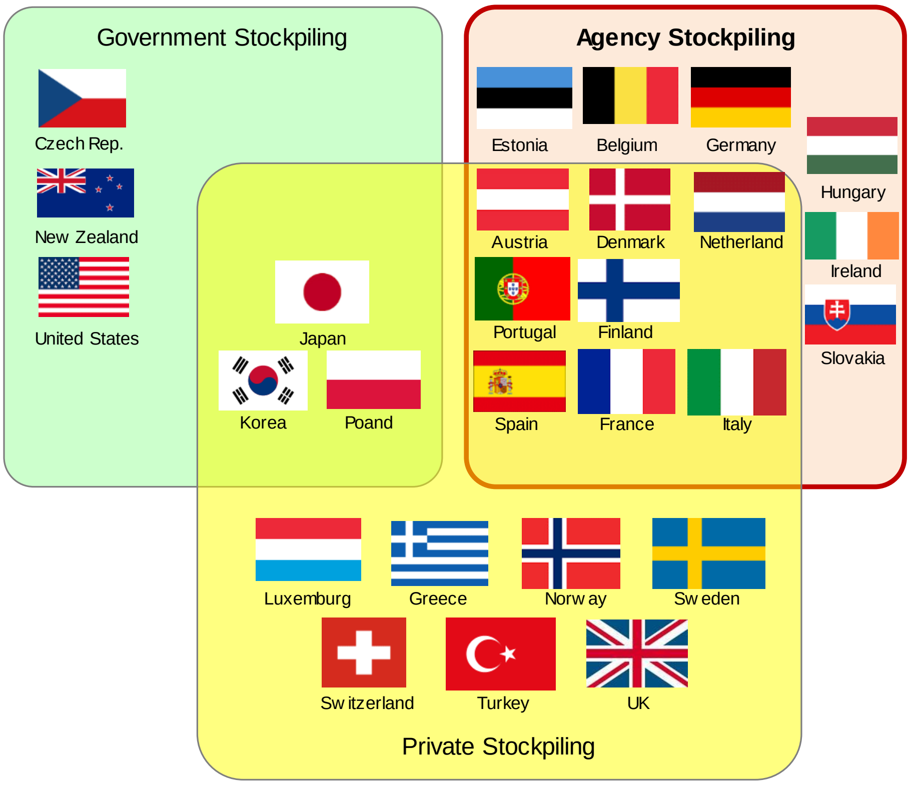
Figure 3-1. Ownership of Oil Stockpiling



Source: IEA (2014).

Agency stockpiling is managed by an agency specialised in oil stockpiling maintenance and operations. The agency is managed primarily a public organisation under the applicable laws and regulations, with the member companies providing funds to promote stockpiling business. The legal status and operation style vary slightly from country to country, according to the structure of the oil market and the concept of oil supply security. This is a system common in Europe and is often combined with private stockpiling (see Figure 3-2).

Figure 3-2. Stockpiling Type by Country



Source: JOGMEC website.

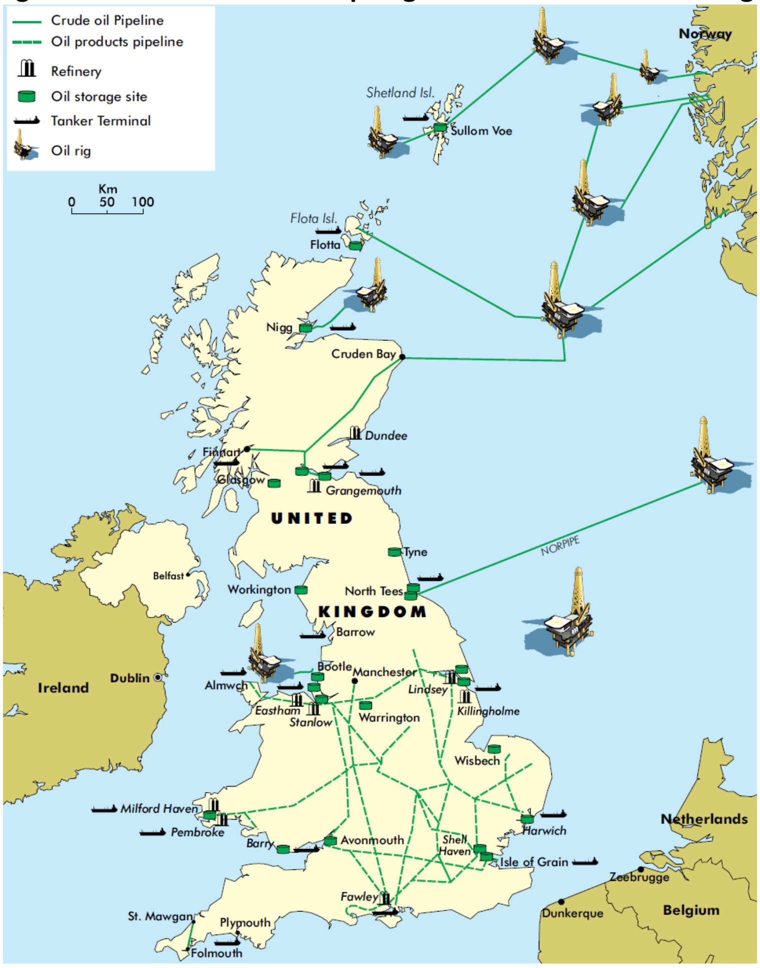
3-3 Case Studies in Developed Countries

This section presents examples that are useful in considering the advantage of partnerships with industry in building stockpiles. Specifically, it discusses the UK (private stockpiling only), Germany (agency stockpiling only), France (private and agency stockpiling), Japan (private stockpiling, government stockpiling, and third-party joint stockpiling), and Australia (which is gearing up for stockpile targets, though has yet to achieve the 90-day stockpiles recommended by the IEA).

3-3-1 United Kingdom

The UK is fully dependent on private stockpiling. All oil companies operating in the country, domestic and foreign, are privately owned. The Energy Act (instituted in 1976) and the Oil Stockpiling Order (issued in 2012) mandate them to maintain sufficient stockpiles; 67.5-day stockpiles for oil refiners and 58-day stockpiles for importers and traders with an annual handling of over 50,000 kilo tonnes, both based on the supply over the last 12 months. As there are no consolidated oil stockpiling facilities in the UK, all stockpiles are stored at private refineries or tank yards.

Figure 3-3. Locations of Stockpiling Facilities in the United Kingdom



Source: IEA (2014).

Of particular note is the use of international ticket stockpiling. Around 30 percent of the national stockpiling is held abroad as ticket stockpiling (see Table 3-1).

Table 3-1. Stocks Held by Product and Location

(Crude oil equivalent)

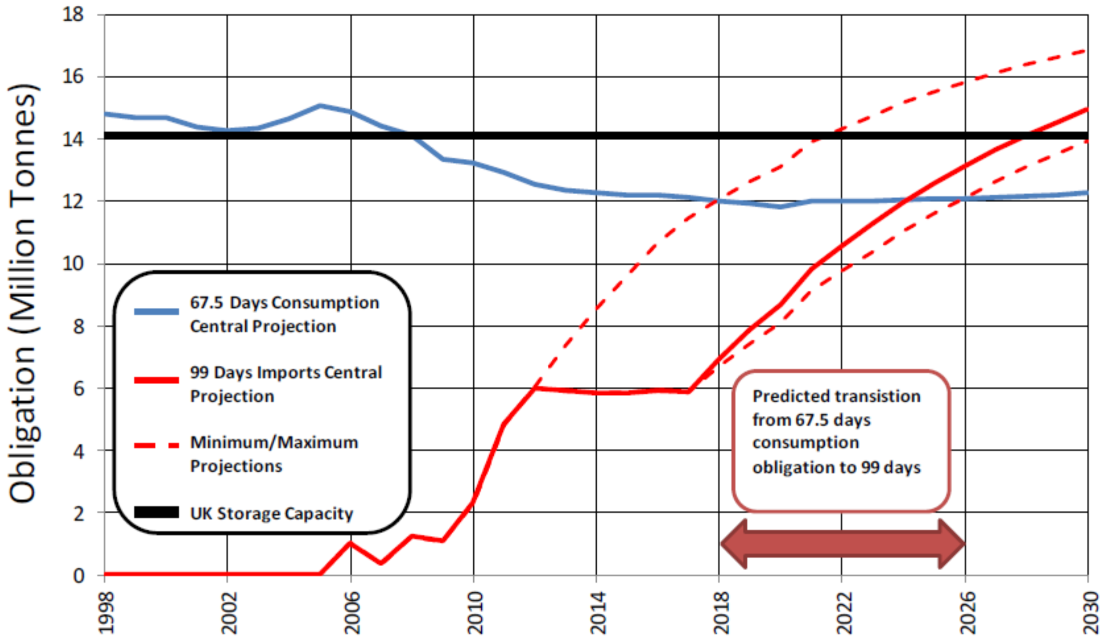
	Gasoline	Diesel/Gas Oil	Jet/Kerosene	Any Oil, Total	Total
Held abroad*	259 (26%)	639 (32%)	208 (26%)	2,570 (33%)	3,676 (32%)
Held in the United Kingdom	724 (74%)	1,346 (68%)	577 (74%)	5,177 (67%)	7,824 (68%)
Total	983	1,985	784	7,748	11,500

* Overseas ticket stockpiling.

Source: Department of Energy and Climate Change (2013).

There is no specific support provided for oil stockpiling in the UK. This is partly because the UK is capable of producing nearly 1 million b/d of oil (as of 2014), which results in low levels of stockpiling obligations, and overseas ticket stockpiling is not capped, which reduces the burden on private businesses.

Figure 3-4. The United Kingdom's Projected Oil Demand and Stockpiling Obligation



Source: Department of Energy and Climate Change (2013).

The recent decline in domestic oil production, however, is resulting in an increase in stockpiling obligations imposed on each oil company (see Figure 3-4) and the UK government is concerned about the relatively high rate of overseas ticket stockpiling of above 30 percent. Discussions are thus underway to establish agency stockpiling and cap overseas ticket stockpiling. The UK government published a report on the country's future stockpiling policy, which proposed an agency stockpiling system given the following facts (Department of Energy and Climate Change, 2013).

- Economies of scale can be expected for stockpiling.
- The amount of buffer stock can be minimised, compared to cases where each company holds stock to meet its stockpiling obligations.
- Funds for stockpiling and capital investment can be easily procured.
- With domestic demand remaining sluggish, it is difficult for private companies to

invest in the plant and equipment needed to meet stockpiling obligations.

- A further increase in overseas ticket stockpiling is not recommended in view of energy security.
- Determining the UK's stockpiling costs makes it easier to plan future capital investments and pass the costs on to end consumers.

3-3-2 Germany

In Germany, the Oil Stockpiling Law, which was instituted in 1978, provides the framework for the country's stockpiling system, Erdölbevorratungsverband (EBV), which was established in the same year according to the law and is the sole agency managing the country's stockpiles. The EBV has underground stockpiling facilities at four locations in the country in addition to tank storages on the ground at 130 locations. The stockpiles, which are about 90 days' worth of domestic consumption, consist of 15 million tons of crude oil and 9.5 million tons of petroleum products. Most crude oil is stored in salt cavern storage sites located in the northern part of the country and supplied through pipelines to refineries in times of emergency.

Figure 3-5. Locations of Stockpiling Facilities in Germany

Source: IEA (2014).

The EBV is funded by its member oil companies and importers, which each contribute €3.56 euros per tonne of oil they deal with (corresponding to 0.030 euro cents per litre of gasoline). The Oil Stockpiling Law mandates all refiners and oil importers to join the EBV.

The origin of German oil stockpiling dates back to the mid-1960s. As domestic oil demand kept increasing and the OECD recommended building stockpiles in 1962, the government imposed stockpile obligations in 1965 on domestic refiners and petroleum product importers. Following the first oil crisis, moreover, refiners were mandated to hold 90-day stockpiles and petroleum product importers 70-day stockpiles, in accordance with the International Energy Program agreement made in 1974 with the IEA.

While the German oil industry has been passive in building stockpiles, oil majors and independent oil companies operating in the country submitted a joint proposal to the government in 1975, recommending that oil stockpiling be managed by a public agency consisting of all domestic oil companies. Having learned lessons from the first oil crisis and in view of the establishment of the IEA, the German oil industry made an about-face in its stockpiling policy regarding how oil stockpiles should be built. The German government carefully examined the proposal, which led to the institution of the Oil Stockpiling Law and the establishment of the EBV in 1978.

There are several reasons why oil companies made the recommendation. The main reason is that consolidating domestic stockpiling capacity produces economies of scale and minimises burdens on the oil industry. At the same time, establishing a sole stockpiling agency and mandating all oil companies to join it provides competitive equality. Delegating stockpiling to an independent organisation, moreover, obviates the need for oil companies to put stockpiles on their balance sheets. At any rate, the key to success of the G-I relationship in Germany lies in the fact that the oil industry devised a constructive stockpiling system that was put into practice by the government.

3-3-3 France

While the UK is fully dependent on private stockpiling and Germany on agency stockpiling, France is positioned in between these two countries, using both options. Its private stockpiling system is based on the Oil Industry Law (Law 92-1443, instituted in 1992), which mandates French oil companies (refiners, importers, and distributors) to hold stockpiles equivalent to 29.5 per cent of the previous year's domestic consumption. Oil company percentages, however, are optional and can be either 44 percent or 10 percent, with the rest delegated to a stockpiling agency, called Société Anonyme de Gestion de Stocks de Sécurité (SAGESS). Oil companies that have refineries usually opt for 44 percent, while distributors dealing with significant amounts of low-cost gasoline choose 10 percent. The rest is taken care of by SAGESS.

SAGESS is a private stockpiling agency that was established in 1988 according to a French oil companies' initiative and with the support of the French government. National stockpiles amounted to 163 million barrels as of April 2013, about two-thirds (108 million barrels) of which were held by SAGESS. Unlike Germany's EBV, SAGESS leases French oil company storage facilities for stockpiling at 120 locations nationwide.

SAGESS is monitored by Comité Professionnel des Stocks Stratégiques Pétroliers (CPSSP), a government agency established in 1992. Oil companies belonging to SAGESS pay fees to CPSSP, which are then allocated to SAGESS for its operation. CPSSP functions as a mediator between SAGESS and oil companies to ensure payment to SAGESS (see Figure 3-6).

Figure 3-6. Financing of SAGESS Operations

Source: SAGESS website.

France has a long history of oil stockpiling. Its origins trace back to the Oil Import Law, which was instituted back in 1928, mandating all oil importers to hold emergency oil stockpiles. In 1951, refiners were also obliged to hold 10-day stockpiles, which were raised in 1958 and 1975, resulting in the current 90-day stockpiles. As France raised its stockpiles significantly before the first oil crisis when oil prices were still low, it had fewer cost problems in building stockpiles than other developed countries. Another factor that made it easier was the presence of the then national oil company, Total, which played a central role in the stockpiling initiative. Unlike in Germany, private oil companies were not exempted from stockpiling obligations even after the establishment of SAGESS, which may be due to 'dirigisme', the French government's powerful influence over the industry.

The oil industry's involvement in France's stockpiling development is certainly attributable to the traditional approaches taken to ensuring the oil supply and the government's powerful influence over the domestic industry, particularly over the then national oil company, Total, which is now a private company. As in the case in Germany, lessons learned from the first oil crisis and the IEA's subsequent initiative to build stockpiles also served as driving forces.

Figure 3-7. Locations of Stockpiling Facilities in France

Source: IEA (2014).

3-3-4 Japan

Japan provides a good example of government stockpiling combined with two other types of private stockpiling. As of November 2015, Japan held 49.3 million kilolitres of government stockpiles, 35.9 million kilolitres of private stockpiles, and 1.2 million kilolitres of third-party lease stockpiling, jointly held with Saudi Arabia and the UAE, totalling 86.4 million kilolitres (equivalent to 173-day stockpiles). Private stockpiles are stored in tanks owned by oil companies and importers, and government stockpiles are held at national storage stations at 10 locations nationwide and in tanks leased by private oil companies (see Figure 3-8). The Japanese government, moreover, has been building third-party joint stockpiling since 2009 in cooperation with Saudi Arabia and the UAE.

Figure 3-8. Oil Storage Bases in Japan

Source: International Energy Agency (2014).

As Japan became more dependent on oil for its energy supply in the 1960s, there was a growing awareness of the importance of oil stockpiling. While many European countries held 90-day stockpiles at the time, Japan's stockpiles stood at less than 60 days' worth of domestic consumption, with the supply of oil heavily dependent on imports. There was thus a pressing need to increase stockpiles, but the oil industry voiced concerns about the costs involved, which hampered the stockpiling initiative.

The situation, however, changed dramatically in the 1970s as resource nationalism gained momentum worldwide and Japan's economy was hit by two oil crises. In 1972, the 60-day Stockpiling Expansion Plan started under the supervision of the then Ministry of International Trade and Industry. The first oil crisis in 1973 was a major turning point for Japan's stockpiling development. The crisis caused panic throughout Japan, raising awareness of the vulnerability of the oil market to geopolitical factors and oil's extensive impact on the domestic economy. As a result, Japan's oil industry, which had been reluctant to increase stockpiles, had no choice but to acknowledge the importance of oil stockpiling. Under these circumstances, the Oil Stockpiling Act was instituted in 1975, which set the framework for national stockpiling policy, making private stockpiling mandatory. The two oil crises were severe enough to prompt the government to create a robust oil stockpiling system.

Obligations or recommendations imposed by international organisations also played a pivotal role in improving Japan's stockpiling system. In the wake of the first oil crisis, which dealt a severe blow to the world economy, 18 Western countries signed the International Energy Program in November 1974, established by the IEA under the OECD. The IEA, meanwhile, aimed to build stockpiles equivalent to 90 days' worth of net oil imports by 1980, requesting each member country to hold the same levels of stockpiles so that they could help each other in times of emergency. As a member of IEA, Japan, too, was obliged to hold 90-day stockpiles by 1980.

To build 90-day stockpiles, the following were implemented in order:

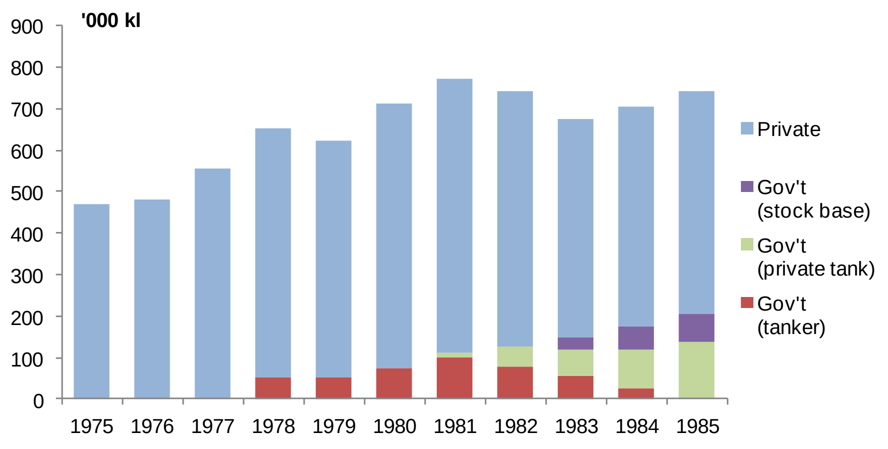
(1) Expansion of industry obligations

(2) Phased expansion of national stockpiles

(3) Relaxation of private stockpiling obligations

First, measures such as low-interest loans were adopted according to the Oil Stockpiling Act to construct storage facilities and procure oil for stockpiling purposes, thereby increasing industry obligation stockpiling. As a result, industry obligation stockpiling (including commercial stockpiling) increased by 5 days' worth of domestic consumption annually from 1975, showing an increase by as much as one-third in 1980 (see Figure 3-9).

Figure 3-9. Stockpile Increases in the 1970s and the 1980s



Source: IEEJ based on Ministry of Economy, Trade, and Industry website.

In 1978, the government concluded that it should build stockpiles on its own to supplement private stockpiling, as the world's oil demand was projected to increase and the 90-day stockpiling target was likely to be achieved. Specifically, Japan National Oil Corporation (currently reorganised as Japan, Oil, Gas, and Metals National Corporation) began to stockpile oil in September 1978 using redundant, privately owned oceangoing tankers as an emergency measure to increase government stockpiles. Subsequently, the government leased domestic oil company tankers for stockpiling purposes, which gradually gave way to stockpiling stations being developed in the country. Stockpiling in tankers, however, was abolished at the end of 1985 as the government had secured enough stockpiles. As national stockpiling stations expanded, the government relaxed stockpiling obligations in 1993 from 90 days to the current 70 days from the viewpoint of competitiveness among private oil companies.

As a new development in oil stockpiling, Japan started government stockpiling of oil products. It introduced 4-day stockpiling of diesel and kerosene as a part of its government stockpiling. This was due to the Great East Japan Earthquake in 2011, when several quake-hit areas experienced serious oil product shortages. Before the disaster, Japan's stockpiling was heavily weighted toward crude oil because it was assumed that a sudden disruption of crude oil supply due to geopolitical reasons in oil producing countries was the largest risk. Experience from the earthquake suggested that an oil supply disruption could happen due to domestic factors, and in such a case, the prompt supply of oil products would be critically important. The Japanese government therefore decided to maintain a certain volume of oil products and started government stockpiling of oil products.

3-3-6 Australia

Australia is a valuable example for ASEAN countries, as its refining capacity falls short of domestic demand, requiring it to import petroleum products, and it has no distribution infrastructure linking it to neighbouring countries, as a result of its geographical conditions.

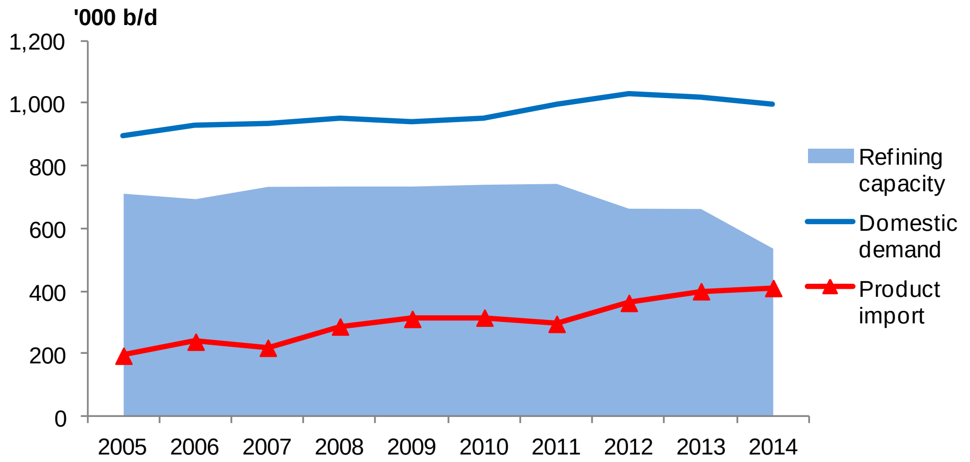
Figure 3-10 shows Australia's oil demand, refining capacity, and petroleum product imports. While oil majors have scaled down their refining capacities, domestic oil demand has remained relatively stable, resulting in an increase in petroleum product imports, which stood at 400,000 b/d in 2014, or about 40 percent of the domestic market.

Australia is an oil-producing country. Its production stood at 450,000 b/d in 2014, nearly 70 percent of which was produced in the Carnarvon Basin (located in the northwest region) and destined primarily for exports. The rest is produced in the Gippsland Basin (located in the southern region), most of which is processed at nearby refineries.

There are four refineries in Australia, each operated by BP, Caltex, ExxonMobil, and Vitol. The total refining capacity stands at about 442,000 b/d. In addition to domestic production, crude oil is sourced primarily from Malaysia, Indonesia, Nigeria, and the UAE. Since all the country's refineries were built 50–60 years ago and hence are less competitive than large-scale, modern refineries in the Asian region, many have been closed or have been sold. Shell closed down its Clyde Refinery (opened in 1928) in October 2012 and sold off its oil refining and distribution business (including the Geelong refinery and 870 filling stations) to Vitol in February 2014.

Caltex's Kurnell refinery, which started operating in 1956, was also closed down in October 2014 for conversion into a large-scale petroleum product terminal. BP followed suit, closing down its refinery in Bulwer Island in May 2015. As a result, the domestic market for petroleum products is growing; Singapore accounts for more than 50 percent of total imports, followed by Korea and Japan.

Figure 3-10. Australia's Oil Demand, Refining Capacity, and Petroleum Product Imports



Source: BP (2015); IEA Energy Balances of OECD Countries.

Figure 3-11. Oil Infrastructure in Australia

Note: Bulwer refinery and Clyde refinery in the map have been closed as of April 2016.

Source: International Energy Agency (2014).

Table 3-2. Australia's Refineries

('000 barrels per day)

	Capacity	Location	Status	Date
Caltex Lytton	109	Queensland	Operating	
BP Kwinana	138	Western Australia	Operating	
Geelong	120	Victoria	Sold by Shell to Vitol-led consortium	2014
ExxonMobil Altona	80	Victoria	Operating	

Source: IEEJ based on Energy Intelligence Group.

Australia is fully dependent on commercial stocks and has no national stockpiling system in place. Domestic commercial stockpiles had been enough to meet the IEA stockpiling standards, as Australia was a net oil exporting country until 2000 (imports, if any, were negligible). Domestic oil production, however, has been on the decline since around 2000, resulting in a gradual increase in imports. According to the IEA, Australia is the only IEA member country that is fully dependent on commercial stockpiling for its strategic stockpiles, with available commercial stockpiles of less than 90 days. The IEA is thus requesting Australia to immediately meet its strategic stockpiling obligations.

In the medium-to-long term, however, petroleum product imports are most likely to increase as domestic oil production declines and domestic demand continues to grow, and obsolete refineries discontinue operations, losing competitiveness against their advanced counterparts in Asia. Thus, discussions are underway to determine the ideal stockpiling system. A report entitled *National Energy Security Assessment (NESA) Identified Issues: Australia's International Energy Oil Obligation* was issued in July 2012 and presents and examines four options: government ticket stockpiling, government physical stockpiling, private ticket stockpiling, and private physical stockpiling (Hale and Twomay, 2012). It concludes that government ticket stockpiling is the most cost-effective, flexible, and secure option.

The need to improve the stockpiling system is being recognised to some extent in Australia. This may be due to the fact that refineries in Australia are being closed down and increasing private stockpiling is not a viable option. Government stockpiling is the most probable option, given that oil company involvement is costly and requires complex procedures, such as the development of legal systems.

Table 3-3. Options for Stockpiling in Australia

	Model 1	Model 2	Model 3	Model 4
Responsibility	Government	Government	Government and Industry	Industry
Stock type	Ticket only	Physical stock and tickets	Physical stock and ticket	Physical stock and ticket
Funding	General budget or levy	Probably levy	Budget or levy + industry pass through	Industry pass through
Improve domestic security	Poor - average	Good	Good	Good
Estimated capital required as of 2022 (AUD milions)	0	9,738	9,722	9,695
Per litre charge (AU cpl)	1.1	1.2 - 2.2	1.3 - 2.2	2.2 - 3.1
Flexibility	Good (but volume required)	Good	Good	Average
Complexity to implement	Good (not complex)	Average	Complex	very complex
Legislation required	Levy	Some	Lots	Lots

Source: Hale & Twomay (2012).

3-4 What is Needed for a Successful Government-Industry Relationship?

This section discusses what is needed to create a successful G-to-B relationship based on the examples presented above.

3-4-1 Legislative regulations

Developing domestic legal systems is essential in encouraging the oil industry to cooperate in building stockpiles. Every country discussed in this chapter, except for Australia, has its own oil stockpiling law. Oil stockpiling legislation is imperative for developing a comprehensive stockpiling system as well as in encouraging the oil industry's involvement. Accordingly, the objectives and procedures for domestic stockpiling and the sharing of responsibilities between governments and industry should be determined. While oil stockpiling can take a variety of forms, such as government, private, agency, and ticket stockpiling, as discussed previously, legal systems of some sort are key to define the role of each player. Such legal systems imposing obligations on the oil industry are only possible through close communication between governments and industry.

3-4-2 International agreements

International agreements, preferably binding agreements, are also key to encouraging the domestic oil industry to cooperate in building stockpiles. The developed countries addressed in this chapter are all IEA members, and the IEA's 90-day stockpiling obligations are a major driving force in engaging the oil industry in stockpiling development in each country. It goes without saying that lessons learned from the first oil crisis prompted the IEA to impose the obligations. In the meantime, OECD recommendations to build stockpiles, which started in the 1950s, contributed to gradually increasing stockpiles in the original member countries.

For European countries, the 90-day stockpiling obligations imposed by the European Union Minimum Stocks of Crude Oil and/or Petroleum Products Directive (issued in 2009) and its requirement that one-third of the existing stockpiles should consist of petroleum products (which can be consumed directly without being processed) drove them to build stockpiles. Both the IEA and the European Union impose the same stockpiling obligations on all their member counties without exemption, which helps them gain consensus from industry, as such obligations do not create competitive gaps among companies.

The ASEAN Petroleum Security Agreement (APSA), meanwhile, is expected to transform itself into a more practical framework, eventually imposing similar types of stockpiling obligations or other binding requirements on its member countries, which will drive them to cooperate in the initiative.

3-4-3 Significance of communication

Smooth communication between governments and industry is indispensable in creating a successful G-I relationship. Specifically, the two parties should foster a trusting relationship through opportunities such as regular and informal meetings. Such opportunities are also key to designing a system that enhances the incentives for industry.

In this respect, Finland's emergency response system may serve as a good example, as there is close communication between businesses and the government and its agencies. They have built solid, trusting relationships with each other. The National Emergency Supply Agency (NESA), a government agency responsible for emergency response, takes the lead in sharing information on emergency response between the Finnish government and businesses. Specifically, the Council for Security of Supply, a high-level government agency consisting of ministerial executives and the chief executive officers of major domestic companies, facilitates communication between the government and businesses for oil supply security. This council controls a working group consisting of NESA staff members and the emergency response managers of businesses. They hold meetings 4–6 times a year to discuss recent oil supply security situations and problems, along with possible countermeasures.[8]

Likewise, the Japanese government and industry jointly conduct an emergency drill every year in regret that the government and oil industry could not communicate smoothly with each

[8] For details, see the NESA website: http://www.nesa.fi/

other in the wake of the Great East Japan Earthquake of 2011. This includes cross-functional approaches involving the country's self-defence force.

While it may be difficult for ASEAN to directly establish similar response systems at this stage, the governments and businesses of the region should have more opportunities to exchange opinions on emergency response and, by extension, encourage industry involvement in stockpiling development.

3-4-4 Incentives for industry involvement

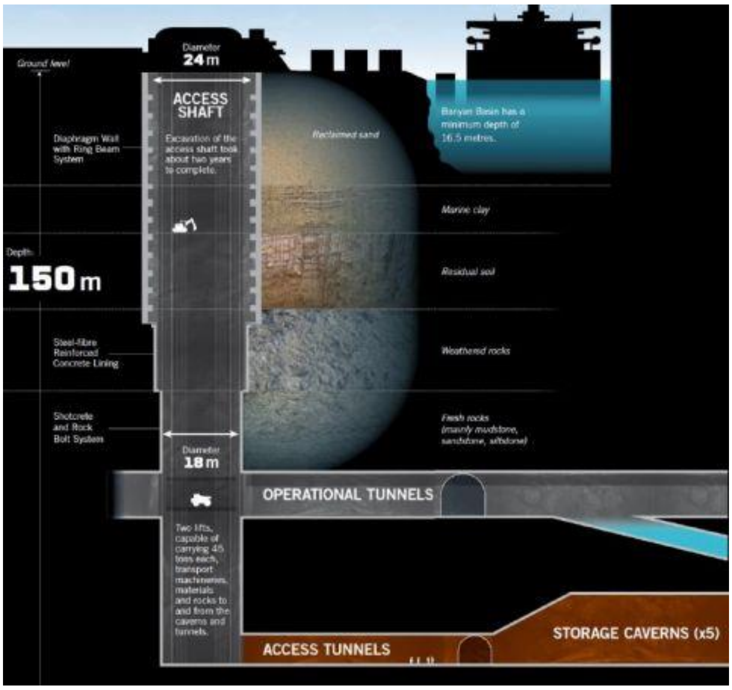
It is also important to provide incentives that encourage industry participation, particularly commercial advantages for oil companies. Such incentives make their involvement sustainable. To this end, it is essential that oil companies are involved in the planning stages to develop a system that is acceptable to them, not a malfunctioning system designed unilaterally by a government. It should be designed taking into account oil company opinions and should identify the opportunities that would generate profits for them. One possible option is to pursue economies of scale and allocate the resulting gains to oil companies. In particular, the costs of building new facilities can be compared with those of other options, with the resulting gains shared among the parties involved.

Although it is not oil stockpiling in a strict sense, the underground stockpiling system in Jurong Island, built by the JTC Corporation, provides a good example of the successful involvement of private companies. JTC Corporation, a Singaporean government agency established in 1968, has control over the development of infrastructure in Singapore, including Jurong Island, which is home to the heavy chemical industry. The construction of the storage facilities started in 2007 and was completed in July 2014, followed by the construction of 1.47 million kl underground rock caverns.

These underground rock caverns, which were built due to land constraints on Jurong Island, are designed to store oil deep underground in a solid stratum. They are the first of their kind built in Southeast Asia, saving 60 hectares of land on the island, according to JTC. They are located 130 metres below the ground and oil is stored in 8 kilometre-long tunnels. CNN estimated their construction cost at S$950 million.[9]

[9] CNN Travel, 25 May 2011. (http://4.bp.blogspot.com/-0LSRjqXNwtI/VBelOGFD1XI/AAAAAAAAZKs/GlbYl9Bv3LM/s1600/The%2BNew%2BPaper%2Bgraphics%2B-Jurong%2BRock%2BCaverns.jpg)

Figure 3-12. Jurong Rock Cavern



Source: JTC Corporation website.

The operation of the facilities has been delegated to Vopak,[10] a Dutch company, as a joint venture in which Vopak has a 40 percent stake through a 15-year contract. This JTC project is a good example of oil storage facilities that have been built primarily for private company use, but that also contribute greatly to the inventory of the country. While robust demand for oil storage facilities in Singapore (the hub of the Asian petrochemical market) is a prerequisite for this project, its business model will be a good reference in building stockpiling facilities in ASEAN as the operation of storage facilities, including those designed primarily for commercial use, can be delegated to private companies while ensuring stable revenues and recovery of construction costs.

3-4-5 Government support for private stockpiling

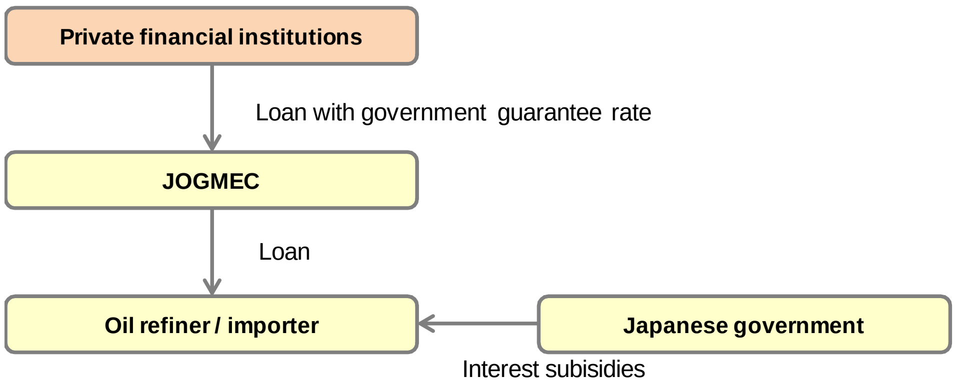
Direct and indirect government support for the oil industry will greatly promote cooperation in stockpiling development. One such example is the Japanese government's financial support for private oil companies, which helps them build private stockpiles. Government-affiliated financial institutions provide low-interest loans for the construction, operation, and maintenance of stockpile stations, while supporting oil companies to increase and hold stockpiles by providing funds and interest subsidies.

For example, the Development Bank of Japan finances up to 50 percent of the construction, operation, and maintenance costs of tanks at low interest rates. As for facilities in Okinawa

[10] Vopak press release, 15 January 2014. (https://www.vopak.com/newsroom/news/jtc-corporation-awards-contract-vopak-terminals-singapore-and-partners-operate-jurong)

Prefecture, the Okinawa Development Finance Corporation finances up to 70 percent of the costs, also at low interest rates. The government, meanwhile, subsidises interest above 5.5 percent in addition to a system launched in 2002 to subsidise interest on loans for additional stockpiling procurement imposed by the government on private oil companies. This system is provided by the government-affiliated Japan Oil, Gas and Metals National Corporation. While the Oil Stockpiling Act mandates 70-day stockpiles on oil companies, up to 80 percent of the costs required for procuring 25-day stockpiles are financed based on the assumption that 45-day stockpiles would be just enough for regular operations, with interest on the loans subsidised by the government. Thus, the government financial support consists of fund loans from government-affiliated financial institutions and interest subsidies (see Figure 3-13).

Figure 3-13. Structure of the Japanese Government's Financial Support



JOGMEC = Japan Oil, Gas and Metals National Corporation.
Source: Ministry of Economy, Trade and Industry website.

The Swiss government also subsidises private stockpiling. With no government stockpiles available, Switzerland is fully dependent on stockpiling by private oil companies (which started in 1938, long before the establishment of the IEA). Specifically, the government mandates 4.5-month stockpiles. Stockpiles for gasoline and heating oil are allocated according to oil company imports in the last 3 years and those of gas oil and jet fuel are based on their market shares. Oil importers in Switzerland must be members of CARBURA, which issues import permits, monitors domestic stockpiles, and manages guarantee funds. CARBURA is authorised to keep track of stockpiles on behalf of government agencies and punish those who fail to meet their obligations.

With the private stockpiling system in place, the Swiss government requires the guarantee funds, which are collected from oil importers, to bear the mandatory stockpiling costs on the grounds that they should not be passed on to private companies; importers holding stockpiles are onsubsidised with the funds. The subsidies amount to as much as €50 million a year. As the funds are collected from all oil importers, they can be secured and allocated without undermining each importer's competitiveness, in contrast with the UK, where such taxation and allocation are non-existent.

3-5 Conclusion

As discussed, cooperation between governments and the oil industry is key to building stockpiles. At the same time, close communication among the parties involved should be maintained to solicit cooperation from the oil industry, while stockpiling systems should be introduced in a way that minimises impacts on business and competitive conditions. Overseas case studies show that the most practical way to build stockpiles is to first impose stockpiling obligations on the oil industry and then transfer them to governments as national stockpiles build up.

Successful G-I relationships facilitate not only stockpiling development but also smooth day-to-day operations and release actions in cases of emergency. Building such a relationship should be regarded as a cornerstone for effective stockpiling development and operation.

CHAPTER 4

Future Actions

As a conclusion of the study, this chapter presents future actions to be taken by ASEAN countries to proceed with stockpiling development.[11] Such actions can be categorised into domestic actions and international actions. This chapter explores the two kinds of actions followed by a model road map for the future actions.

4-1 Domestic Response for Improvement of Oil Stockpiling

The following five steps should be taken for the future improvement of oil stockpiling.

[1] Providing principles and legislation

[2] Developing an accurate and timely data collection system

[3] Founding a specialised organisation

[4] Financing

[5] Selecting an oil stockpiling option

[6] Securing sites and carrying out construction and operations

4-1-1 Providing principles and legislation

The top priority is the determination of a government policy for the improvement of oil stockpiling and the development of the legal system required for the improvement. The investment of large funds and human resources is necessary for the development oil stockpiling. For this reason, basic policies for developing national oil stockpiling must be determined. These include whether oil stockpiling should be improved on a governmental basis or private sector basis at first, whether oil should be stored in the form of crude oil or products, and the degree to which funds and aid should be accepted from foreign corporations and countries. Next, it is necessary to develop the legal system required for mobilising various domestic resources. A legal framework and its rationale must be prepared based on the requirements of oil stockpiling development, such as the formulation of a detailed plan and securement of a budget, and the responsibilities to be taken by the government organs and oil companies.

[11] As mentioned in the Foreword and Chapter 1, the particular geographical focus of this report is on ASEAN. Descriptions in this chapter therefore assume future actions by ASEAN countries.

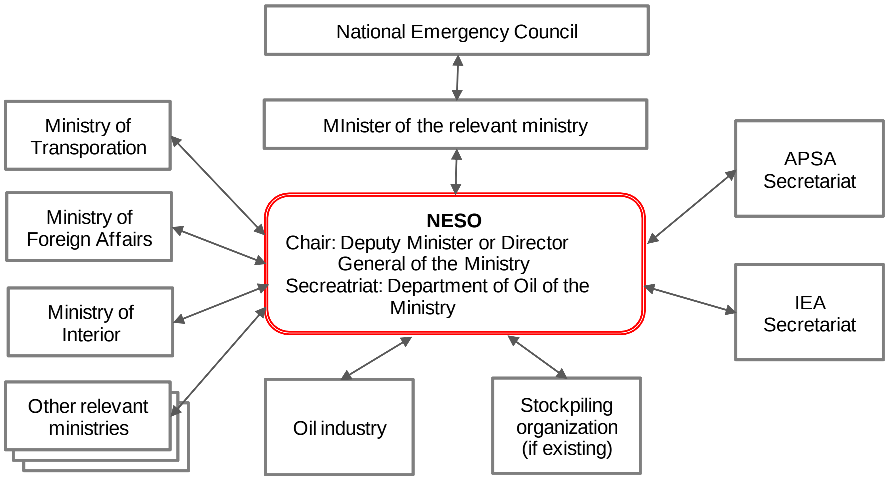
4-1-2 Developing an accurate and timely data collection system

Accurate and timely data on demand, supply, and inventory is important for appropriate policy decisions in every aspect of energy policy. This is also the case for oil stockpiling development. In setting targets for stockpiling volumes, forecasts of the future oil demand and supply balance are required. Needless to say, accurate statistical data are needed to prepare such forecasts. Without an understanding of the kind of oil and the quantity of oil that is domestically consumed, a government cannot effectively determine its oil stockpiling targets. Also, recent trends and projections for oil imports are an important benchmark of the extent to which a country is vulnerable to external oil supply disruptions, and can be used in determining the grade of oil that needs to be stockpiled most urgently. In cases of emergency, accurate and timely statistical data are critical in releasing and allocating a limited amount of oil to the most needy users. Developing such a statistical data collection system is always a challenging task, but it is a highly important condition for developing an effective oil stockpiling system.

4-1-3 Founding a specialised organisation

The next step is establishing an organisation for promoting oil stockpiling based on the provisions in the legal system. In light of its importance in energy security, the organisation in charge of oil stockpiling should preferably be independent. Among the IEA member countries, the National Emergency Strategy Organisation (NESO) exists to control overall emergency response actions and coordinate domestic oil industries and the IEA (see Figure 4-1). Countries planning to newly promote oil stockpiling should establish an organisation similar to NESO to allow smooth coordination between the government parties concerned and industrial circles. Also, it is necessary to clarify who is responsible for the development of domestic oil stockpiling and establish a professional organisation in charge of oil stockpiling to accumulate expertise. When this is done, it is imperative to arrange a sufficient number of full-time personnel.

Figure 4-1. Model Case of NESO



Source: Elliott (2012), modified by the IEEJ.

4-1-4 Financing

Next, funds for the development of oil stockpiling must be secured. A supportive financial base is imperative to allow the practical functioning of the legal system and organisation. To secure such funds, it is necessary to identify a procurement source, and decide whether they should be allocated out of the government budgets or loaned from commercial financial institutions or private corporations. Since two types of funds have to be secured for the construction of stockpiling facilities and operations after completion, the respective fund sources have to be determined. Table 4-1 lists the fund procurement sources in IEA member countries. Looking at the examples, the majority of the countries procure the expenses required for initial improvement of oil stockpiling from government budgets or government-guaranteed financial support. On the other hand, once the oil stockpiling facilities have been constructed, operating expenses are procured from government budgets in half of the countries and by imposing taxes on the industry, such as import taxes, in the remaining half. The method of procuring the funds depends on the particular circumstances in each country, but it is important to create a mechanism that allows for constant and stable securement of the funds.

Table 4-1. Financing Sources for Stockpiling

	Initial set-up costs			Running costs		
	Government budget	Government-backed loan	Bank loans/ bonds	Government budget	Levy on industry	Tax
Austria		X			X	
Belgium			X		X	
Czech Republic	X			X		
Denmark*			X			
Estonia	X				X	
Finland	X					X
France			X		X	
Germany		X			X	
Hungary		X			X	
Ireland			X		X	
Japan	X			X		
Korea	X			X		
Netherlands**		X				X
New Zealand***				X		
Poland	X			X		
Portugal			X		X	
Slovak Republic	X			X		
Spain			X		X	
United States	X			X		

* In Denmark running costs are covered by the financial surplus the Danish stockholding agency built up in the early 1990s in the wake of falling demand and rising indigenous output, together with the amortisation of storage facilities.
** In the Netherlands running costs are covered by a levy on final consumers.
*** New Zealand has not built up a physical reserve for emergencies. The difference between operating industry stocks and the IEA obligation is entirely covered by stockholding tickets. Therefore, there have been no set-up costs.

Source: IEA, Energy Supply Security.

4-1-5 Selecting an oil stockpiling option

The fourth process is the selection of an oil stockpiling option. As described in Chapter 2, although there are four traditional types of oil storage base, it may be preferable for ASEAN countries to begin with a lower-cost option. There are many restrictive factors to promoting oil stockpiling, which differ greatly among countries. These may be geographic conditions, economic efficiency problems, differences in technological capabilities, lack of acceptance from local residents regarding planned construction sites, or depending on the case, required compensation for agriculture- or fishery-related losses. Under such restrictive factors, the best possible oil stockpiling option for each country should take into account the highest-priority factors.

It is also important to conduct a risk assessment at this stage. Identifying the most likely risks, or determining the risks that will have the biggest impact, is necessary for designing the oil stockpiling system in an optimal manner. In particular, assuming a shutdown of a country's largest oil supply infrastructures, such its refineries, receiving terminals, or pipelines, is a useful method to examining the potential impact to a country's oil supply chain.

Among those options, ticket stockpiling is the easiest option to start the development of stockpiling efforts. Ticket stockpiling is an established practice in Europe, and in the Asia-Pacific region, Australia and New Zealand have in fact adopted this option after through examinations of the various stockpiling options. Tickets may be issued by Japan or Korea, which have large storage capacities and surplus stockpiling volumes, or Singapore or Thailand, both of which have large refining capacities and large oil product storage capacities. Because oil demand in ASEAN is highly likely to continue to grow, construction of a permanent stockpiling facility should be pursued in the long run and thus ticket stockpiling should be treated as a temporary measure.

Besides ticket stockpiling, upgrading commercial inventory to oil stockpiling is also a relatively easy option. This option, described in Section 2-2, obligates the currently operating domestic oil companies to hold part of their commercial stockpiles as emergency oil stockpiles. It prompts companies to engage in oil stockpiling by specifying the number of days of oil and the concrete volume of oil according to sales volume that they must stockpile. In doing so, it is important to set the goal at a level that as far as possible does not place excessive burden on their business. In this sense, close communication with oil companies is necessary, even before the introduction of the oil stockpiling system.

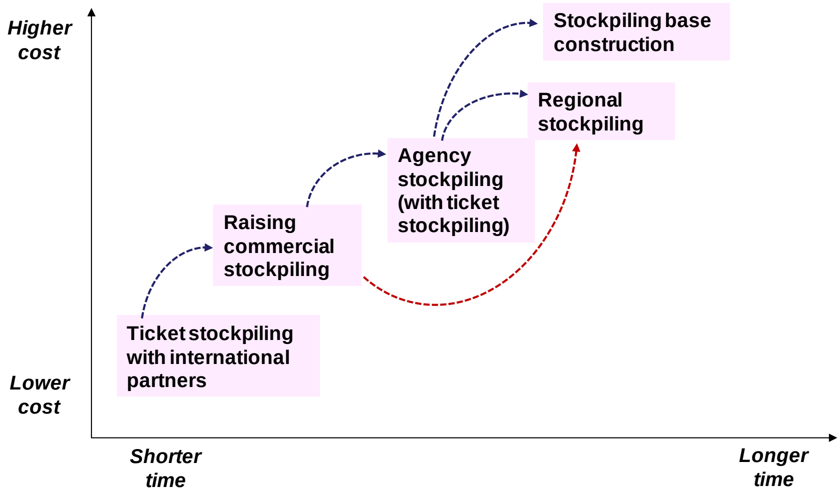
When using commercial stockpiles as emergency oil stockpiling, the target volumes and stockpiling days will increase as the storage capacity goes up on the part of the oil companies. Oil stockpiling development can proceed more smoothly if there is financial support by the government for the improvement and operation of oil stockpiling, as has been observed in Japan or Switzerland. Depending on the case, the implementation of ticket stockpiling with overseas oil companies may be worth considering.

The next possible short-term option is the introduction of agency stockpiling. As explained previously, the greatest benefit of agency stockpiling is that it makes use of economies of scale by establishing one leading body to hold and operate the oil stockpiling. In some ASEAN countries, medium and small-sized import business operators are incapable of single-handedly constructing the necessary facilities for oil stockpiling. The agency stockpiling system would be a significant, viable option for promoting oil stockpiling in such cases. Agency stockpiling is an effective option for facilitating investments in stockpiling facilities. It separates the stockpiling elements from a competitive environment and provides a medium to long-term solution by creating a central organisation specialised in stockpiling. What is important is the securement of funds. For this, the simplest method is to collect a membership fee from domestic oil companies, as is the case in Germany and France.

In ASEAN, regional stockpiling may be the next step. As discussed in previous sections, ASEAN has many good reasons to explore the possibility of regional stockpiling. Combination with international ticket stockpiling, where smaller countries purchase tickets from countries with large storage capacities, may be a relatively easy arrangement.

While developing such short-term options, the construction of an oil storage base or bases should be carried out in the medium and long term. There are four types of oil storage base, as described in Section 2-1, and the best possible type should be selected in line with the peculiar circumstances in each country. However, this is just a medium- to long-term approach. As observed in the cases in Europe and Oceania, emphasis should be initially placed on an approach centring on the improvement of oil stockpiling through private stockpiling, ticket stockpiling, or agency stockpiling.

Figure 4-2. Stockpiling Options for ASEAN



Source: Institute of Energy Economics, Japan.

In considering the oil stockpiling improvement options, an important point is also whether the oil should be stored in the form of crude oil or petroleum products. A merit of oil stockpiling in the form of crude oil is the low cost. This is simply because crude oil is less expensive than petroleum products, resulting in lower initial oil stockpiling expenses. Other factors are that different types of crude oil may be stored mixed together, and the quality does not deteriorate like it does for petroleum products, even after long-term stockpiling, so there is no need to replace the inventory regularly. Furthermore, if stored in the form of crude oil, it is also possible to refine products to a certain extent by adjusting the refining process in cases of emergency.

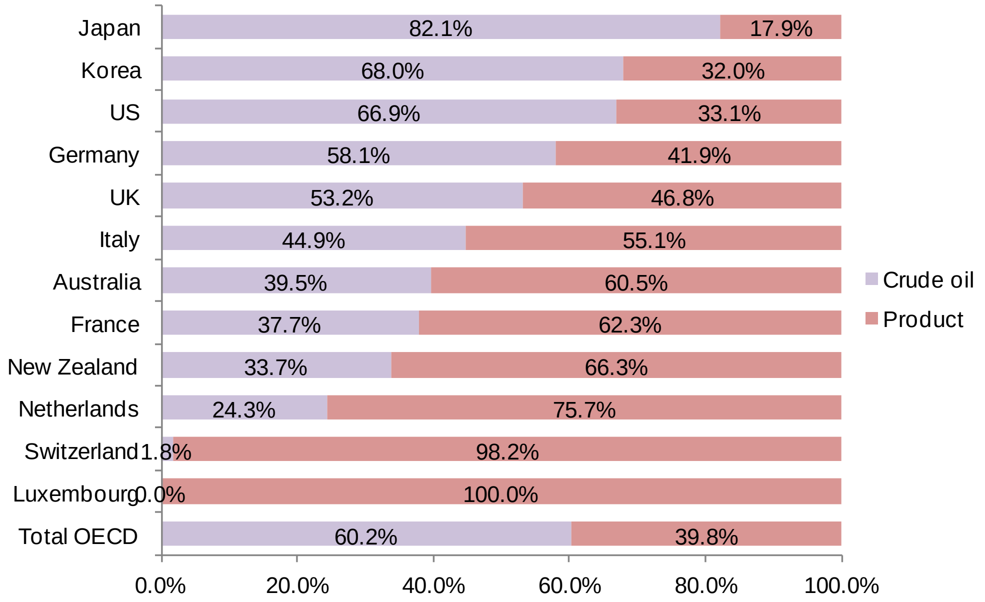
The merits of oil stockpiling in the form of petroleum products include that the necessary products can be supplied in a timely manner to sites that require the products in times of emergency. Except for some uses for power generation, crude oil cannot be consumed directly.

As such, in cases where there are no oil refineries near to locations that need petroleum products, or in cases where an oil refinery is located far away, oil stockpiling in the form of petroleum products is more practical. Furthermore, the oil supply is not always disrupted at the crude oil phase. If it is disrupted due to trouble at oil refineries, the effect of the oil supply disruption can be minimised by storing the petroleum products in advance. However, a problem for storing the petroleum products is the cost. In the case of kerosene or diesel oil, in particular, it is necessary to replace inventory every few years in order to avoid quality deterioration.

The stockpiling ratio of crude oil to petroleum products varies among IEA member countries (Figure 4-3). For domestically stored inventory, Japan has the highest stockpiling ratio of crude oil, at 82.1 percent as of 2014. This is because national oil stockpiling in Japan is mostly in the form of crude oil. The US and Korea also have a high stockpiling ratio of crude oil. This is because, as with Japan, oil stockpiling is mainly implemented on a national basis and crude oil is collectively stored in large-scale national stockpiling facilities, so the crude oil can be refined quickly, even in an emergency, as there is sufficient domestic refining capacity to satisfy domestic demand. For this reason, under such conditions, it would be economically preferable for ASEAN countries to have stockpiles in the form of crude oil.

In Europe, on the other hand, more oil is stored in the form of petroleum products. This is partly due to European Union regulations, which require at least one-third of oil stockpiling to be in the form of petroleum products. Luxemburg stores all its oil in the form of petroleum products. This is because there are no oil refineries in the country. The Netherlands has many domestic oil refineries, but Rotterdam is an oil trading hub in the European market with many domestic product stockpiling facilities, hence the country’s high stockpiling ratio of petroleum products.

Figure 4-3. Share of Crude Oil and Oil Products (as of 2014)



Source: IEA, Oil Market Report, June 2015.

Upgrading the commercial inventory, by obligating a part of the commercial stockpile to be used for oil stockpiling, can be a viable option for ASEAN countries to build an inventory of petroleum products, particularly diesel oil. As domestic refining capacities are developed, oil stockpiling can shift from products to crude, which can be stored at low costs.

In selecting the oil stockpiling option, countries should undergo a comprehensive cost-benefit analysis. As described in Chapter 2, many countries have already made cost-benefit analyses of the individual oil stockpiling improvement options. Oil stockpiling improvement expenses vary greatly depending on the individual factors in each country, but such analysis can be implemented in a relatively easy manner based on already established international methods. This analysis is important as a reference for making a rational final decision.

4-1-6 Construction and operation of an oil storage base

The final process is securing a site and the construction and operation of the oil stockpiling base. Finding and acquiring an appropriate site for stockpiling is always a challenging task. Preferably, the location should be geographically close to the demand centre and linked to existing oil supply infrastructure by pipelines or other readily available transpiration means. Environmental and ecological issues must be thoroughly considered, and most importantly, public acceptance must be gained from the neighbouring local communities. The government may need to play an important role in finding the location and coordinating with the relevant ministries and communities to carry out the construction.

Considering the security implications of the oil stockpiling base, it is preferable to make maximum use of domestic corporations in constructing the oil storage base. Depending on the type of oil stockpiling base, assistance by foreign corporations may be needed to some extent, requiring preparation of an engineering contract to that end. In such cases, an important requirement is to select business operators depending on the extent that the technologies will be transferred from the participating foreign corporations to the host country. Preferably, the base should be mainly operated by the aforementioned specialised organisation (corresponding to NESO). As a transitional measure, however, an option is to entrust the operation of the base to the domestic oil industry.

4-2 International Response Required for the Improvement of Oil Stockpiling

4-2-1 Regional cooperation

While domestic approaches should be encouraged, it is also important to make use of international resources as much as possible. One way is through the regional approach. ASEAN countries have already agreed to a regional framework, APSA, and operationalisation the framework is imperative. APSA is a framework for transferring stockpiled oil during oil supply disruptions. An emergency interchange framework has been also created, modelled after the Coordinated Emergency Response Mechanism of the IEA. However, there have been no cases of actual emergency interchange so far and its operationalisation is an urgent issue. A task force team formed by ERIA in cooperation with ASEAN countries is currently studying this issue. Some of the problems of the present APSA have been identified: there is only a low volume of interchangeable stockpiled oil in the entire region; the requirements for invoking emergency interchange are strict (30-day continuation of a 10 percent supply reduction); an interchange is implemented only in a voluntary and commercial manner; and there is no permanent secretariat. These issues should be assessed for achieving a more effective framework.

Regional stockpiling is one of the regional cooperation items to be considered. While agency stockpiling allows benefits from economies of scale, some ASEAN countries cannot make full use of economies of scale single-handedly due to low domestic demand. Accordingly, international regional stockpiling is worthy of consideration. The specific procedures are as follows:

(1) Agree to an international framework for promoting regional stockpiling

(2) Agree to fund the arrangements for establishing regional stockpiling

(3) Establish a permanent stockpiling supervisory organisation

(4) Construct a base or specify particular existing facilities as a regional stockpiling base

For Step (1), it is appropriate to include such an article in APSA. If the procedure takes time, however, it might be conceivable to conclude an international agreement separately. Step (2) should also be discussed together with the conclusion of such an international framework. An objective sharing ratio should be determined, such as setting a share of expenses according to the oil consumption and oil import volume in each country. For Step (3), the APSA permanent secretariat currently being discussed should be the relevant organisation. Specifically, it will be rational to expand the functions of the ASEAN Centre for Energy, which regulates energy cooperation in the ASEAN region, or those of the ASEAN Council of Petroleum, a body of national oil companies in ASEAN countries. Concerning Step (4), it is of course ideal to install a permanent storage base in the ASEAN region, but it will be difficult to implement in the short run due to the problem of expense. From the viewpoint of regional balance, the most practical idea may be to set up regional stockpiling facilities in the existing facilities in Singapore, as the country is a hub for the oil market in Asia. Alternatively, the facilities may be based in Thailand, where there are concentrations of oil refineries and stockpiling facilities are relatively large. In the long run, it may be an option to construct oil stockpiling facilities in a future development area, such as Dawei in Myanmar, to ensure regional stockpiling.

One issue in promoting regional stockpiling is that some countries are averse to stockpiling their oil in another country's territory from the viewpoint of security. As there is a high demand for stockpiling facilities in Singapore, borrowing stockpiling facilities there for regional stockpiling may require a large budget. When implementing regional stockpiling, it more effective to stockpile in the form of petroleum products. In cases where the product standards differ among countries, however, it is also necessary to consider product or stockpiling styles that minimise such issues.

Unlike European countries, ASEAN countries are separated geographically by sea, they are at different phases of national development, have different political systems, and have differing degrees of development of their domestic law systems. As such, they differ greatly from each other and energy issues are often treated in a politicised manner. Accordingly, it is true that their regional cooperation has distinct difficulties in comparison to Europe[12]. However, the countries have common oil security problems, such as the increasing demand for oil imports and the volatile international oil market. ASEAN countries should work together to overcome these problems and engage in energy cooperation for deeper regional economic integration and cooperation.

[12] Tom Cutler, "The Architecture of Asian Energy Security," in Mikkal E. Herberg, Roy Kamphausen, Tsutomu Toichi and Tom Cutler, *Adapting to a New Energy Era: Maximizing Potential Benefits for the Asia-Pacific* (Washington DC: National Bureau of Asian Research, 2014)

4-2-2 Bilateral cooperation

For the improvement of oil stockpiling, multilateral approaches are the most desirable when taking in to account factors such as the commonality of oil security problems among countries, the the internationally integrated oil market, advantages of economies of scale, and on-going market integration in the ASEAN region. For problems peculiar to each country, however, bilateral cooperation may provide more flexible, tailor-made solutions.

Bilateral cooperation is more likely to be realised between ASEAN and non-ASEAN member countries than between ASEAN countries. Detailed cooperation items are not mentioned here because they were summarised in last year's report (ERIA, 2015), but the following items are conceivable with respect to the particular problems in each country, from the viewpoint of order-made cooperation items.

- Support for the development of laws related to oil stockpiling
- Form and functions of the organisation for regulating oil stockpiling and securement of operating expenses
- Technological support for construction and operation of the oil storage base
- Ticket stockpiling with ASEAN countries by making use of surplus inventory
- A preferential product interchange agreement in case of an emergency by making use of surplus refining capacity
- Provision of an opportunity for third-party stockpiling by providing domestic surplus tanks and provision of dynamic stockpiling thereof

Some ASEAN countries do not have a clear reference point of how to initiate their stockpiling development. Capacity building and training for stockpiling policy, or in some cases technology transfer provided by IEA member countries in East Asia, will facilitate the efforts for stockpiling development by ASEAN countries. One such example is the agreement between Japan and Cambodia made in November 2015. The Japan Oil, Gas, and Metals National Corporation (JOGMEC), a Japanese state-owned organisation, supported the Cambodian government to draft a road map for stockpiling development based on the agreement.[13]

4-2-3 Road map

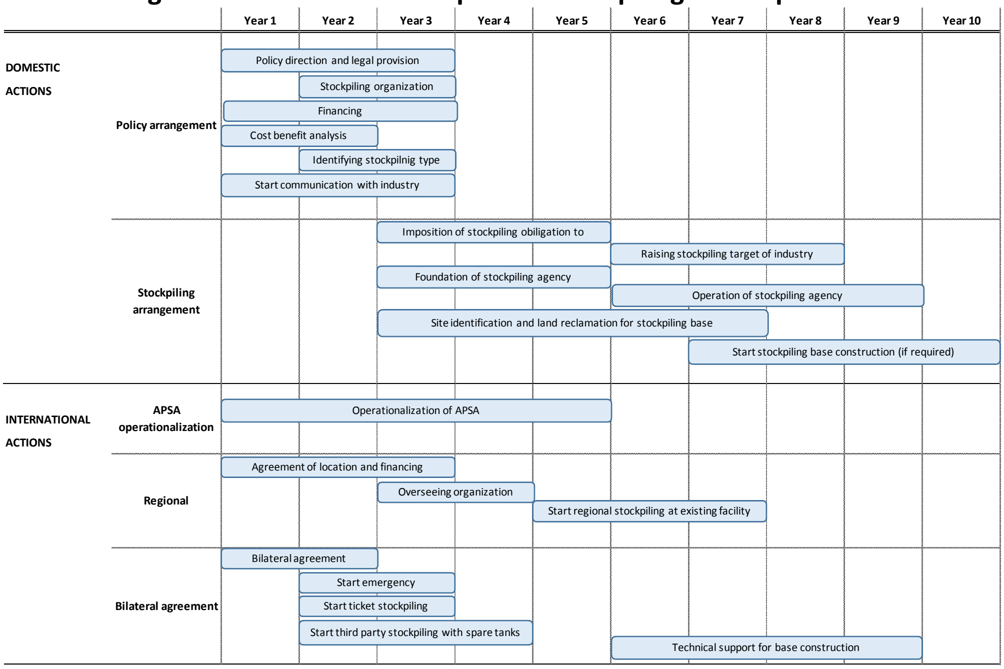
Figure 4-4 is a simple road map showing the previously described responses. The specific number of years is only a guide because the time required for realisation differs from one country to another. Since the details and order of options to be taken also differ depending on

[13] JOGMEC website (http://www.jogmec.go.jp/news/release/news_06_000124.html)

the country, this road map is treated only as a model.

It is never easy to improve oil stockpiling. With increased uncertainty of current international oil demand and supply, and greater dependence on oil imports in the ASEAN region, however, its importance has been increasing day by day. To protect domestic economies and people's lives from unexpected supply disruptions, oil stockpiling has to be improved step by step, making progress where we can.

Figure 4-4. Model Road Map of Oil Stockpiling Developments in ASEAN



Source: Institute of Energy Economics, Japan.

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