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The Strategic and Economic Value of Joint Oil Stockpiling Arrangements for Middle East Exporters and ASEAN Importers

Edited by

Economic Research Institute for ASEAN and East Asia

The Strategic and Economic Value of Joint Oil Stockpiling Arrangements for Middle East Exporters and ASEAN Importers

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Foreword

Oil supply security has received renewed attention in 2022 as geopolitical risks worsen. The Russian Federation's invasion of Ukraine in February shook the core of energy security in Europe and beyond. Unfortunately, the world is full of energy supply risks that are likely to remain for decades. In the sphere of oil supply security, stockpiling is the last resort to ensure supply.

Whilst International Energy Agency (IEA) member countries stockpile at least 90 days of net imports, Association of Southeast Asian Nations (ASEAN) countries have inadequate stocks. With the inevitable rise of oil import dependency, ASEAN countries will be more exposed to oil supply insecurity. The study justifies and promotes oil stockpiling in ASEAN countries.

I hope the report will encourage policy discussions in ASEAN Member States to expand oil stockpiling and include international schemes such as joint oil stockpiling with Middle East crude oil exporters.

Professor Hidetoshi Nishimura
President
Economic Research Institute for ASEAN and East Asia

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List of Abbreviations and Acronyms

APS	Announced Pledges Scenario
ASEAN	Association of Southeast Asian Nations
BAU	business as usual
bbl	barrel (159 litres)
CAPEX	capital expenditure
EIA	Energy Information Administration
ERIA	Economic Research Institute for ASEAN and East Asia
IEA	International Energy Agency
IEEJ	Institute of Energy Economics, Japan
GDP	gross domestic product
KAPSARC	King Abdullah Petroleum Studies and Research Center
mb/d	million barrels per day
SPR	strategic petroleum reserves
US	United States

Executive Summary

The study justifies and promotes oil stockpiling in Association of Southeast Asian Nations (ASEAN) countries and explores the possibility of joint stockpiling with Middle East crude oil exporters. Despite ASEAN countries' attempts to decarbonise energy consumption, oil demand in ASEAN will increase and import dependency rise. Considering oil supply risks, oil stockpiling will continue to be needed to tackle supply disruption. ASEAN countries have 20–50 days of oil stocks because of national initiatives, whilst joint oil stockpiling with Middle East crude oil exporters and/or ticket stockpiling with other importing countries offer cheaper options.

The benefit of oil stockpiling exceeds the cost in Indonesia, the Philippines, and Viet Nam. Including joint and ticket stockpiling will reduce stockpiling cost significantly. Joint oil stockpiling with Middle East crude oil exporters has strategic and economic value and creates a win–win situation. ASEAN importers could begin discussions with Middle East exporters; evaluate the advantage of joint stockpiling; and study the feasibility of potential sites, quantities, entities, legal frameworks, and emergency response schemes.

Introduction

With robust economic growth and motorisation, the Association of Southeast Asian Nations (ASEAN) is emerging rapidly as an oil demand centre. Despite decarbonisation efforts, ASEAN oil demand is growing steadily. How it will be met raises a question over oil supply security. Regional crude oil production is in decline. Whether refinery capacity will be added on time to meet product demand is uncertain. Concern over oil supply security will become more serious as import dependency rises.

Countries employ many countermeasures against oil supply insecurity, targeting more supply, less demand, and better facility and transport security. These countermeasures are important and should be pursued, and oil stockpiling is a last resort to secure supply against disruption. The study focuses on oil stockpiling because it is not developed adequately amidst rising import dependency.

Chapter 1 outlines future oil demand and supply in ASEAN, summarises supply risks, and covers the status of oil stockpiling. Taking Indonesia, the Philippines, and Viet Nam as examples, chapter 2 analyses the costs and benefits of oil stockpiling based on scenarios of stockpiling development options and supply disruptions. Chapter 3 summarises the discussion and presents policy recommendations.

Chapter 1

Rising Oil Import Dependency and Oil Stockpiling in ASEAN

The chapter sets the scene for the study in terms of demand and supply outlooks in ASEAN and the oil stockpiling situation. Referring to the Institute of Energy Economics, Japan's (IEEJ, 2022) *Energy Outlook 2022* and the International Energy Agency's (IEA, 2021a) *World Energy Outlook 2021*, we argue that, despite the decarbonisation trend, robust oil demand and declining regional crude oil production will inevitably result in rising oil import dependency in ASEAN. Most of the demand growth will be met by the Middle East. Major supply risks to be covered in this study are supply disruption in the Middle East, accident and blockage of sea transport choke points, and natural disasters in importing countries. The chapter also covers oil stockpiling in ASEAN countries, which is generally inadequate.

1. Rising Oil Import Dependency

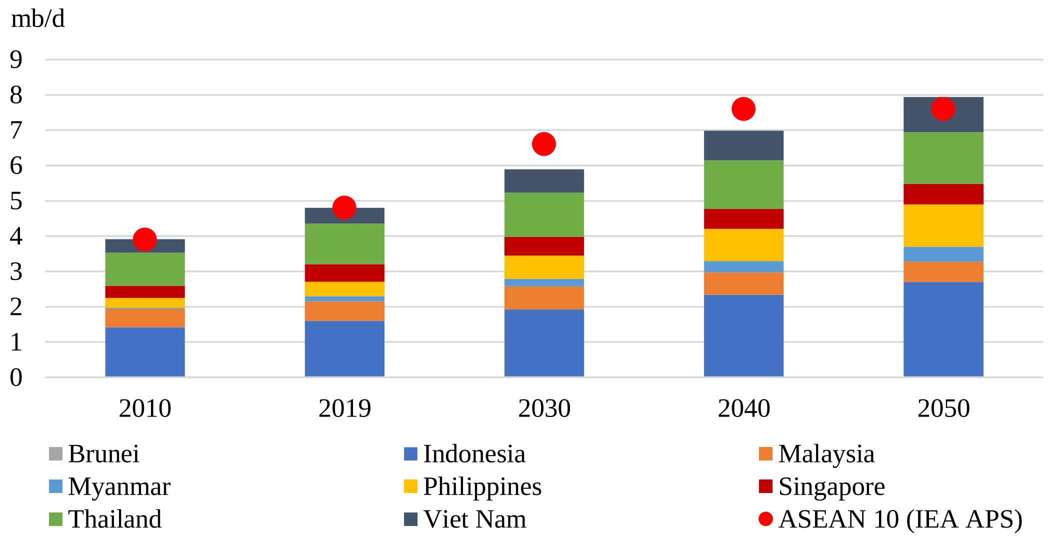
1.1. Demand Outlook

With robust economic growth, oil demand in ASEAN 8 is growing steadily.[1] In 2010–2019, the average annual growth rate was 2.3% and demand reached 4.8 million barrels per day (mb/d). Demand is likely to continue increasing and go up to 7.9 mb/d in 2050 (IEEJ, 2021). Indonesia, the Philippines, and Viet Nam will drive demand, altogether accounting for 78% of demand growth in ASEAN.

As decarbonisation is globalised, ASEAN countries now set ambitious targets to tackle climate change, which will not, however, necessarily decrease oil demand. According to the Announced Pledges Scenario (APS) (IEA, 2021a), even if all reduction targets are implemented on time and completely, oil demand will peak only around 2045 and go up to 7.6 mb/d in 2050 (Figure 1.1).

[1] The ASEAN 8 are Brunei, Indonesia, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam. They accounted for 98% of ASEAN oil demand in 2019.

Figure 1.1. Oil Demand in ASEAN



IEA APS = International Energy Agency Announced Pledges Scenario, mb/d = million barrels per day.
Source: Institute of Energy Economics, Japan (2021); International Energy Agency (2021a).

APS covered greenhouse gas reduction targets as of mid-2022 and does not fully reflect the latest targets in ASEAN countries. From July to November 2021, Indonesia, Malaysia, Thailand, and Viet Nam announced net-zero targets by 2050–2065, which are not reflected in the APS. Whilst the targets are ambitious, governments have not outlined clear pathways or passed laws to achieve the goals. More important, the mid-term targets were not dramatically upgraded even in 2021 (Table 1.1). Therefore, despite the anticipated decarbonisation process, oil demand will not likely peak for years and oil security will remain a stringent policy issue.

Table 1.1. Greenhouse Gas Reduction Targets by ASEAN Countries

	Target Year	Target
Brunei	2030	• -22% from BAU scenario in 2030
Cambodia	2030	• -42% from BAU scenario in 2030
Indonesia	2030 & 2060	• Unconditional: -29% by 2030 Conditional: -41% by 2030 with international support • Net zero by 2060
Lao People's Democratic Republic	2030	• Unconditional: -60% by 2030 Conditional: -63.5% by 2030 with international support
Malaysia	2030 & 2050	• -45% of emission intensity in 2030 • Net zero by 2050
Myanmar	2030	• Unconditional: -244.52 MT CO_2e in 2030 Conditional: -414.75 MT CO_2e in 2030
Philippines	2030	• Unconditional: -2.71% in 2030 • Conditional: -75% in 2030 with international support
Singapore	2030	• Peaking at 65 MT CO_2e in 2030 • Net zero as soon as viable in the second half of the century
Thailand	2030 & 2065	• -20% from BAU scenario in 2030 • Net zero by 2065
Viet Nam	2030 & 2050	• Unconditional: -9% by 2030 Conditional: -27% by 2030 with international support • Net zero by 2050

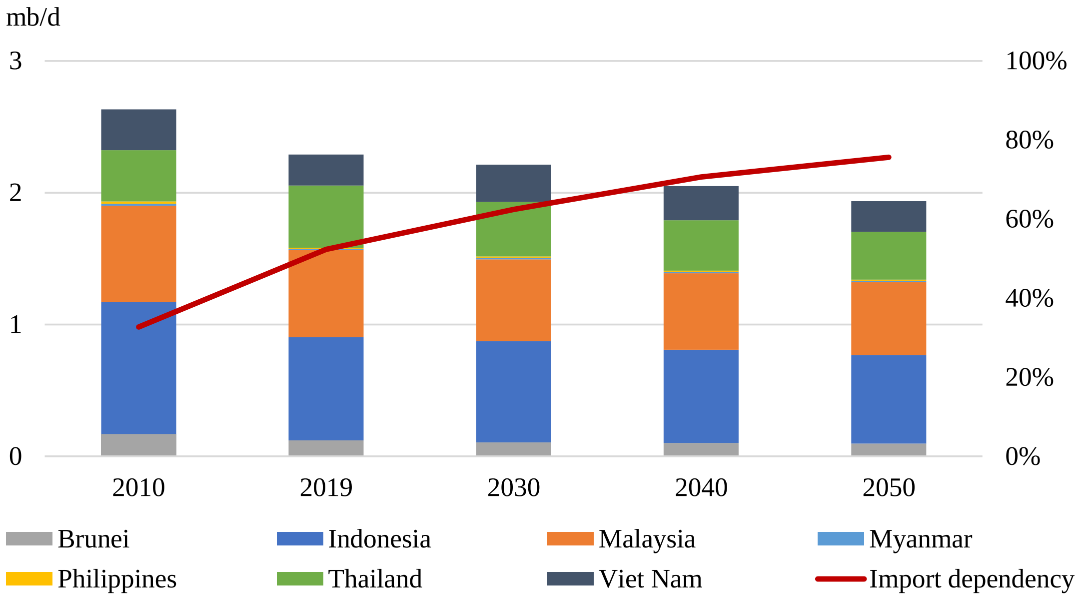
BAU = business as usual, MT CO_2e = million tonnes of CO_2 equivalent.
Source: United Nations Framework Convention on Climate Change (2022).

1.2. Supply Outlook

(1) Crude Oil

Crude oil production in ASEAN peaked in 2000 and has been declining since then. Production in 2019 was 2.3 mb/d, which is 13% lower than in 2010. Despite all efforts and policies, production will steadily decrease. IEEJ estimates that production in 2050 will be 1.9 mb/d. With steady demand growth, import dependency will inevitably rise. The import dependency rate was modest at 19% in 2010 but will rise to as high as 76% in 2050 (Figure 1.2). Most crude oil is expected to come from the Middle East because of the potential of increasing production and competitiveness in the ASEAN market.

Figure 1.2. Crude Oil Production in ASEAN 8



mb/d = million barrels per day.
Source: Institute of Energy Economics, Japan (2021).

(2) Oil Products

There were 32 refineries in ASEAN as of 2019. All countries except Cambodia and Lao People's Democratic Republic have refineries. Total capacity as of 2019 was 5.3 mb/d and produced 3.6 mb/d of oil products. Singapore, Thailand, and Indonesia are the three largest refining countries, sharing 70% of total capacity (Table 1.2). Whilst refineries in Thailand and Indonesia primarily serve the domestic market, Singapore has long been a net exporter of oil products. Oil products produced in the region met 76% of demand in 2019.

Table 1.2. Refineries in ASEAN

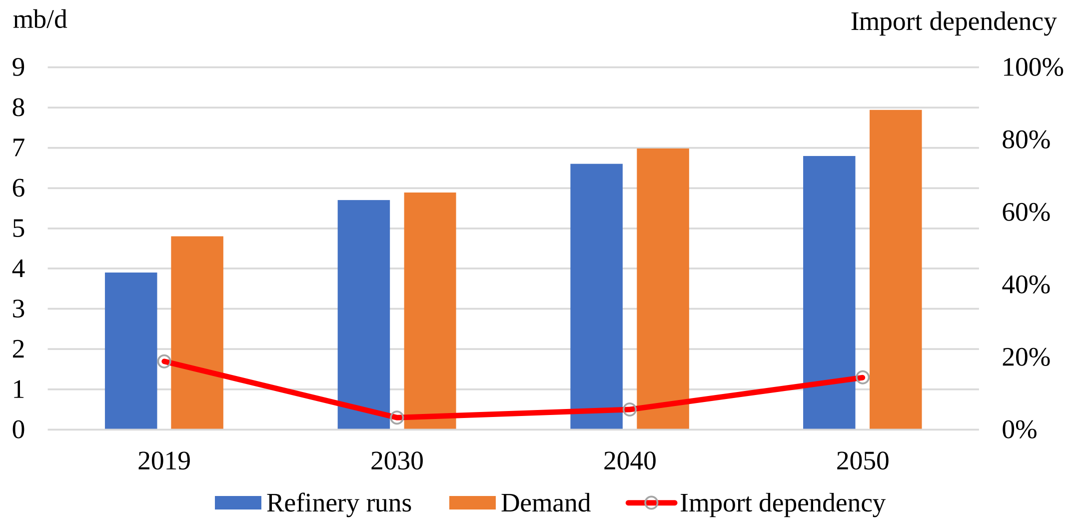
	Number of Refineries	Capacity (kb/d)	Major refiners
Brunei	2	129	Shell, Zhejiang Hengyi Petrochemicals
Cambodia	0	-	Cambodian Petrochemicals
Indonesia	8	1,114	Pertamina
Lao People's Democratic Republic	0	-	-
Malaysia	8	827	Petronas, Saudi Aramco, Shandong Hengyuan Petrochemical
Myanmar	2	32	MPE
Philippines	2	276	Petron, (Shell)
Singapore	3	1,331	ExxonMobil, Shell, Singapore Refining
Thailand	5	1,239	PTT, ExxonMobil, Star Petroleum, Bangchak
Viet Nam	2	331	PetroVietnam, Idemitsu, KPC
ASEAN total	32	5,279	

kb/d = thousand barrels per day, KPC = Kuwait Petroleum Corporation, MPE = Myanma Petrochemical Enterprise.

Source: Oil and Gas Journal (2020); International Energy Agency (2019); Institute of Energy Economics, Japan (2021).

Refining capacity in ASEAN will expand to 7.3 mb/d in 2050 and refinery runs will increase from 3.9 mb/d in 2019 to 6.8 mb/d in 2050 (average annual growth rate of 1.8%) (IEA, 2021a). Production of oil products in ASEAN will grow slightly faster than demand (average annual growth rate of 1.6% per annum) although the region will remain a net importer of oil products until 2050. Holding a certain amount of product stocks will, therefore, be important to mitigate possible oil supply disruption.

Figure 1.3. Refinery Runs and Oil Demand in ASEAN



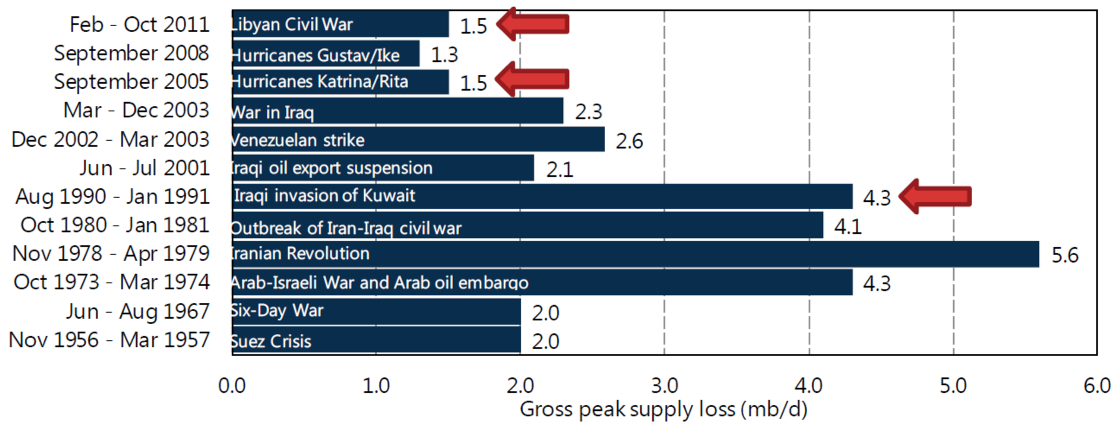
mb/d = million barrels per day.
Source: International Energy Agency (2021a).

2. Oil Supply Risks for ASEAN

2.1. Major Oil Supply Disruptions in the Past

Supply disruptions, major or minor, happen frequently for various reasons. Major disruptions up until 2011 are summarised in Figure 1.4, often caused by deterioration of security: revolutions, wars, or strikes in major oil-producing countries, whose impact was immense. The Arab–Israeli war and Arab oil embargo caused the first oil crisis, which resulted in establishing the IEA by the Organisation for Economic Co-operation and Development countries. During the Iranian revolution, as much as 5.6 mb/d or almost 9% of the world's total supply was lost, directly causing the second oil crisis, which doubled oil prices.

Figure 1.4. Major Oil Supply Disruptions



mb/d = million barrels per day.
Source: International Energy Agency (2014).

Disruptions did not end in 2011. Sanctions by the United States (US) and the European Union (EU) on Iran decreased Iranian production by almost 1 mb/d from 2011 to 2013. Revived US sanctions in 2016 slashed Iranian production by almost 1.5 mb/d from 2017 to 2019. The Houthi attack on Saudi oil facilities led to a 5.7 mb/d production loss in 2019 (Reuters, 2019).

Similarly, US sanctions on Venezuela had a huge impact on oil production there. It once produced more than 3 mb/d in mid-2000 but production went under 1 mb/d in 2019. Relatively minor disruptions have happened in recent years, such as military action in Iraq in early 2020 and Hurricane Ida in the US in 2021. There is no denying the possibility of future supply disruptions. Since predicting when and how such disruptions will happen is difficult, oil stockpiling in consuming countries is justified.

2.2. Oil Supply Risks and Oil Stockpiling as a Countermeasure

Energy security is 'the uninterrupted availability of energy sources at an affordable price' (IEA, 2022a). Energy insecurity is caused by extreme tightening of demand and supply and skyrocketing prices. Major risks and countermeasures are summarised in Table 1.3.

Table 1.3. Oil Supply Risks and Countermeasures

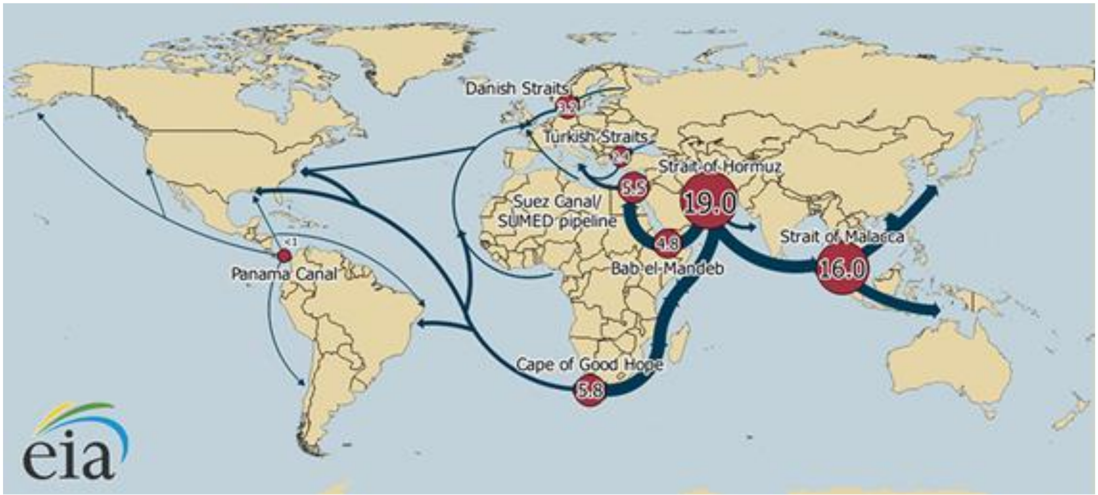
	Supply Disruption Risks	Countermeasures
Upstream (exporting countries)	• War • Terror (including cyber) attack • Industry strike • Underinvestment	• Security enhancement • Supply expansions
Midstream (transport)	• Piracy and terror (including cyber) attack • Tanker accident • Sea blockage	• Security enhancement • Tanker re-routing
Downstream (importing countries)	• Natural disaster • Refinery accident • Terror (including cyber) attack	• Natural disaster proof infrastructures • Demand control • Stockpiling

Source: Author.

Considering past supply disruptions, various upstream risks such as wars, terror attacks, or industry strikes remain major risks. Underinvestment (or overinvestment) is arguably part of the market cycle, however, especially in the context of decarbonisation. Underinvestment could become more serious because environmental concerns and uncertain future oil demand could hold back steady upstream investment.

Because most crude oil and oil products are transported by tankers to the ASEAN region, sea transport safety is a significant risk of oil supply. Whilst Energy Information Administration (2017) cites several choke points for oil transport, the Strait of Hormuz and Strait of Malacca are the main ones from the Middle East. The safety of tanker transport in the South China Sea has become a great concern. China claims sovereignty over maritime areas inside the so-called nine-dash line, and tensions are mounting between China and its neighbours and between China and the US. Because of its location and lack of alternative sea transport routes, Viet Nam would be the most affected if the South China Sea were to be blocked.

Figure 1.5. Maritime Oil Choke Points



Source: Energy Information Administration (2017).

In importing countries, natural disasters and refinery accidents might be major risks. Natural disasters such as earthquakes, tsunamis, volcanic eruptions, and floods have often caused major supply disruptions in ASEAN countries (ERIA, 2017). Climate change could aggravate typhoon and flood risks. Amongst the three countries in chapter 2, the Philippines is particularly vulnerable since it is seen to have the fourth-highest climate risk in the world (Germanwatch, 2021).

Countermeasures are mainly defensive, either in the form of security and infrastructure enhancement, re-routing of transport, or demand control. Stockpiling is considered a last resort, and, therefore, is of immense importance in securing oil supply.

3. Developing Oil Stockpiling in ASEAN

3.1. Status of Oil Stockpiling in ASEAN

The importance of oil stockpiling as a policy tool to tackle supply insecurity is well recognised in ASEAN countries. All ASEAN countries legislate and implement oil stockpiling, most of which is held by industry players. Viet Nam is the only country that has government stockpiling or strategic petroleum reserves (SPR), targeting expansion to 20 days of net imports in 2025 (Ministry of Industry and Trade [Viet Nam], 2022). Other countries are considering more government involvement. Indonesia plans to introduce Energy Buffer Reserves whereby oil is provided by the government. However, the plan is delayed due to the budget constraints (Ministry of Energy and Mineral Resources [Indonesia], 2022). The Philippines is considering introducing SPR with the 2021 department circular on the SPR Program (Department of Energy [Philippines], 2022). Stockpiling schemes and implementation differ country by country, but many countries oblige oil companies to stockpile different amounts, depending on the oil product or business segment (e.g. importer, refiner, distributor). Indonesia obliges oil companies to have storage capacity but has no rule on how much oil should be stockpiled. Whilst the actual stockpiled amount is not often disclosed, IEEJ assumes that most ASEAN countries hold 20–50 days of demand, mostly as oil products.

Table 1.4. Oil Stockpiling in ASEAN Countries

Component	BRN	CAM	INA	LAO	MAS	MYA	PHI	SIN	THA	VNM
▪ Gas and Oil products Stockpiling Policy	N/A	N/A	Yes	N/A	N/A	Yes	Yes	N/A	Yes	Yes
▪ Infrastructure ownership	Private	Private	Private	Private	Private	National, Private	Private	N/A	Private	National, Private
▪ Private Mandatory Stocks (days of domestic demands)	31 days	30 days	14-23 days	10-21 days	30 days	N/A	15-30 days	90 days	3.5-21.5 days	10-40 days
▪ Form of stocks	Refined Oil (Product)	Refined Oil (Product)	Refined Oil (Product) and Crude	Refined Oil (Product) and Crude	Refined Oil (Product)	Refined Oil (Product)	Refined Oil (Product)	Refined Oil (Product)	Refined Oil (Product) and Crude	Refined Oil (Product) and Crude
▪ Strategic Petroleum Reserves / National Mandatory Stocks	No	Currently doing FS on SPR	Currently drafting Bill on Energy Buffer Stock	Currently under discussion	No	Currently emergency stock of 60 days (by MOEE)	Currently doing FS on SPR	No	Currently doing Study on SPR	Yes.
▪ Target	N/A	Private: 30-40 days for products, and 25-42 days for crude SPR: 35 days of consumption (Products & Crude) by 2035	Private: 30 days of consumption SPR: 30 days of consumption	30 days by 2020 3 months by 2025 5 months by 2030	N/A	30 days by 2020 45 days by 2045 90 days by 2050	SPR: 30 days of consumpti on by 2020	N/A	N/A	Private: 55 days SPR: 14 days (products) and 6 days (crude) and to reach 90 days of net imports by 2020
▪ Development Priority	High	High	High	High	Low	Moderate	Moderate	Low	High	High

BRN = Brunei Darussalam, CAM = Cambodia, INA = Indonesia, LAO = Lao People's Democratic Republic, MAS = Malaysia, MYA = Myanmar, PHI = Philippines, NA = not applicable, SIN = Singapore, SPR = strategic petroleum reserves, THA = Thailand, VNM = Viet Nam.
Source: ASEAN Centre for Energy (2021).

3.2. Stockpiling Options for ASEAN Countries

(1) National Initiative

Oil stockpiling primarily aims to address supply shortage of oil for domestic use. The domestic oil industry or government is the main body in charge of developing, maintaining, and releasing stockpiled oil. Most oil stockpiling around the world was developed by oil industries and governments on their own.

Holding a certain amount of stock is normal in the oil industry to adjust demand and supply. Advanced economies usually developed oil stockpiling based on industry stock. For instance, Japan initiated stockpile development in 1972 when the government recommended that oil companies hold 60 days of imports. In 1975, the oil companies were obliged by law to hold 90 days of imports.

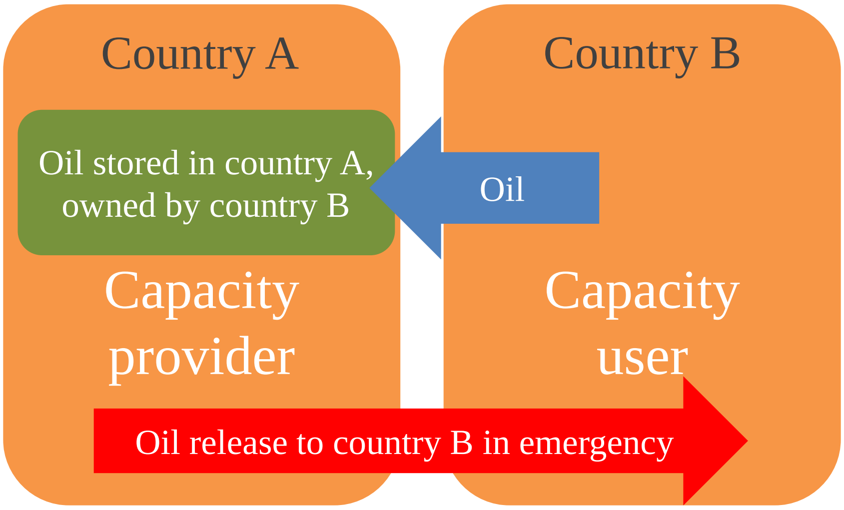
With the first oil crisis, in 1973, Organisation for Economic Co-operation and Development countries founded the IEA to coordinate energy security and policy amongst its members. Emergency response systems and oil stockpiling have been central to the IEA's role and holding 90 days' stock of net imports is a condition for IEA membership. Government intervention in oil stockpiling was increasingly called for and several countries introduced government stocks in the 1970s. The US established its SPR in 1975 and Japan followed in 1978. Although oil stockpiling in IEA member countries was developed in line with IEA guidelines, the individual member country legislates on, invests in, and owns the facility and stocked oil.

(2) International Ticket Stockpiling

Ticket stockpiling is 'stockholding arrangements under which the seller agrees to hold (or reserve) an amount of oil on behalf of the buyer, in return for an agreed fee' (IEA, 2022b). Tickets are instruments to outsource stockpiling to other countries. Should the ticket stockpiling be conducted between two countries, both governments typically agree on the stockpiling of a specific amount before agencies (usually oil companies or specific entities in charge of oil stockpiling) in the two countries make a contract (Figure 2.4).

The ticket stockpiling system has been widely used in Europe. In Asia and the Pacific, Japan implements ticket stockpiling for New Zealand. The governments of Japan and New Zealand made an agreement in 2007, and a Japanese oil company and the Government of New Zealand subsequently made a contract, under which New Zealand would pay a ticket fee and the Japanese oil company would promise to supply petroleum products to New Zealand in case of emergency (Figure 1.6).

Figure 1.6. Concept of Ticket Stockpiling



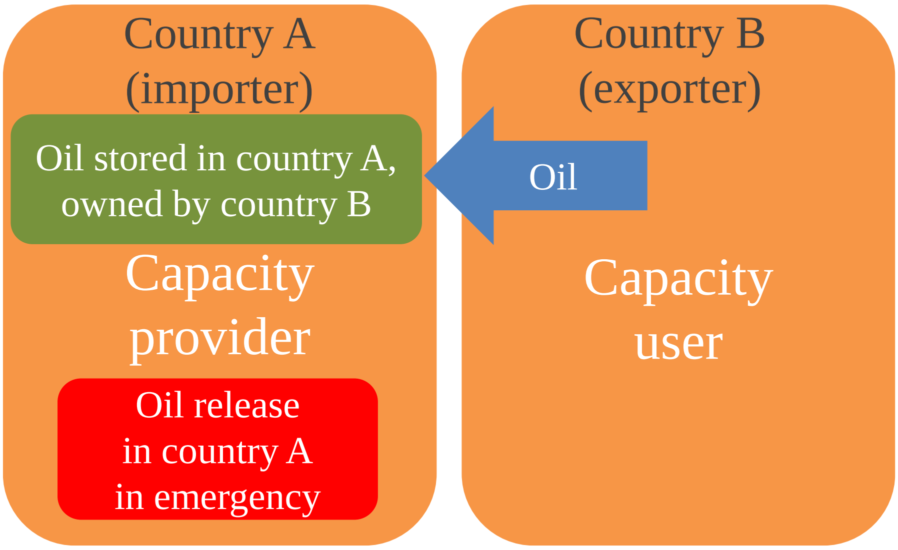
Source: Author.

A prerequisite of ticket stockpiling is that the capacity provider already has storage capacity and other infrastructure. Ticket stockpiling does not require capacity users (ticket buyers) to bear capital expenditure (e.g. tanks, jetties, pumps), although the actual ticket cost depends on a bilateral contract between the capacity provider and user. International ticket stockpiling could evoke national security concerns because oil is stored in another country, especially if it is far away. Therefore, many IEA countries set the upper limit of ticket stockpiling at 10% of required oil stock. Ticket stockpiling offers a cheaper way of stockpiling and could play a supplemental role in ASEAN.

(3) Joint Stockpiling with Crude Oil Exporter

Another form of international oil stockpiling is joint stockpiling with a crude oil exporter. The exporter stores its crude oil in an importing country in exchange for giving the importing country first drawing rights in case of emergency. The exporter can store oil for free, under the condition that the reserves can be called upon in case of an emergency. The reserves can be classified as strategic and commercial and enable an importing country to add to their SPR at a reduced cost (KAPSARC, 2017). The exporter benefits from the commercial use of the storage facilities close to key consumption centres and promising new market areas.

Figure 1.7. Concept of Joint Stockpiling



Source: Author.

Joint stockpiling is growing in Asia.[2] The Republic of Korea (henceforth, Korea) pioneered joint stockpiling with crude oil exporters when it signed a deal with Kuwait in 2006 to store 2 mb of crude oil at the Korea National Oil Corporation's facilities in Korea. It signed a deal in 2016 with Iran to store 2 mb of crude oil. Japan followed in 2009 when it agreed with the United Arab Emirates on joint stockpiling, and now has similar agreements with Saudi Arabia and Kuwait. India signed an agreement with the United Arab Emirates in 2017.

[2] Another form of importer–exporter joint venture is a refining and petrochemical facility that usually has a storage facility. An example is Nghi Son Refinery Petrochemical in Viet Nam, a joint venture of Petro Viet Nam, Kuwait Petroleum Corporation, Idemitsu, and Mitsui Chemical.

Table 1.5. Joint Stockpiling between Crude oil Exporters and Asian Importers

Importing Country	Exporting Country	Year of Initial Deal	Volume (million barrels)
Japan	UAE	2009	6.3
	Saudi Arabia	2010	8.3
	Kuwait	2020	3.1
Republic of Korea	Kuwait	2006	2.0
	UAE	2012	6
	Iran	2016	2
India	UAE	2016	6

UAE = United Arab Emirates.
Source: King Abdullah Petroleum Studies and Research Center (2017); Ministry of Economy, Trade and Industry (Japan) (2020).

Although details of the agreements are not disclosed, the basic arrangement is that the importing country bears the capital expenditure (CAPEX) and the operating expenditure and the exporting country owns the oil. The importing country does not need to purchase oil and still has the first drawing right to the oil in case of emergency. Such joint stockpiling benefits exporters and importers. It gives exporters better access to the demand market at a low cost. Exporters who joint-stockpile their crude oil in importing countries can deliver the crude oil instantly, without long-haul transport. Joint stockpiling provides crude oil exporters a low-cost method of defending their market share in Asia (KAPSARC, 2022). In return, importing countries can expand their stock without initial oil purchase,[3] the largest part of stockpiling cost. Importing countries can 'de-risk' Middle East crude oil since it has already transited the critical choke points of the straits of Hormuz and Malacca (KAPSARC 2017). Strengthening ties benefits importer and exporter, providing supply and demand security of oil. Joint oil stockpiling could have strategic and economic value and create a win–win situation for exporter and importer.

[3] Payment is made when the importing country draws the oil out of the facility.

Chapter 2

Cost–Benefit Analysis on Oil Stockpiling in Indonesia, the Philippines, and Viet Nam

The chapter conducts a cost–benefit analysis of oil stockpiling in Indonesia, the Philippines, and Viet Nam. Based mainly on the methodology and major assumptions of studies by the IEA and the Energy Modelling Forum of Stanford University, the analysis assumes scenarios of stockpiling options and supply disruptions. Stockpiling options are (i) national initiative, (ii) ticket stockpiling, and (iii) joint stockpiling with Middle East crude oil exporters. Supply disruption scenarios are (i) Middle East unrest, (ii) South China Sea blockage, and (iii) a natural disaster in the importing country.

1. Methodology

1.1. Country Selection

Chapter 1 looked at rising oil import dependency, oil supply risks, and stockpiling options for ASEAN countries. However, ASEAN countries vary significantly, especially in demand size, extent of import dependency, and extent of stockpiling development (Table 2.1).

Table 2.1. ASEAN Countries' Oil Stockpiling Profiles

	Oil Fundamentals			Oil Stockpiling	
	Demand in 2019 (kb/d)	Demand Increase towards 2050 (kb/d)	Import Dependency in 2019	Industry Stocks (days of demand)	Strategic Petroleum Reserves
Brunei	27	-0.2	Net exporter	31	No
Cambodia	77	N/A	100%	30	No
Indonesia	1,570	1,106	48%	14-23	No
Lao PDR	18	N/A	100%	10-21	No
Malaysia	559	15	Net exporter	30	No
Myanmar	147	279	94%	N/A	No
Philippines	402	795	97%	15-30	No
Singapore	503	73	0%	90	No

Thailand	1,147	321	66%	3.5-21.5	No
Viet Nam	448	548	47%	10-40	Yes

kb/d = thousand barrels per day, N/A = not applicable, Lao PDR = Lao People's Democratic Republic.
Source: International Energy Agency (2021b), Author.

Whilst oil supply security is important to all ASEAN countries, the study focuses on certain countries for the sake of depth and efficiency, selecting Indonesia, the Philippines, and Viet Nam, mainly for their significant demand size, growth, and import dependency. They share 50% of demand in 2019 and will account for as much as 78% of demand growth in the region towards 2050. Indonesia might most urgently need to expand oil stockpiling because of its demand size, expected growth, and low level of stocks. The Philippines' growth rate will be the highest in the region. Viet Nam' s growth will be third highest and the country is more exposed to the South China Sea than other ASEAN oil importers. Although Viet Nam has already introduced SPR, actual SPR building is behind schedule. Therefore, covering the three countries will be indicative to other ASEAN countries.

1.2. International Energy Agency Studies

As an organiser of oil emergency response of its member countries, IEA conducts studies on oil stockpiling, such as the cost–benefit analysis done in 2013 (IEA, 2013) and updated in 2018 (IEA, 2018).

The 2013 study guides countries on building or expanding oil stockpiling. The present report quantitatively assesses and compares the cost and benefit of holding oil stockpiles. The cost is calculated by adding up the cost components of a stockpiling project, estimated at US$7–US$10 per barrel. The benefit of oil stockpiling is evaluated using the estimated economic loss to the world caused by oil supply disruptions. In assessing the risk of supply disruption, the results of an analysis of the probability, and duration of disruption events, the study uses the outcome of Energy Modelling Forum (2016), a programme of Stanford University. The EMF has developed a risk assessment framework and evaluated the likelihood of oil disruptions mainly from geopolitical, military, and oil market points of view. As a result of the analysis using oil supply scenario simulations, oil stockpiles developed under the IEA framework were estimated to bring a total benefit of $3.5 trillion over 30 years (about $50 per barrel) to IEA member countries and non-IEA net oil importers. The report concludes that the net benefit of oil stockpiling is about $40 per barrel and stresses the importance of retaining and expanding oil stockpiling.

The IEA updated the study in 2018 to consider changes in the oil market, such as the growing presence of the US as an oil-producing country and volatile oil prices. Some assumptions of the cost–benefit calculation have changed, but the basic methodology remains the same. The IEA study concludes that the benefit of stockpiling outweighs the cost.

We adopt most of the methodologies of the IEA analyses in calculating the cost of oil stockpiling. However, the present study calculates the benefit for each country (Indonesia, the Philippines, and Viet Nam) separately, while the IEA analysed the benefit for the entire world.

1.3. Methodology Outline

The cost of oil stockpiling assumes a target stockpile volume and construction of new stockpile terminals to achieve a stockpiling amount of 90 days of domestic demand.[4] The construction cost of stockpiling facilities and the cost of operating and maintaining the stockpile for 30 years are accumulated and calculated to arrive at a unit cost of stockpiling (US$/barrel [159 litres] of crude oil [bbl]).

The benefit of oil stockpiling is based on how much gross domestic product (GDP) contraction can be avoided in the event of oil supply disruption. Assuming supply disruption scenarios and disruption probability exogenously, various supply situations (with or without disruptions in any given time during 30 years) are simulated randomly to calculate the benefit of oil stockpiling. Finally, the cost and benefit are compared, and if the benefit exceeds the cost, constructing additional oil stockpiles is worthwhile.

2. Cost Analysis

2.1. Main Assumptions

The cost of oil stockpiling for Indonesia, the Philippines, and Viet Nam is calculated by adding up the cost of implementing oil stockpiling projects. The target is 90 days of domestic demand, and oil storage terminals are assumed to be constructed to meet the shortfall. Oil could be stored in tanks onshore or offshore and in underground structures such as depleted oil fields or salt caverns. The study assumes that oil tanks are onshore, which is most common. The number of stockpiling days is calculated based on each country's consumption in 2019. The project life is set at 30 years, which is consistent with IEA studies on oil stockpiling.

The study consider three oil stockpiling schemes: national initiative, ticket stockpiling, and joint stockpiling with Middle East crude oil exporters. Ticket stockpiling and joint stockpiling are assumed to cover only crude oil stockpiles. For a national initiative, the ratio of crude oil and petroleum product stockpiling is set individually based on the level of oil imports and refinery capacity. Table 2.2 shows the estimated existing oil stockpiles and the assumed target stockpiles by crude oil and oil product. Indonesia is assumed to have a large crude oil stockpile because its refinery capacity is large. The Philippines and Viet Nam are assumed to have larger stockpiles of oil products than crude oil because they have fewer refineries and are expected to continue to have high dependence on petroleum product imports.

[4] The target of 90 days follows the IEA standard. However, the study sets 90 days of domestic demand instead of 90 days of net imports, which the IEA stipulates, primarily for consistency with stockpiling regulations in many ASEAN countries, where stockpiling amount is legislated in days of domestic demand or sales.

Table 2.2. Assumed Target Days of Oil Stockpiling

Indonesia

	Existing	Necessary Additions	Total
Crude oil	10 days	40 days	50 days
Oil products	10 days	30 days	40 days
Total	20 days	70 days	90 days

Philippines

	Existing	Necessary Additions	Total
Crude oil	20 days	20 days	40 days
Oil products	20 days	30 days	50 days
Total	40 days	50 days	90 days

Viet Nam

	Existing	Necessary Additions	Total
Crude oil	25 days	15 days	40 days
Oil products	25 days	25 days	50 days
Total	50 days	40 days	90 days

Source: Author.

The assumptions for the cost calculation are in Table 2.3. Most parameters are set with reference to the IEA studies. The CAPEX of a stockpiling facility consists mainly of tanks, pumps, and jetties. Tank construction for petroleum products costs more than for crude oil because product tanks, especially for gasoline, require more complex structures to lower the fire risk of low flash point. The unit cost of jetties, however, is more expensive for crude oil facilities because crude oil tankers are large.

The operating expenditure consists of initial oil purchase costs, operating expenses, land lease, and stockpile replacement costs. Since the properties of crude oil are stable, it may be replaced only once in 20 years, whilst petroleum products degrade easily and need to be replaced every 6 years. The study largely utilises IEA's assumption for most of the parameters in Table 2.3. Prices of crude oil and petroleum products are assumed at levels in the third quarter of 2021.

Table 2.3. Parameters for the Cost Calculation

Parameter		Value
General assumptions	Project life	30 years
	Interest rate	3%
Oil purchase	Crude oil Oil product	Assumed crude price at $72/bbl and product price at $79/bbl (3Q 2021 market prices)
CAPEX	Construction costs of storage facilities (excluding jetty)	$150/m^3 (for crude) $165/m^3 (for product)
	Construction costs of jetty	$35mn (for VLCC) $12mn (for product tankers)
OPEX	Land utilization	3.5 m^3/m^2
	Land lease expenses	$0.3/m^2 per month
	Operating expenses	$12/m^3 per year
	Refreshment interval	Every 20 years for crude Every 6 years for product
	Cost of alternative storage during refreshment	$21/m^3 per refreshment (for crude) $27/m^3 per refreshment (for product)
	Terminal handling cost during refreshment	$15/mn tonne (for crude) $4/mn tonne (for product)

bbl = barrel, CAPEX = capital expenditure, m^3 = cubic metre, mn = million, OPEX = operational expenditure Q = quarter, VLCC = very large crude carrier.

Note: The interest rate could vary depending on the country's policy interest rate and the financing scheme. We follow the assumption by International Energy Agency (IEA) but, considering the interest rate is generally higher in developing countries, argue that the rate could be higher in ASEAN countries. A lower rate is available, however, for infrastructure projects such as oil stockpiling, especially if international financial assistance is secured.

Source: IEA (2013, 2018), Japan External Trade Organization (2022), Author.

National initiative stockpiling requires all the cost items. Ticket stockpiling, however, is assumed to utilise the surplus stockpiling capacity in other countries and to not bear CAPEX. In the case of joint stockpiling, the crude oil exporter is assumed to own the crude oil, and the importing country does not bear the initial oil purchase cost and stockpile replacement costs.

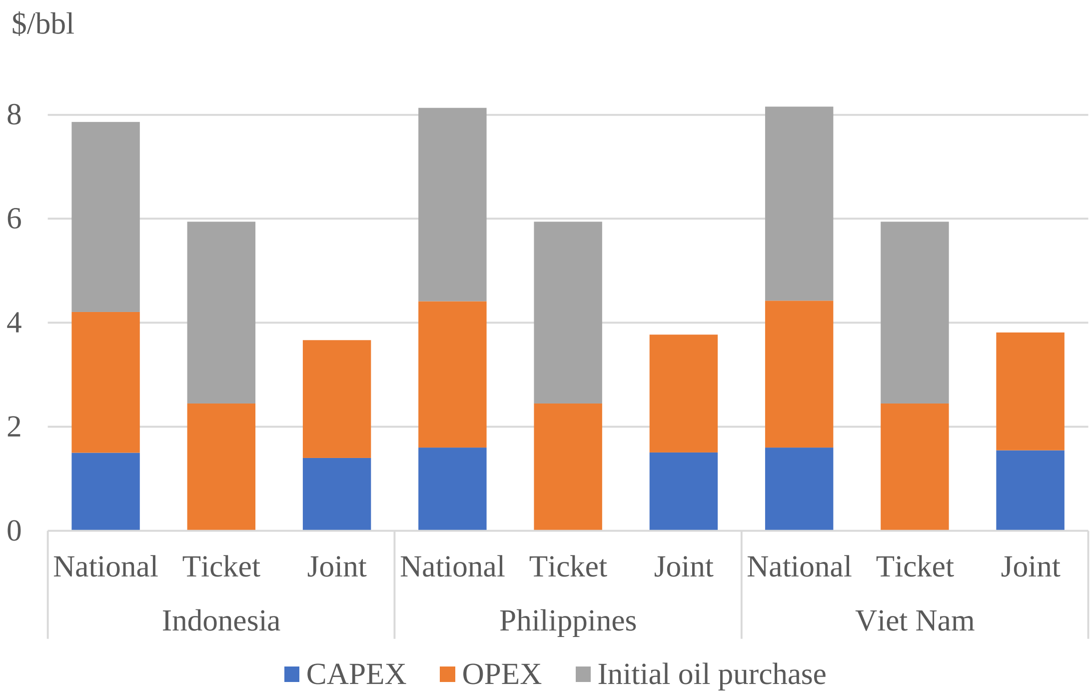
2.2. Results

The cost estimate of oil stockpiling in Indonesia, the Philippines, and Viet Nam is US$3.7–US$8.2/bbl (Figure 2.1) The difference between countries is small but the difference between stockpiling schemes is large.

For a national initiative, the largest cost component is the initial oil purchase (46% of the total), followed by operating expenditure (34%–35%) and CAPEX (19%–20%). Ticket stockpiling is assumed not to include CAPEX, and joint stockpiling does not include the initial oil purchase.[5] Therefore, the two schemes are, unsurprisingly, much cheaper than a national initiative. Whilst a national initiative costs US$7.9–US$8.2/bbl, the ticket cost is $5.9/bbl and joint stockpiling is the cheapest at US$3.7–US$3.8/bbl.

The difference in costs amongst countries is mainly due to the difference in the assumed composition of crude oil and oil products. In the Philippines and Viet Nam, which are assumed to stockpile more oil products with higher tank costs and initial inventory purchase costs, stockpile holding costs are slightly higher than in Indonesia.

Figure 2.1. Cost of Oil Stockpiling by Country and by Development Option



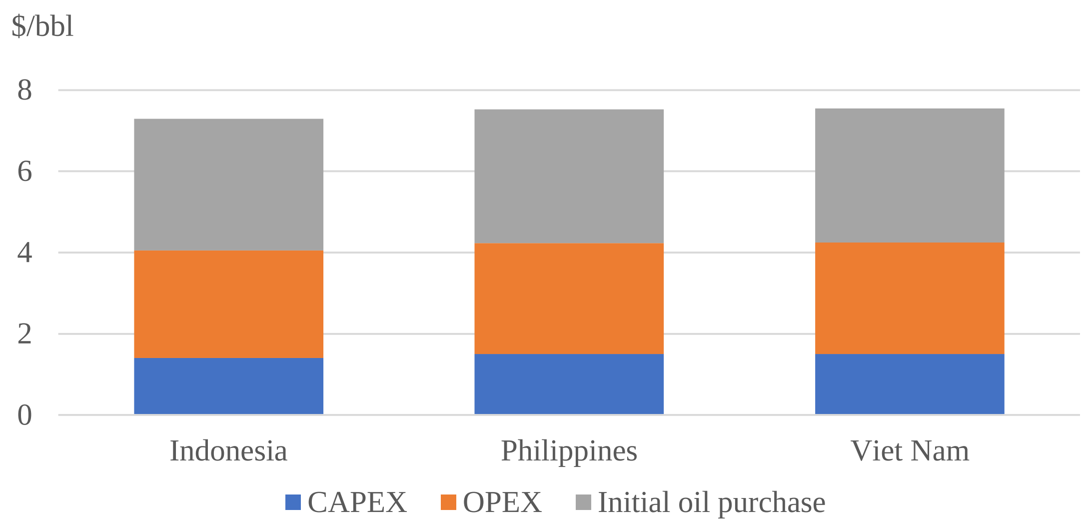
bbl = barrel, CAPEX = capital expenditure, OPEX = operational expenditure.
Source: Author.

Indonesia, the Philippines, and Viet Nam hold 20–50 days of oil stocks, all developed by national initiative without any international cooperation such as joint or ticket stockpiling. The situation is understandable because of the nature of oil supply security; a country naturally intends to retain full control of the whole stockpiling scheme within its territory. Therefore, whilst ticket stockpiling and joint stockpiling are inexpensive, assuming that the three countries solely rely on them is not realistic. Japan, for instance, has joint stockpiles with Saudi Arabia, United Arab Emirates, and Kuwait, and had 7 days of joint stockpiles out of 246 days of overall stockpiles at the end of 2020. The study assumes that Indonesia, the Philippines, and Viet Nam will develop their stockpiling mainly by national initiative and that

[5] The actual ticket fee and other cost sharing depend on a bilateral contract between capacity provider and user.

joint and ticket stockpiling will be supplemental. The target 90 days would be broken down as 75 days by national initiative, 5 days by ticket stockpiling, and 10 days by joint stockpiling, and the unit cost of stockpiling would be US$7.3–US$7.6/bbl (Figure 2.2).

Figure 2.2. Average Cost of Oil Stockpiling by Country



bbl = barrel, CAPEX = capital expenditure, OPEX = operational expenditure.
Source: Author.

Since a pure national initiative costs US$7.9–US$8.2/bbl, joint and ticket stockpiling clearly reduce some cost. Indeed, if the three countries developed 90 days of stockpiling based on the above combination of stockpiling options, they could save as much as US$0.4–US$1.6 billion from a pure national initiative. Joint stockpiling with Middle East crude oil exporters could offer not only economic value but also strategic value since the Middle East would be the main source of additional crude oil supply.

3. Benefit Analysis

3.1. Main Assumptions

The benefits of oil stockpiling are assessed by the avoided contraction in real GDP caused by a disruption in oil supply. We, therefore, compare the case of having no additional oil stockpiling with the case of having 90-day stockpiling.

The calculation method is as follows. First, oil supply disruption scenarios, occurrence probability, and the amount of oil disrupted are set exogenously. Next, under the probability, we simulate 1,000 cases over 30 years using the Monte Carlo method, utilising random numbers. The loss of real GDP in the event of supply disruption is calculated separately, and the cumulative GDP loss for 30 years is calculated. This loss is converted to an annual basis and further divided by the 90-day oil stockpiles to obtain the benefit of oil stockpiling per barrel.

The following three scenarios are assumed as oil supply disruptions: (i) a Middle East emergency, (ii) a blockade of the South China Sea, and (iii) a natural disaster in the importing country. Assumptions on the impact of each disruption event on each country and its probability of occurrence are shown in Table 2.4. The probability of occurrence of each disruption event is based on Energy Modelling Forum (2016), which estimates the annual probability and volume of oil supply disruptions that may occur in places such as the Middle East, Africa, and the Russian Federation. The Energy Modelling Forum estimated probability ranges from 1.03% to 6.38% per annum, depending on the scenarios. For simplicity, we average the percentages and use 4.0% per annum as occurrence probability. The duration of the disruption is assumed to be 90 days.

Table 2.4. Assumptions on the Impact of Oil Disruption and its Probability

	Indonesia	Philippines	Viet Nam	Occurance Probability per Annum
Middle East crisis	259 kb/d (10% of oil import)	110 kb/d (7% of oil import)	102 kb/d (6% of oil import)	
South China Sea blockade	0 kb/d	0 kb/d	203 kb/d (11% of oil import)	4.0%
Domestic natural disaster/incident	157 kb/d (6% of oil import)	40 kb/d (2% of oil import)	45 kb/d (3% of oil import)	

kb/d = thousand barrels per day.
Source: Energy Modelling Forum (2016), Author.

The impact of oil supply disruptions on real GDP consists of the contraction of economic activity due to the loss of oil as raw material or fuel and the higher cost of oil imports. The contraction of economic output due to a disruption occurs when oil is unavailable in industrial sectors that use oil as raw material or fuel. A decline in output in one sector caused by oil shortages will cause a decline in output in other sectors that use that output as an intermediate input. Due to the spillover effect, an oil shortage will have a significant impact on a country's total economic output. The impact can be estimated by applying the Ghosh model using the input–output table. The model is developed to calculate changes in gross sector outputs for exogenously specified changes in sector inputs. We use the input–output table constructed by Asian Development Bank (2022) and calculate the rate of change in total output if oil imports were disrupted at the rates shown in Table 2.4. The main assumptions used in the calculation are summarised in Table 2.5.

Table 2.5. Parameters for the Benefit Calculation

Parameter	Value	Remark
Project life	30 years	
Crude price in 2021	$72/bbl	Same as the cost calculation
Crude price in 2050	$88/bbl	
Product price in 2021	$79/bbl	Same as the cost calculation
Product price in 2050	$97/bbl	
GDP growth in Indonesia	4.6%	
GDP growth in Philippines	4.2%	
GDP growth in Viet Nam	5.4%	

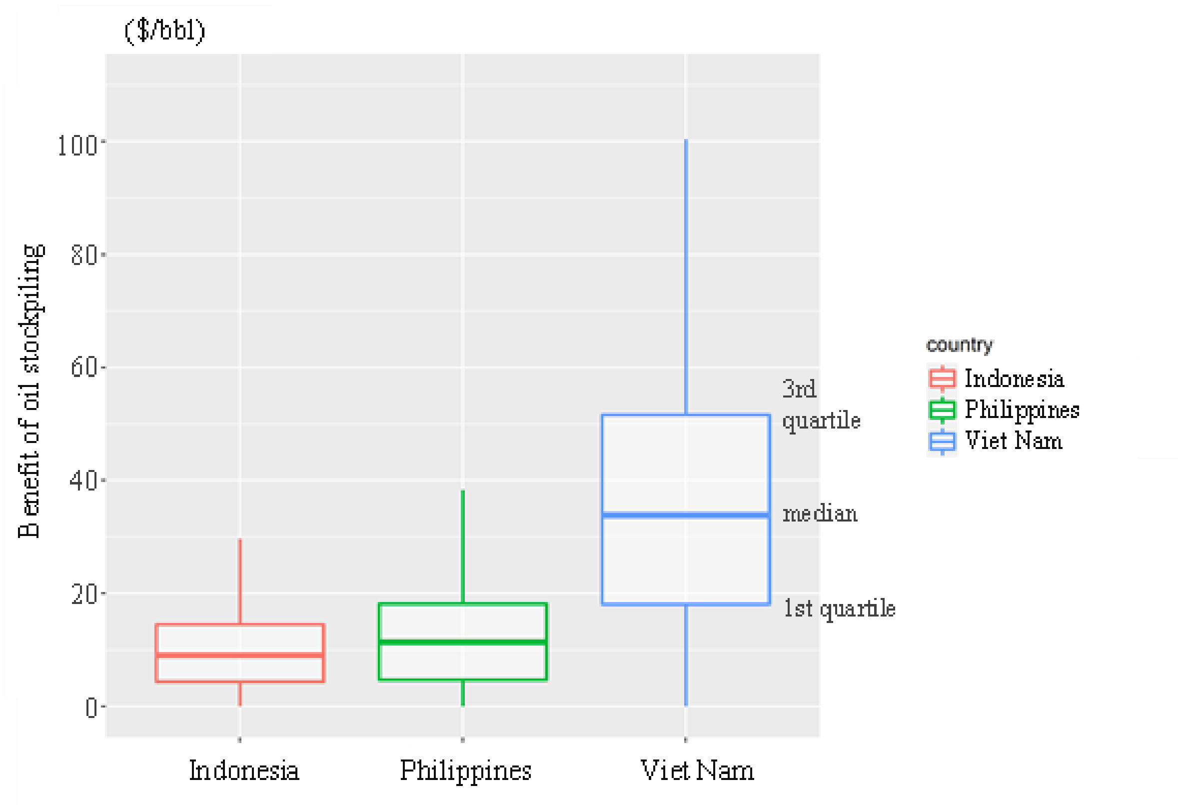
bbl = barrel, GDP = gross domestic product.
Source: International Energy Agency (IEA) (2018), IEA (2021), Author.

3.2. Results

The benefits of oil stockpiling vary, depending on no supply disruption (zero benefits) and supply disruption scenarios. Figure 2.3 shows a box plot of the benefits of oil stockpiling for each country under 1,000 simulations. The upper and lower limits (i.e. $39 and $0 in the case of Indonesia) represent the highest and the lowest benefit. Excluding the top 250 and bottom 250 values generates the range of the first and third quartiles, which can be considered statistically meaningful. The median is the 500th value from the highest (or the lowest). The first quartile is the 250th value from the lowest, and the third quartile is the 250th value from the highest. The benefits range from US$4.4/bbl–US$14.5/bbl for Indonesia, US$4.7/bbl–US$18.2/bbl for the Philippines, and US$18.3/bbl–US$52.5/bbl for Viet Nam (ranges from the first and third quartiles). The median values are US$9.1/bbl for Indonesia, US$11.4/bbl for the Philippines, and US$34.4/bbl for Viet Nam.

The reason oil stockpiling in Viet Nam is estimated to have particularly high benefit stems from the country's location and its large exposure to the South China Sea. A blockade in the South China Sea would have a catastrophic impact on oil supply to Viet Nam, but less so on oil supply to Indonesia and the Philippines. Indonesia's dependence on oil for its primary economic sectors, such as manufacturing and construction, is lower than the Philippines' and Viet Nam's. Therefore, the benefits of oil stockpiling in Indonesia and the Philippines are smaller than in Viet Nam.

Figure 2.3. Estimated Benefit of Oil Stockpiling

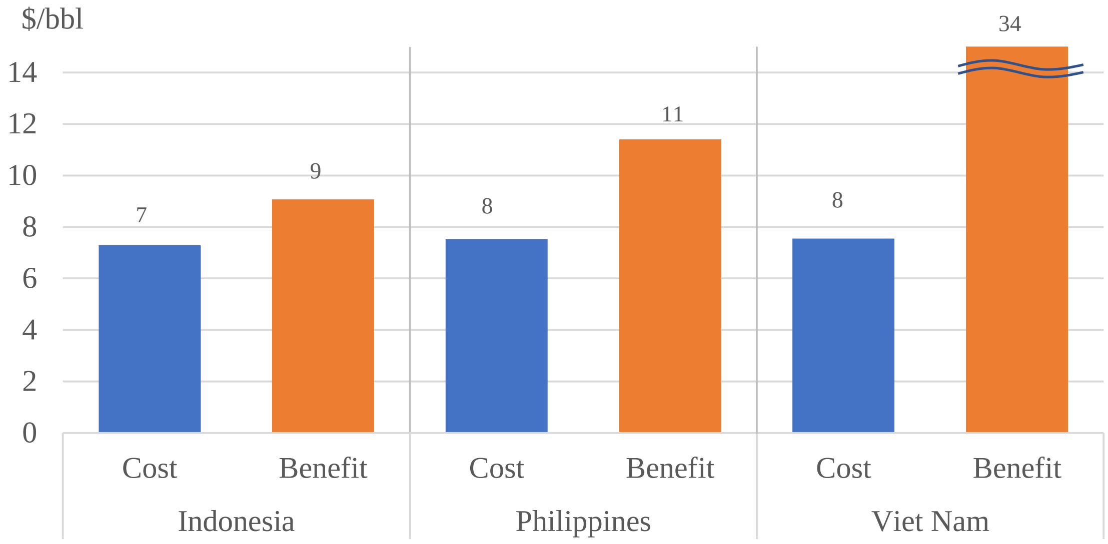


bbl = barrel.
Source: Author.

4. Summary and Implications

Comparing the costs and benefits (i.e. median values of Figure 2.4) of oil stockpiling in Indonesia, the Philippines, and Viet Nam, the expected benefits of oil stockpiling exceed the costs in all countries. The benefit is extremely large in Viet Nam, which is highly exposed to the risk of a blockade of the South China Sea. The evaluations so far assume a 90-day oil stockpile in accordance with IEA standards. The three countries already have oil reserves of about 20–50 days' worth of oil and building them up further would provide more benefit.

Figure 2.4. Summary of the Cost and Benefit Analysis



bbl = barrel.
Source: Author.

Chapter 3

Summary and Policy Recommendations

The study justifies and promotes oil stockpiling development in ASEAN countries, and explores the possibility of joint stockpiling with Middle East crude oil exporters.

Chapter 1 covered rising oil import dependency, oil supply risks, and oil stockpiling in ASEAN. Despite the decarbonisation trend, robust oil demand and declining regional crude oil production will inevitably result in rising oil import dependency. Most demand growth will be met by Middle East crude oil. Although refinery capacity will increase in the region, ASEAN is expected to remain a net importer of oil products.

The world is not short of oil supply disruptions throughout the supply chain, from upstream in exporting countries through midstream (transportation) to downstream in importing countries. Whilst countermeasures are available to address supply insecurity, stockpiling is considered the last resort in the case of supply disruption. All ASEAN countries legislate and implement oil stockpiling to different extents. Whilst actual stockpiling amounts are not often disclosed, IEEJ assumes that most ASEAN countries hold 20–50 days of demand, mostly in the form of oil products.

Stockpiling options are categorised into national initiatives and international initiatives such ticket and joint oil stockpiling. Whilst national initiatives are the main option because of national security, international initiatives offer cheaper options. Joint oil stockpiling with Middle East crude oil exporters eliminates the initial oil purchase cost for importers and provides better market access and removes the storage cost for exporters. Therefore, joint oil stockpiling would have strategic and economic value and be a win–win for exporter and importer.

Chapter 2 conducted a cost–benefit analysis on oil stockpiling in Indonesia, the Philippines, and Viet Nam. Based mainly on the methodology and major assumptions of studies of the IEA and the Energy Modelling Forum of Stanford University, the analysis assumed scenarios of stockpiling options and supply disruptions.

Whilst the national initiative of oil stockpiling costs US$7.9–US$8.2/bbl, ticket stockpiling costs US$5.9/bbl and joint stockpiling is the cheapest at US$3.7–US$3.8/bbl. Assuming a stockpiling portfolio of a national initiative (75 days), joint stockpiling (10 days), and ticket stockpiling (5 days), the cost would be US$7.3–US$7.6/bbl, for a total cost of US$20 billion for Indonesia and US$4 billion–US$5 billion each for the Philippines and Viet Nam. The sums are huge but including international initiatives (i.e. 10 days' joint stockpiling and 5 days' ticket stockpiling) would save as much as US$0.4 billion–US$1.6 billion from a pure national initiative.

Assuming supply disruption in the Middle East and the South China Sea and a natural disaster in the importing country, the benefit was calculated through a Monte Carlo simulation. The median values of the benefit are US$9.1/bbl for Indonesia, US$11.4/bbl for the Philippines, and US$34.4/bbl for Viet Nam. Therefore, the benefit exceeds the cost in all three countries.

The above analysis suggests that there are good reasons to expand oil stockpiling. At the webinar organised by ERIA, KAPSARC, and IEEJ on 21 February 2022, participants from Indonesia, the Philippines, and Viet Nam confirmed the importance of oil stockpiling to address supply insecurity. They have long been working on enhancing stockpiling but have not necessarily achieved the policy target, mainly because of financial constraints as stockpiling by itself does not create financial returns. However, stockpiling is like an insurance policy that prevents national energy, economic, and social disaster, and its effectiveness has been justified.

Therefore, governments not only in Indonesia, the Philippines, and Viet Nam but also in other ASEAN importing countries should, first, raise awareness and give priority to oil stockpiling. The government is primarily responsible for the energy security policy; therefore, little can be done without prioritising oil stockpiling in the energy policy. Governments could publish policy papers, hold workshops, and enhance public relations to remind others how vulnerable oil supply security can be and how important oil stockpiling is to address supply disruptions.

Second, to mitigate financial constraints, governments could consider the portfolio approach of oil stockpiling. Based mainly on national development, ASEAN importers could include joint oil stockpiling with Middle East crude oil exporters and ticket stockpiling with other importing countries because of the substantial saving. Indonesia, the Philippines, and Viet Nam have not yet considered international initiatives.

Third, ASEAN importing countries could consult countries involved in joint and/or ticket stockpiling because, as the webinar revealed, the importing countries are unaware of the details of such schemes. The opportunity for international cooperation is great. Feasibility studies could follow to assess potential sites, quantities, entities, legal frameworks, and emergency response schemes.

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