ERIA Research Project Report FY2023 No. 01

Strategic Oil Stockpiling in Myanmar

Edited by

Shigeru Kimura
Tetsuo Morikawa

Strategic Oil Stockpiling in Myanmar

Economic Research Institute for ASEAN and East Asia (ERIA)
Sentral Senayan II 6th Floor
Jalan Asia Afrika No. 8, Gelora Bung Karno
Senayan, Jakarta Pusat 12710
Indonesia

ERIA Research Project Report FY2023 No. 01
Published in May 2023

Preface

Myanmar produces small amounts of crude oil, some of which are exported, and the remaining are refined at a small refinery in Myanmar. Thus, since 96% of petroleum products, such as gasoline and diesel oil, are mainly from Singapore, Myanmar could face a petroleum shortage. This shortage is due to an oil supply disruption, such as accidents in oil facilities, natural disasters, and geopolitical conflicts like the Russian invasion of Ukraine. Moreover, in the final energy consumption, oil is consumed across the industry, transport, residential and commercial, and agriculture and fisheries sectors due to the convenient oil transportation and usage. Thus, Myanmar would face serious economic and social damages once the oil supply is disrupted.

There are several ways to avoid oil shortage: having diverse oil import channels and setting up strategic oil stockpiling. Myanmar investigates the different oil stockpiling methods, appropriate oil stockpiling amounts, and the cost and benefit of and/or from the oil stockpiling system. In addition, a road map for setting up oil stockpiling facilities is prepared to address the affordability of oil stockpiling.

In this regard, the Oil and Gas Planning Department, Ministry of Energy of Myanmar, requested the Economic Research Institute of ASEAN and East Asia (ERIA) to investigate which oil stockpiling system is appropriate for Myanmar to avoid an oil shortage. ERIA kindly prepared this report. Myanmar hopes this report will contribute to establishing oil stockpiling in Myanmar.

His Excellency U Myo Myint Oo
Union Minister
Ministry of Energy, Myanmar

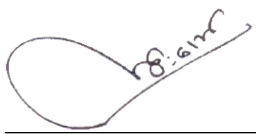
Acknowledgements

Myanmar imports petroleum products. Therefore, securing the petroleum supply (import) is crucial. This study provides several ideas for preparing strategic oil stockpiling in Myanmar to avoid serious economic and social damages due to an oil supply shortage.

On behalf of the Ministry of Energy, I am especially grateful to the Economic Research Institute for ASEAN and East Asia (ERIA). Likewise, I sincerely thank the authors from the Institute of Energy and Economics, Japan, for contributing to the preparation of this thematic report.

Special thanks go to the Oil and Gas Planning Department for their leading role. I also appreciate the Steering Committee and Working Group members of the Strategic Oil Stockpiling in Myanmar participating in this research. I believe this report will be useful for establishing Myanmar's strategic oil stockpiling system and would be ideal for the investment frameworks of government policy.

Special acknowledgement is also given to Shigeru Kimura of ERIA and his team for their excellent contribution to this project.



U Min Maw
Director General
Oil and Gas Planning Department
Ministry of Energy, Myanmar

List of Project Members

Shigeru Kimura, Special Advisor on Energy Affairs, ERIA

Alloysius Joko Purwanto, Energy Economist, ERIA

Yoshihiko Omori, Board Member, Director, Charge of Fossil Energies and International Cooperation Unit, IEEJ

Tetsuo Morikawa, Senior Economist, Manager, Oil Group, Fossil Energies and International Cooperation Unit, IEEJ

Kenji Masuya, Senior Researcher, Oil Group, Fossil Energies and International
Cooperation Unit, IEEJ

Steering Committee

U Win Maw, Director General, Oil and Gas Planning Department, MOE

U Min Min Oo, Deputy Permanent Secretary, Ministry of Energy, MOE

U Saw Sithu Hlaing, Deputy Director General, Department of Electric Power Planning, MOEP

U Aung Soe Min, Deputy Director General, Oil and Gas Planning Department, MOE

U Htet Shan Phyo, Deputy Director General, Petroleum Products Regulatory Department, MOE

U Thet Htun, Deputy Managing Director, Myanma Oil and Gas Enterprise, MOE

U Kyaw Min Thu, Assistant Secretary, Ministry of Energy, MOE

U Pyae Sone Chan Thar, Assistant Secretary, Ministry of Energy, MOE

U Tin Zaw Myint, Director, Myanma Petrochemical Enterprise, MOE

Daw Yin Yin Aung, Director, Myanma Petrochemical Enterprise, MOE

Oil Stockpiling Members

Daw Wint Thiri Swe, Director, Oil and Gas Planning Department, MOE

U Aung Myo Thant, Director, Petroleum Products Regulatory Department, MOE

U Min Min Zaw, Director, Petroleum Products Regulatory Department, MOE

U Ye Tint, Director, Myanma Oil and Gas Enterprise, MOE

Daw Khin Thein Yi, Director, Myanma Oil and Gas Enterprise, MOE

U Tin Zaw Myint, Director, Myanma Petrochemical Enterprise, MOE

Daw Yin Yin Aung, Director, Myanma Petrochemical Enterprise, MOE

Daw Soe Soe Nyein, Deputy Director, Oil and Gas Planning Department, MOE

Daw Win Win Kyu, Deputy Director, Oil and Gas Planning Department, MOE

Daw Swe Swe Than, Deputy Director, Oil and Gas Planning Department, MOE

U Tin Moe Oo, Deputy Director, Myanma Petrochemical Enterprise, MOE

U Soe Thiha, Myanmar Petroleum Trade Association

Table of Contents

	Preface	iii
	Acknowledgements	iv
	List of Project Members	v
	List of Figures	viii
	List of Tables	ix
	List of Abbreviations and Acronyms	x
	Executive Summary	xi
Chapter 1	Introduction	1
Chapter 2	Basic Concept of an Oil Strategic Stockpiling System	4
Chapter 3	Recommended Oil Stockpiling for Myanmar	20
Chapter 4	Recommended Road Maps of Oil Stockpiling System	28
	References	34

List of Figures

Figure 1.1	Major Oil Supply Disruptions	1
Figure 2.1	Oil Storage Options	5
Figure 2.2	Concept of Ticket Stockpiling	6
Figure 2.3	Concept of Joint Stockpiling with Crude Exporter	7
Figure 2.4	Oil Stockpiling Cost by Facility Type	8
Figure 2.5	Cost–Benefit Comparison	9
Figure 2.6	Oil Stockpiling Cost in Indonesia, the Philippines, and Viet Nam, by Development Option	10
Figure 2.7	Average Oil Stockpiling Cost in Indonesia, the Philippines, and Viet Nam	11
Figure 2.8	Cost–Benefit Comparison of Oil Stockpiling in Indonesia, the Philippines, and Viet Nam	11
Figure 2.9	Emergency Response Framework by the IEA	12
Figure 2.10	US Oil Stock, as of May 2022	14
Figure 2.11	SPR Sites in the US	14
Figure 2.12	Oil Stock in OECD Europe, as of May 2022	16
Figure 2.13	Oil Infrastructure in Europe	16
Figure 2.14	Government Oil Stockpiling Sites in Japan	18
Figure 3.1	Energy Mix Outlook in Myanmar	20
Figure 3.2	Oil Demand Outlook by Sector in Myanmar	21
Figure 3.3	Oil Supply Outlook in Myanmar	22
Figure 3.4	Unit Cost Estimate	27
Figure 4.1	Road Map for Oil Stockpiling Development in Myanmar (Option 1)	30
Figure 4.2	Road Map for Oil Stockpiling Development in Myanmar (Option 2)	31

List of Tables

Table 1.1	Oil Supply Risks and Countermeasures	2
Table 2.1	Oil Stockpiling by Ownership	4
Table 2.2	Joint Stockpiling Agreements between Japan and Middle East Crude Exporters	19
Table 3.1	Refineries in Myanmar	22
Table 3.2	Oil Storages in Myanmar	23
Table 3.3	Possible Oil Stockpiling Options in 2040 for Myanmar	25
Table 3.4	Main Assumptions for Cost Estimates	26

List of Abbreviations and Acronyms

ADNOC	Abu Dhabi National Oil Company
ASEAN	Association of South East Asian Nations
CAPEX	capital expenditure
DOE	US Department of Energy
ERIA	Economic Research Institute for ASEAN and East Asia
IEA	International Energy Agency
IEEJ	The Institute of Energy Economics Japan
IEP	International Energy Programme
JOGMEC	Japan Organization for Metals and Energy Security
KAPSARC	King Abdullah Petroleum Studies and Research Center
KPC	Kuwait Petroleum Corporation
kb/d	thousand barrels per day
mb/d	million barrels per day
METI	Ministry of Economy, Trade and Industry
Mt	million tonnes
Mtoe	million tonnes of oil equivalent
OECD	Organisation for Economic Cooperation and Development
SPR	Strategic Petroleum Reserves
US	United States

Executive Summary

Strategic oil stockpiling incurs capital and fuel costs. However, it also returns some benefits, such as (i) continuous use of petroleum products at lower prices during emergencies (oil price hikes during emergencies), (ii) mitigation of economic and social damage during emergencies, and (iii) declining oil consumption applying short-term measures of emergency preparedness and response. The benefits are usually bigger than the costs if an oil price hike is significant compared to an ordinary oil price.

There are several ways of constructing strategic oil stockpiling. Ticket stockpiling is the lowest way, followed by joint stockpiling, underground, onshore tanks, and offshore tankers. At the initial stage, this report recommends applying ticket stockpiling with a foreign country, such as Thailand and Viet Nam, if available. At the next stage, joint stockpiling is recommended, such as ASEAN joint stockpiling in collaboration with Middle East countries such as Saudi Arabia and the United Arab Emirates. Lastly, Myanmar will establish a physical stockpiling system applying underground, onshore, and offshore ways.

However, before starting the construction of strategic oil stockpiling, the government should consider the regulatory framework of stockpiling. Under the legal framework of strategic oil stockpiling, the public and private sectors can proceed with an appropriate oil stockpiling system on a mandatory basis.

Due to the current regulation, private oil companies are requested to stock 34 days of petroleum products. However, this report suggests that the Ministry of Energy, Myanmar, hold 45 days by 2030 and 60 days by 2040 nationwide considering the increase in petroleum demand in the future and for emergencies and actual stockpiling of international society. In addition, 5 days of international cooperation ticket stockpiling will be secured. These 60 days national stock will come from the private sector (40) and the Strategic Petroleum Reserves (SPR) by the government (20). If Myanmar installs a refinery with a 5 Mt/y capacity, oil stockpiling in 2040 will change to products (50), crude oil (10), and ticket and joint stockpiling (10). By contributor, the private sector will hold the products for 34 days, followed by SPR by the government (26).

How can 60 days of national oil stockpiling be achieved? This report suggests the following steps until 2040:

2022–2025: Forming national consensus on the necessity of stockpiling system and (i) finalising a stockpiling plan, (ii) amending laws and legislation, (iii) conducting site feasibility study, and (iv) consulting with potential partners regarding the ticket and joint stockpiling.

2025–2030: (i) Larger stock obligation for the private sector, (ii) establishment of SPR, (iii) construction, (iv) knowledge transfer from International Energy Agency (IEA) countries, (v) periodical emergency drills, and (vi) signing ticket and joint stockpiling agreement

2030–2040: (i) Build up private stock, (ii) build up SPR, (iii) transfer knowledge from IEA countries, (iv) periodical emergency drills, (v) build up ticket and joint stockpiling

A 20-year stockpiling establishment plan is appropriate for Myanmar. The Oil and Gas Planning Department, Ministry of Energy of Myanmar, will prepare this plan with the support of the Organisation for Economic Co-operation and Development (OECD) countries, such as Australia and Japan.

Chapter 1
Introduction

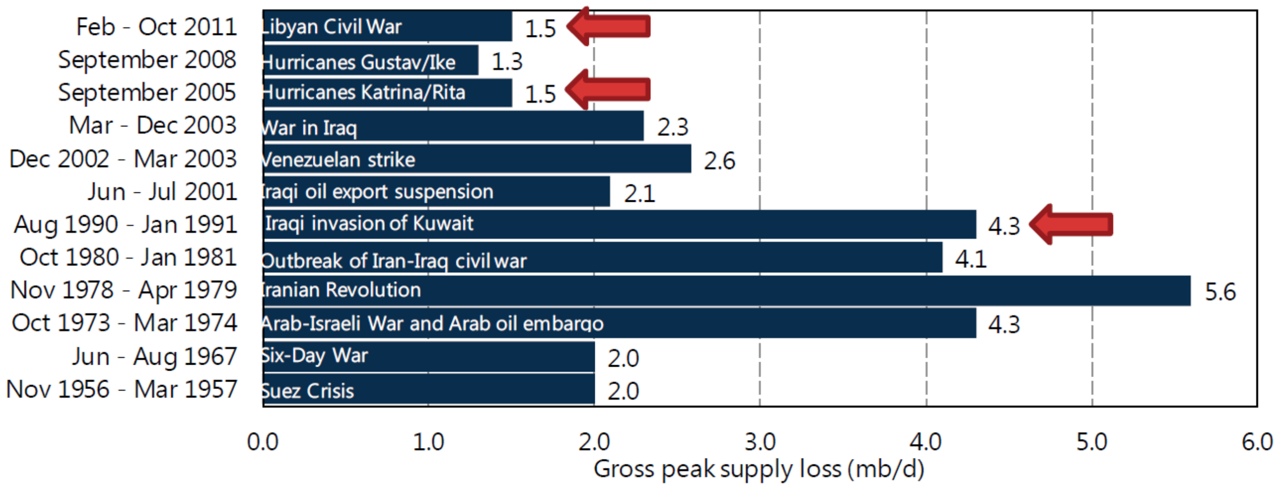
Oil demand is growing rapidly in Myanmar, and import dependency was as high as 95% in 2019. The demand growth will likely continue, albeit at a lower rate, towards 2050. Thus, oil supply security is and will be vulnerable, and one solution is to expand oil stockpiling for the country. This study seeks appropriate stockpiling methods for Myanmar at an affordable cost, appropriate stockpiling level, and appropriate sharing ratio between the public and private sectors. This introductory chapter intends to set the scene for the discussion, explaining why oil stockpiling is necessary and describing the history of oil stockpiling, mainly in IEA member countries.

1. Risks and Countermeasures of Oil Supply[1]

The year 2022 highlights a renewed interest in oil supply security because of the war in Ukraine. The Western countries introduced various sanctions on Russia to support Ukraine. More relevantly, for this study on oil stockpiling, IEA member countries released an unprecedented amount of oil to address supply insecurity.

Oil supply insecurity is nothing new. Figure 1.1 summarises major disruptions until 2011, often caused by revolutions, wars, or strikes in major oil-producing countries. The Arab–Israeli war and Arab oil embargo caused the first oil crisis. During the Iranian Revolution, as much as 5.6 million barrels per day (mb/d), or almost 9%, of the world's total supply was lost, directly causing the second oil crisis.

Figure 1.1. Major Oil Supply Disruptions



mb/d = million barrels per day.
Source: IEA (2014).

[1] This section draws heavily from ERIA (2022).

Supply disruptions continued after 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 nearly 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 has decreased oil production in the county by more than 2 mb/d since the mid-2000s. The war in Ukraine and the anticipated oil supply reduction from Russia is the latest example of supply insecurity. Unfortunately, there is no denying the possibility of supply disruptions in the future.

Energy security is 'the uninterrupted availability of energy sources at an affordable price' (IEA, 2022a). Put differently, energy insecurity is caused by extreme tightening of demand and supply and skyrocketing prices. Table 1.1 summarises the major risks for energy security and countermeasures.

Table 1.1. Oil Supply Risks and Countermeasures

	Supply Disruption Risks	Countermeasures
Upstream (exporting countries)	• War • Terrorist (including cyber) attacks • Industry strikes • Underinvestment	• Security enhancement • Supply expansion
Midstream (transport)	• Piracy and terror (including cyber) attacks • Tanker accident • Sea blockage	• Security enhancement • Tanker re-routing
Downstream (importing countries)	• Natural disasters • Refinery accidents • Terrorist (including cyber) attacks	• Natural disaster–proof infrastructures • Demand control • Stockpiling

Source: Authors.

Considering past supply disruptions, various upstream risks such as wars, terrorist attacks, or industry strikes remain major. Underinvestment (or overinvestment) is arguably part of the market cycle. However, extreme underinvestment will surely deteriorate oil supply security. 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).

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

2. History of Oil Stockpiling

Oil stockpiling has been in place for decades in many advanced economies. As far as the author can verify, France legislated stockpiling obligations onto oil companies as early as 1928; Italy followed shortly after in 1933 (JOGMEC, 1994). These two countries have been significant net importers concerned about oil supply security. Although the necessity of oil stockpiling was widely recognised by the 1960s, the first oil crisis in 1973 clearly urged many importing countries to stockpile. Indeed, the establishment of the IEA by the OECD in 1974 directly resulted from the crisis. From then on, the IEA supervised oil stockpiling and release in OECD countries.

The basis of the IEA oil stockpiling is summarised in the International Energy Programme (IEP) in 1974. It outlines four response measures to address supply shortages: stock release, demand restriction, fuel switching, and increasing domestic production to address supply shortages. It is also the IEP that obliged countries to hold net oil imports for 60 days (later enhanced to 90 days). One IEP article specifies that a 7% loss of oil supply during the most recent four quarters will activate emergency actions, such as oil sharing between IEA member countries.

However, even in the second oil crisis in 1979-1980, IEP measures were not activated since the loss was less than 7%. Some flexibility was called for to activate easily collective actions by the programme. As a result, the IEA formulated coordinated emergency measures (CERM) in 1984. CERM emphasises coordinated stock release because adequate stock had been built in the early 1980s, and stock release was immediately effective in covering the supply loss. With CERM, the IEA now recommends that its member countries implement action(s) like a stock release, not just once a significant supply disruption occurs but when one is 'likely to occur' in the 'very near future'.[2] Past stock releases by the IEA were implemented following CERM. The IEA stockpiling scheme will be detailed in the next chapter.

Oil stockpiling is widely introduced worldwide, although the details are often not disclosed to the public. China formulated an oil stockpiling policy in the 10th Five-Year Plan in 2001. Building up stocks since then, China reportedly held nearly 90 days of oil import as of December 2021 (Reuters, 2021). India also established an SPR in 2004. As of 2018, there were 46 days of oil stock, including SPR, in India (JOGMEC, 2020).

The importance of oil stockpiling is well recognised in ASEAN countries, too. It is not clear which country started and when, but now many ASEAN countries legislate and implement oil stockpiling, most of which is held by the industry. While the actual stockpiled amount is not often disclosed, The Institute of Energy and Economics, Japan, (IEEJ) assumes that most ASEAN countries hold 20–50 days of demand, mostly oil products.

[2] Note the flexibility in wording such as 'likely to occur' and 'very near future'.

Chapter 2

Basic Concept of an Oil Strategic Stockpiling System

This chapter outlines the basic concept of an oil strategic stockpiling system regarding ownership, storage options, and nationality. It also describes stockpiling schemes in IEA countries. The stockpiling system amongst these countries varies depending on the oil fundamentals of each country, such as import dependency, refining capacity, and interconnection with neighbouring countries.

1. Oil Stockpiling Types

1.1. Ownership

Having a certain 'commercial stock' is a standard practice in the oil industry, and not necessarily for supply security purposes. For instance, oil companies typically build stocks in spring and autumn to meet summer and winter peak demand. Once companies stock excess oil because of regulatory obligations, companies are said to 'stockpile' or build 'stockpiling'. Nevertheless, the commercial stock is usually included in the total stockpiling quantity (days).

Industry stockpiling is obviously owned by private or state-owned companies, more precisely, oil producers, importers, refiners, or distributors. Public stockpiling is called 'Strategic Petroleum Reserves' or SPR. As this name suggests, public stockpiling is specifically for oil security of supply, and its quantity changes little, regardless of the demand fluctuations. Governments usually own public stockpiling. But some European countries established a dedicated agency for oil stockpiling, named 'Central Stockpiling Entity', which controls public stockpiling on behalf of the government.

Table 2.1. Oil Stockpiling by Ownership

Industry	Public
Commercial Stock	
Stockpiling obliged by government	Stockpiling by government or stockpiling agency (Strategic Petroleum Reserves: SPR)

Source: Authors.

1.2. Storage Options

Oil stockpiling can be differentiated by where storage is built. The most common method is onshore tanks, typically at refineries, import terminals, and other dedicated sites. Occasionally, offshore floating storage is utilised where land availability is limited. Oil can be stored underground where a suitable geological structure is in place, typically rock caverns. Underground storage with suitable geological structures is common in the US and Europe. For example, all the US SPR is stored in underground storage.

Figure 2.1. Oil Storage Options

Sources: DOE (2022), JOGMEC (2022a), JTC (2022).

1.3. Nationality[3]

1) National initiative

Oil stockpiling aims to address the supply shortage of oil in a country. Therefore, the domestic oil industry or government is naturally the main body in charge of developing and maintaining stockpiling and releasing stockpiled oil. Most oil stockpiling worldwide was developed by domestic oil industries and governments.

As mentioned earlier, holding a certain amount of stock is standard in the oil industry to adjust demand and supply. Therefore, many countries developed oil stockpiling first based on commercial industry stock by obliging oil companies to hold a particular stock and introducing government stock or SPR later.

[3] This section draws heavily from ERIA (2022).

2) International initiatives

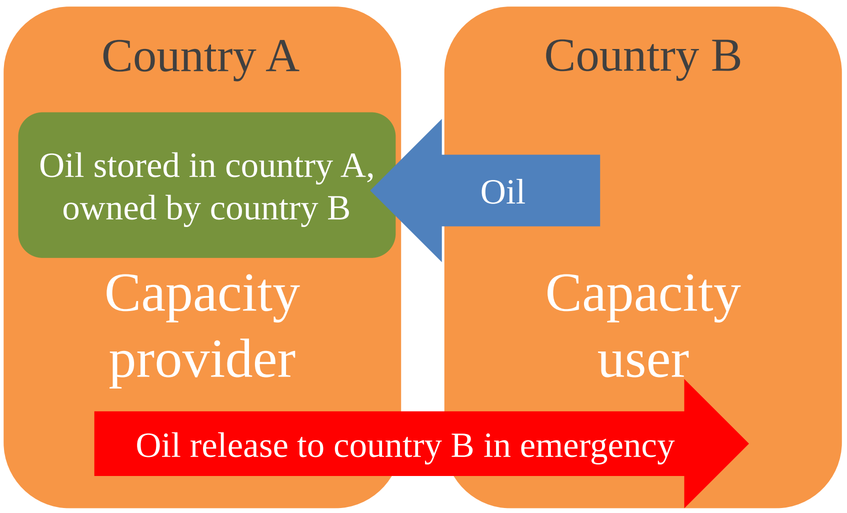
While national initiatives are and will be the mainstream of oil stockpiling worldwide, there are international initiatives involving foreign governments or companies in ticket stockpiling and joint stockpiling.

a) 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 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.

Ticket stockpiling is widely used in Europe. In Asia-Pacific, Japan implements ticket stockpiling for New Zealand. The governments of Japan and New Zealand made an agreement in 2007. Thus, a Japanese oil company and the Government of New Zealand subsequently made a contract under which New Zealand would pay a ticket fee. The Japanese oil company promised to supply petroleum products to New Zealand in an emergency.

Figure 2.2. Concept of Ticket Stockpiling



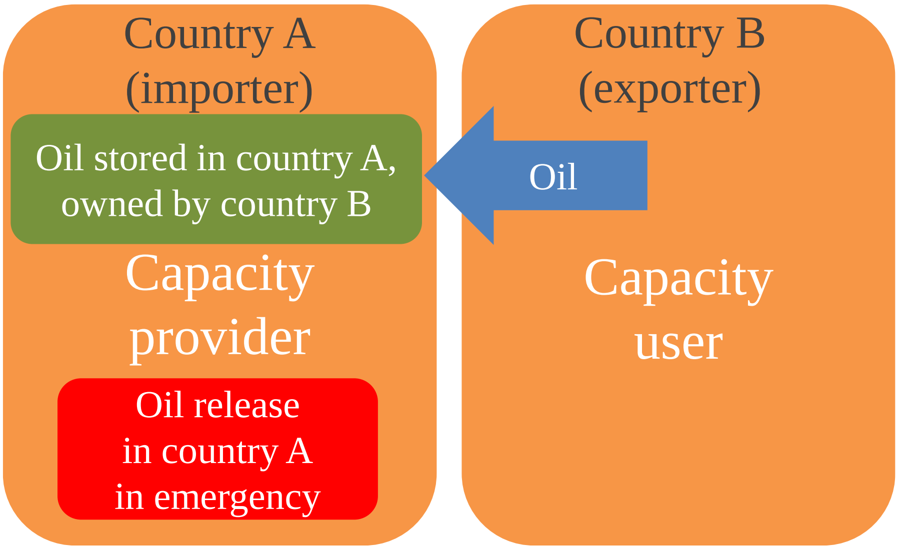
Source: Authors.

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 the capital expenditure (CAPEX) (e.g. tanks, jetties, pumps). However, ticket costs depend on a bilateral contract between the capacity provider and the user. In addition, international ticket stockpiling could evoke national security concerns because oil is stored in another country, especially if said country is far away. Nevertheless, ticket stockpiling is cheaper and could play a supplemental role for many countries, including Myanmar.

3) Joint stockpiling with oil exporters

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 keep 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, enabling an importing country to add to its SPR at a reduced cost (KAPSARC, 2017). The exporter benefits from the commercial use of the storage facilities close to the demand areas.

Figure 2.3. Concept of Joint Stockpiling with Crude Exporter



Source: Authors.

Joint stockpiling is growing in Asia. For example, Japan, Korea, and India have agreements with crude exporters in the Middle East. However, it is essential to note that substantial crude demand (i.e. refineries with significant utilisation rates) is a prerequisite for joint stockpiling to attract crude exporters.

Joint stockpiling with product exporters is theoretically possible, although the author cannot confirm the existence of such a scheme for public stockpiling. Oil exporters, importers, or both commonly build or lease storage capacity in an importing country for commercial operation. If the importing country's government can adequately incentivise product exporters and importers to stock excess products for supply security, that would be joint stockpiling of products. As with joint crude stockpiling, an importing country could offer free storage to the exporter as an incentive. However, this scheme will not work unless it is commercially viable for the exporter. Thus, governments must create a stable and favourable investment climate before inviting exporters to participate. Oil stockpiling alone has no commercial value, so governments must align commercial viability with oil supply security policy.

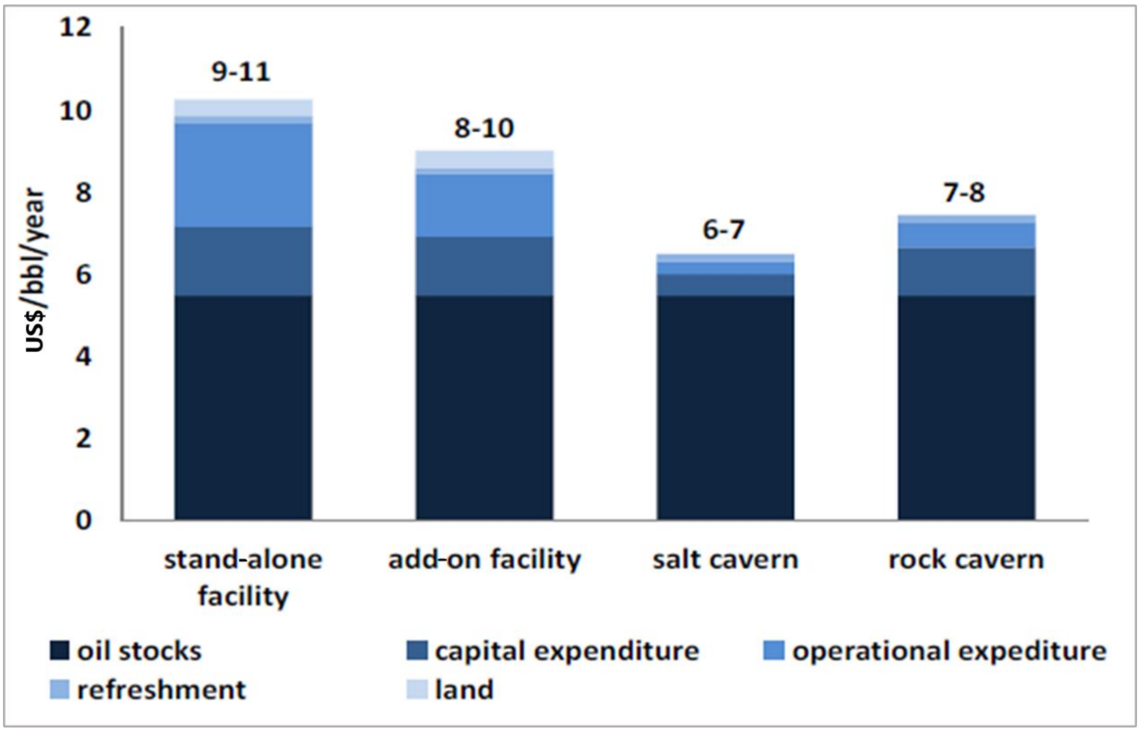
2. Earlier Studies on the Cost and Benefit of Oil Stockpiling

2.1. IEA Studies

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

The 2013 study conducted a quantitative analysis and compared the cost and benefit of holding oil stockpiles. Depending on facility type, the cost is estimated at US$6–US$11 per barrel. The salt cavern is the cheapest, and the stand-alone facility is the most expensive. Oil stocks (commodity cost) are the largest cost component.

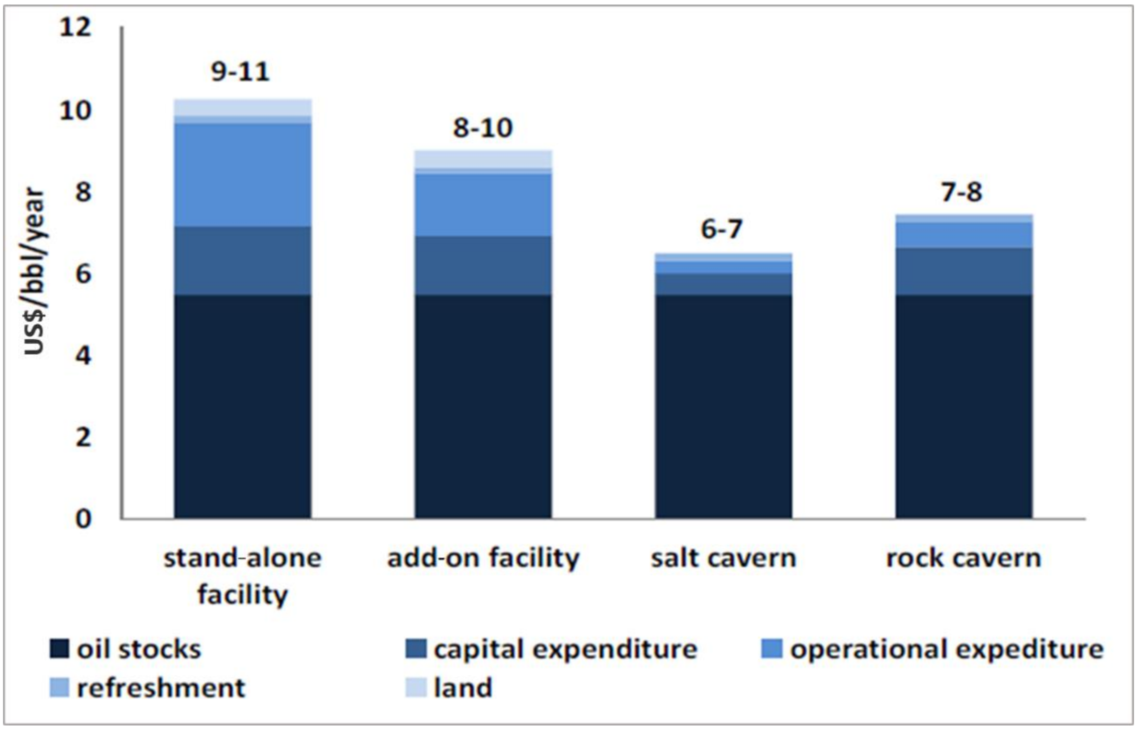
Figure 2.4. Oil Stockpiling Cost by Facility Type



bbl = barrel.
Source: IEA (2013).

The 2013 study evaluated the benefit of oil stockpiling, using the estimated economic loss to the world caused by oil supply disruptions. The study concluded that the net benefit of oil stockpiling ranges from US$11 to US$14 per barrel for IEA countries and US$20 to US$23 per barrel for non-IEA countries.

Figure 2.5. Cost–Benefit Comparison



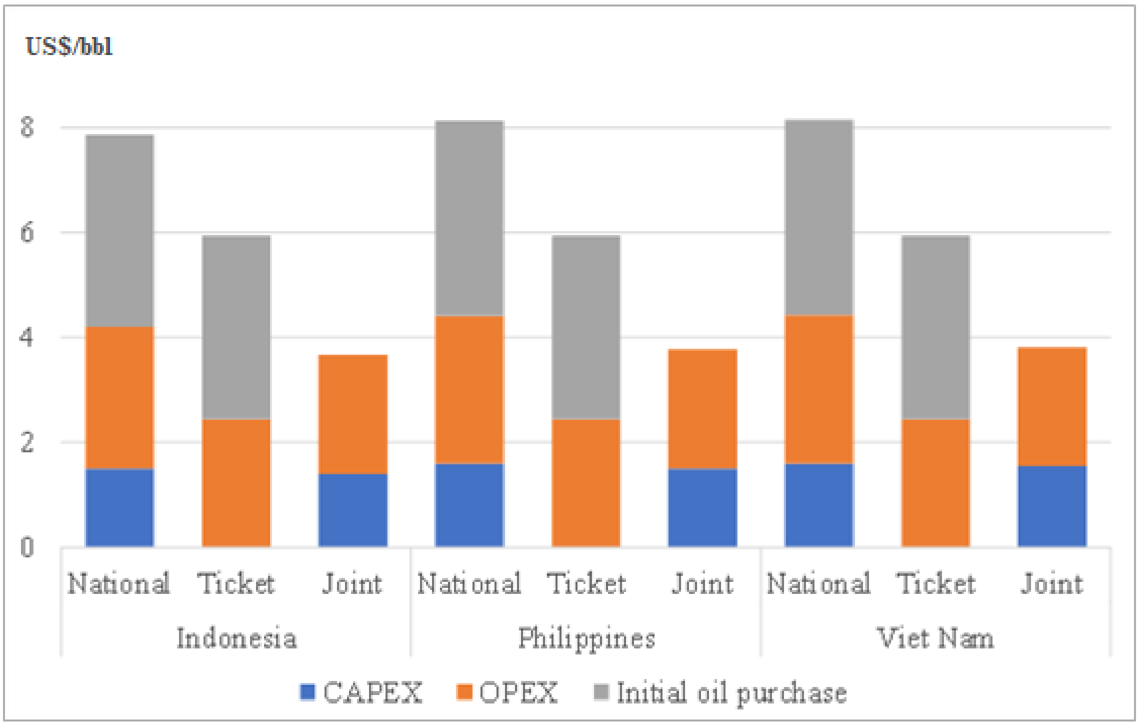
bbl = barrel.
Source: IEA (2013).

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. This IEA study reaffirms that the benefit of stockpiling outweighs the cost.

2.2. ERIA Study

While the IEA studies considered IEA member countries, ERIA (2022) focused on three ASEAN countries: Indonesia, the Philippines, and Viet Nam. This study also considered different stockpiling schemes, like ticket and joint stockpiling, because they are much cheaper. While a national initiative costs US$7.9–US$8.2/bbl, ticket stockpiling costs US$5.9/bbl. According to the analysis, joint stockpiling is the cheapest at US$3.7–US$3.8/bbl.

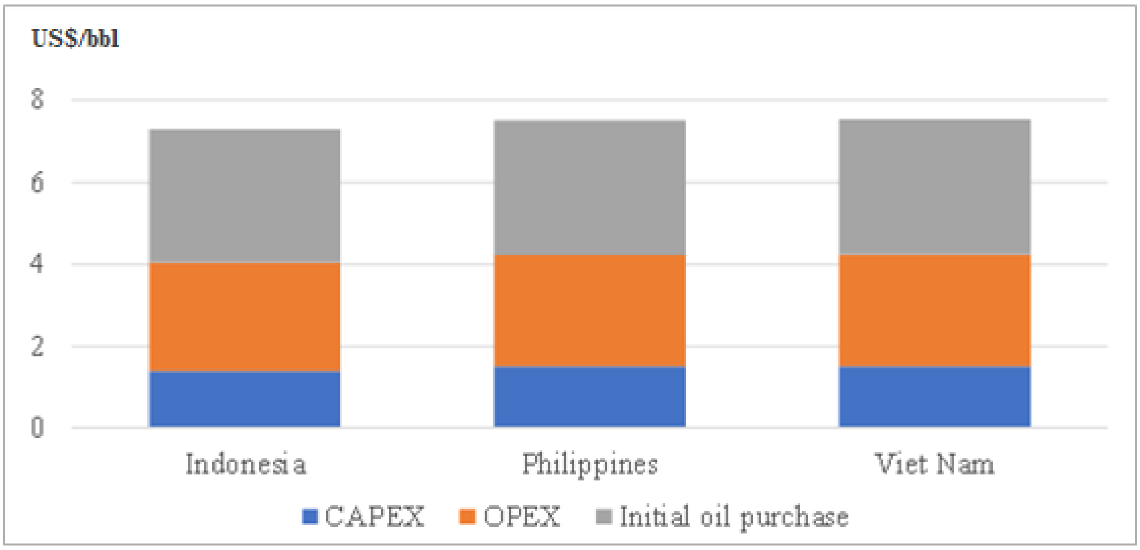
Figure 2.6. Oil Stockpiling Cost in Indonesia, the Philippines, and Viet Nam, by Development Option



bbl = barrel.
Source: ERIA (2022).

Considering that national initiative is and will be the main option when a country develops oil stockpiling, this study assumes that a 90-day stock will consist of 75 days of national development, 10 days of joint stockpiling, and 5 days of ticket stockpiling. The unit cost of this combination will be US$7.3–US$7.6/bbl.

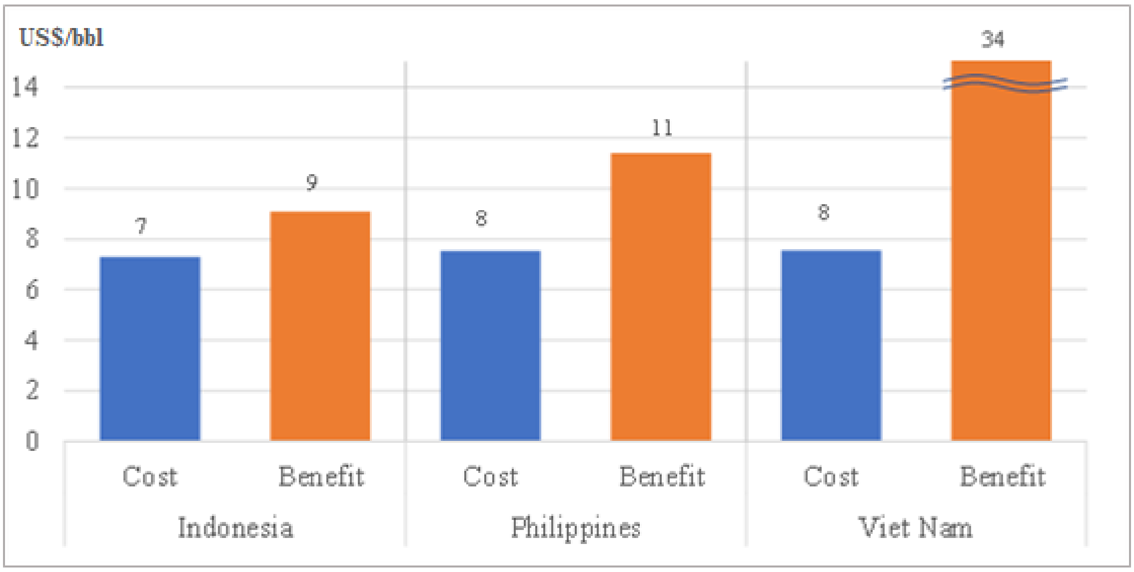
Figure 2.7. Average Oil Stockpiling Cost in Indonesia, the Philippines, and Viet Nam



bbl = barrel, CAPEX = capital expenditure, OPEX = operational expenditure.
Source: ERIA (2022).

The same ERIA study included a benefit analysis, which assumed different disruption scenarios with the probability of 4% per year and no disruption case. The benefit is estimated at US$9.1/bbl for Indonesia, US$11.4/bbl for the Philippines, and US$34.4/bbl for Viet Nam, which exceeds the cost for these countries. The benefit in Viet Nam is exceptionally high, mainly because of the large disruption volume in the South China Sea blockade.

Figure 2.8. Cost–Benefit Comparison of Oil Stockpiling in Indonesia, the Philippines, and Viet Nam



bbl = barrel.
Source: ERIA (2022).

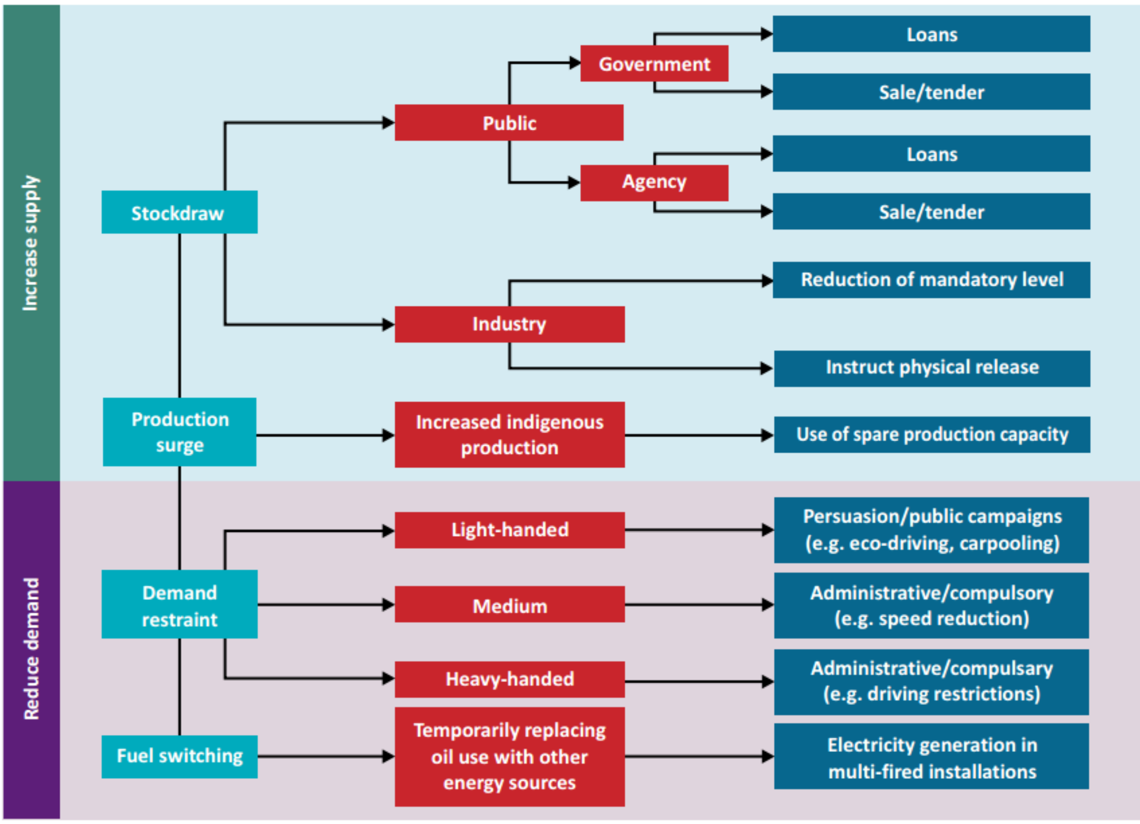
3. Oil Stockpiling in the IEA

3.1. IEA Emergency Response System

Established by the OECD in 1974, the IEA currently has 31 member countries. While IEA's work areas expanded over the years, oil security and stockpiling remain the organisation's core functions. IEA stockpiling is important because it has a long history, covers most of the world, and discloses key information on stockpiling. Therefore, understanding the IEA scheme is helpful for Myanmar in designing its oil stockpiling.

Chapter 1 already mentioned the history of the IEA stockpiling scheme briefly. The IEA scheme is a part of the emergency response framework, whereby oil stock draw and production surges are envisaged as measures to increase supply. It is worth noting that the member countries can reduce demand to secure the supply for consumers who most need it, like households or the public sector. However, demand reduction is not the scope of this study.

Figure 2.9. Emergency Response Framework by the IEA



Source: IEA (2015a).

According to its governing board's decision in 1984, the IEA considers the following issues to assess supply disruption (IEA, 1995):

- origins and causes of the disruption and their probable evolution; its magnitude (after taking into account alternative supply potential); and its probable duration;
- the general state of the world economy;
- probable impact of the supply disruption on particular countries, given the circumstances of their energy economies;
- the current nature and condition of the oil markets, including seasonal factors, and any pertinent situation in any segment of the oil markets;
- current available stock levels and the speed at which they effectively can be brought into the marketplace;
- the probable effects of any actions pursuant to the December 1981 Decision or under the IEP;
- availability, timing, and quantitative effectiveness of oil consumption reduction measures; and
- any other factors which appear to be material in the circumstances

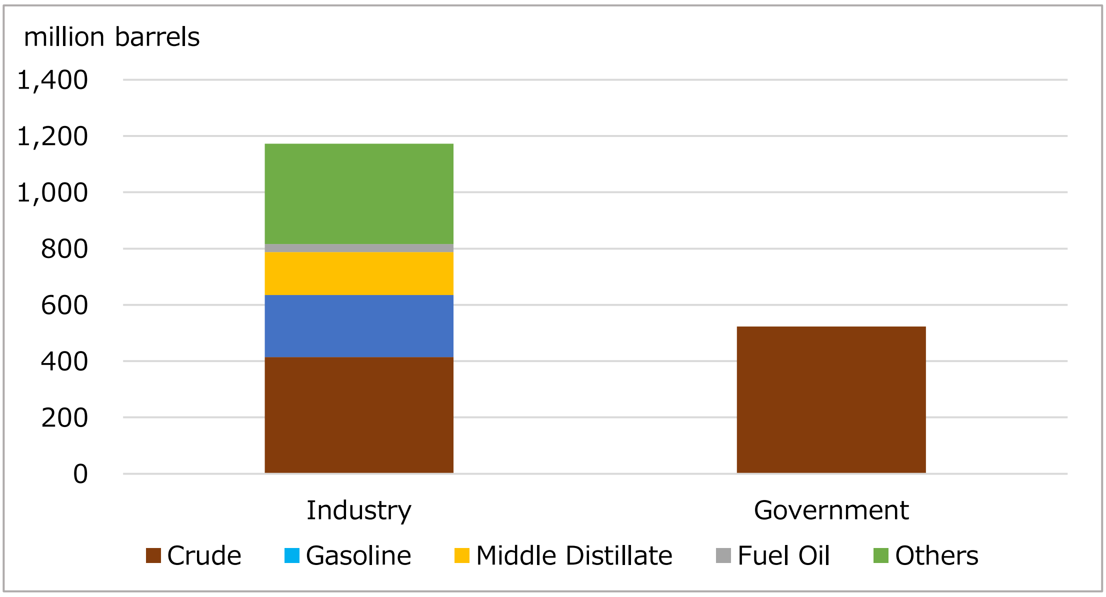
No numerical standards are given here. The IEA governing board assesses all the above issues and determines what action, including stock release, would be advisable to the member countries. For the sake of flexibility, the IEA stock release decision now is not restricted to the extent of supply loss. On the other hand, we can also say that the decision criteria are intentionally ambiguous.

3.2. Individual IEA Member Country and Region

(1) US

The oil stock in the US, which is the largest oil producer and consumer, is also the largest in the world. The total stock amount as of May 2022 was 1,696 million barrels (mb), comprising 1,173 mb of industry stock and 523 mb of SPR. The US has no industry stockpiling obligations, so the industry stocks are commercial. SPR quality is all crude because of the country's cheaper storage cost and adequate commercial product stock. Four SPR sites are all underground facilities in the Gulf region because of lower cost, safety, and good connection to pipelines and ports.

Figure 2.10. US Oil Stock, as of May 2022



Source: IEA (2022c).

Figure 2.11. SPR Sites in the US

Source: DOE (2022).

SPR was first proposed in 1944 but established in 1975 by the Energy Policy and Conservation Act of 1975. This comprehensive law, enforced only 2 years after the first oil crisis, enhances energy security by covering SPR, domestic production stimulation, energy efficiency, and crude oil export ban. In formulating the Act, industry stockpiling obligation was discussed but dropped due to strong opposition from the industry, which distrusted government intervention, and objected cost burden.

Two supplemental stockpiling measures have a substantial demand, specifically for the country's northwest region. The first is the Northeast Home Heating Oil Reserve, established in 2000 to enhance heating oil supply security in the northwest region that relies on heating oil for space heating in winter. The second is the Northeast Gasoline Supply Reserve, established in 2012 to address regional gasoline supply shortages. Under these two schemes, 1 mb of heating oil and 1 mb of gasoline are stored in the northeast.[4]

As for international cooperation, the US has a ticket stockpiling agreement with Australia. (DOE, 2020). The details of the agreement, including quantity and cost, are not disclosed. A similar agreement is discussed with India (Reuters, 2020).

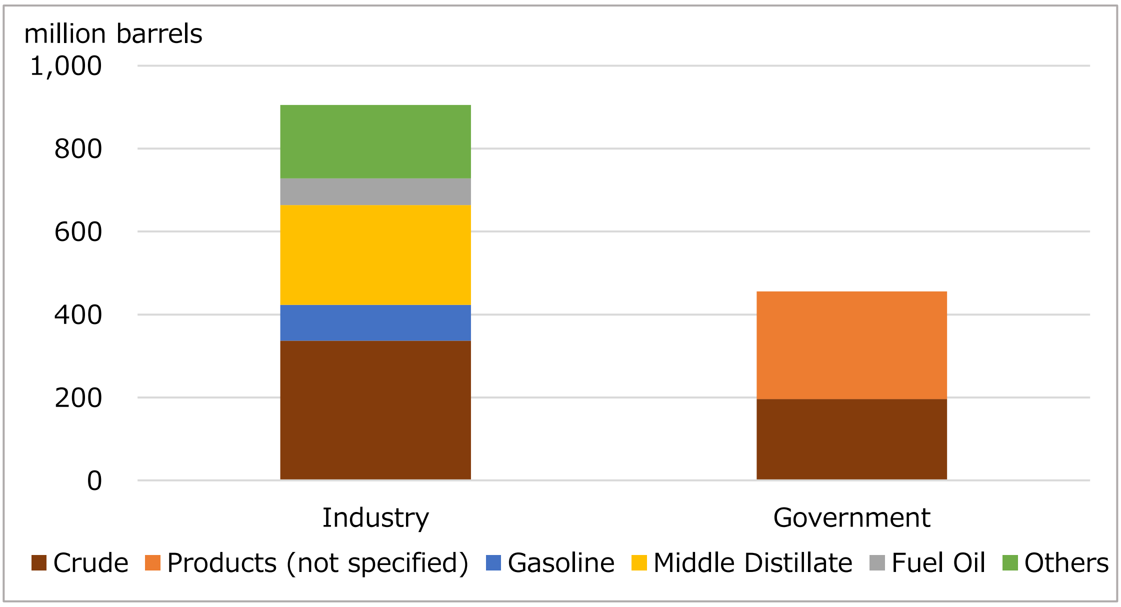
(2) OECD Europe

While OECD Europe shared 13% of the world's oil demand in 2021, its production share was less than 1% in the same year. The EU has always been a significant net importer of oil. The import dependency has been over 90% for the past 10 years. The total stock amount as of May 2022 was 1,361 mb, comprising 905 mb of industry stock and 456 mb of public stockpiling.[5] One difference from the US is that public stockpiling includes products in Europe. The interpretation here is that having products enables quick action to address product shortages rather than having only crude that requires refining to produce gasoline or any other products to reach final consumers. Considering product stockpiling is more costly, having public product stockpiling reflects a sense of supply insecurity in Europe. Public stockpiling locations are understood to scatter across the region, mainly in the form of onshore tanks and underground facilities. However, many countries do not disclose the exact locations for security reasons.

[4] However, these reserves are counted as industry stocks in the IEA statistics.

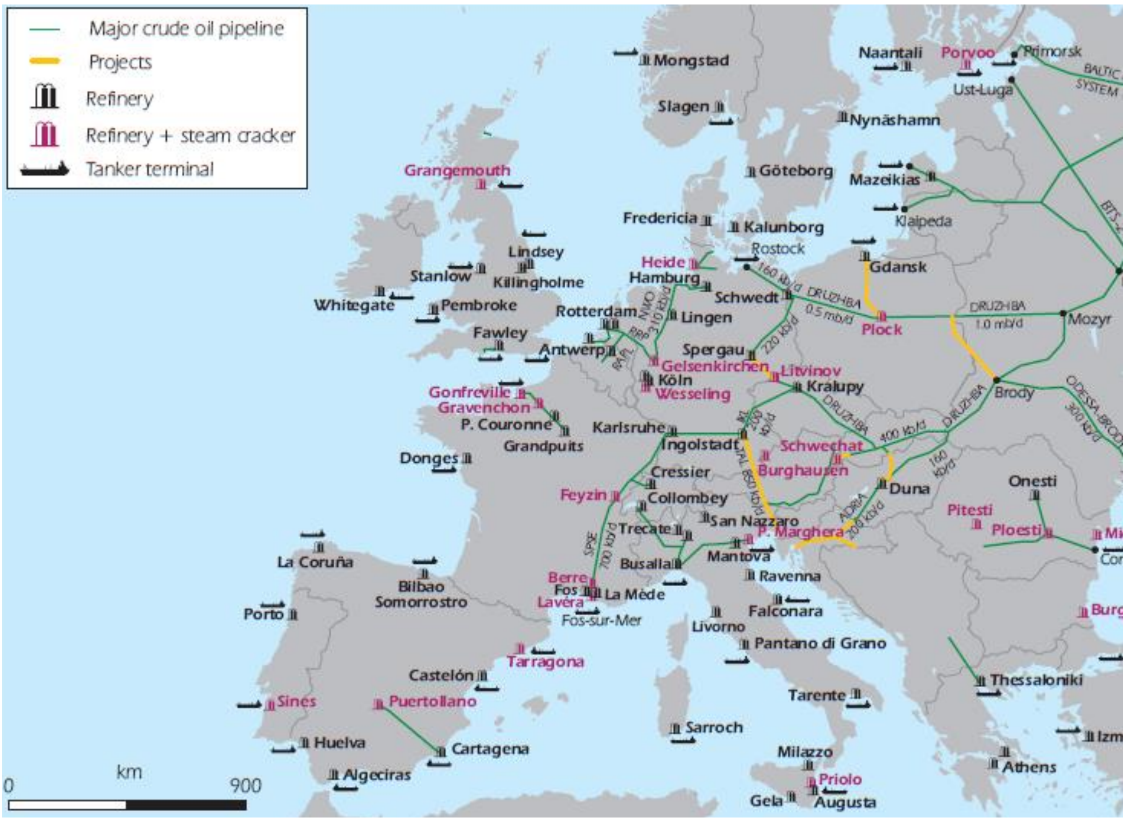
[5] While the term 'SPR' is common to refer to government stockpiling, European Union (EU) countries tend to use 'public stockpiling'.

Figure 2.12. Oil Stock in OECD Europe, as of May 2022



Source: IEA (2022c).

Figure 2.13. Oil Infrastructure in Europe



Source: IEA (2015b).

Being concerned over oil supply security, France and Italy were the first countries that introduced industry oil stockpiling, as mentioned in the previous chapter. After that, individual legislation was gradually integrated into a common framework of the EU. The integration process started in 1968 when European Economic Community (EEC) stockpiling directive (68/414/EEC) was formulated. This directive obliged member countries to stock 65 days of consumption irrespective of industry or public and crude or products. Stock days were increased to 90 days in 1973.

One characteristic of European oil stockpiling is that the EU recommends the central stockpiling entity (CSE), which specialises in oil stockpiling owned by an either national or private entity or mixture. Promoting CSE reflects the lack of a dominant oil industry player and the need to streamline the decision-making process of emergency response. Another distinctive point is that ticket stockpiling is widely used in Europe. Considering many small countries with limited oil infrastructure in the region, ticket stockpiling makes sense for efficiency.

(3) Japan

Japan consumed 3.4 mb/d of oil in 2021, ranking the country as the sixth-largest consumer, sharing 4% of the world's total consumption. With negligible domestic production, oil import dependency is almost 100%. Therefore, like in Europe, oil supply security has been a serious policy issue for the country.

The total stock amount as of May 2022 was 506 mb, comprising 203 mb of industry stock, 294 mb of government stockpiling, and 9 mb of joint stockpiling with crude exporters in the Middle East. Most government stockpiling is crude, but the government also holds some liquefied petroleum gas.

As for government stockpiling, there are 10 sites for crude and 5 sites for LP gas. Storages are onshore and two offshore floating tanks due to limited land availability. In addition, five underground facilities are also in operation. Small land requirements, safety, and little impact on the landscape are advantages of underground facilities (JOGMEC, 2022a).

Figure 2.14. Government Oil Stockpiling Sites in Japan

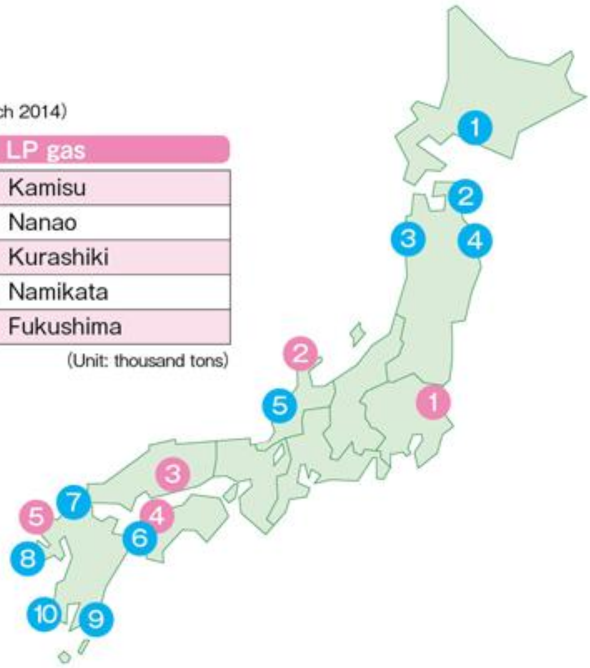
Stockpiling capacity by base (as of the end of March 2014)

Petroleum		
1	640	Tomakomai-Tobu
2	570	Mutsuogawara
3	450	Akita
4	175	Kuji
5	340	Fukui
6	150	Kikuma
7	560	Shirashima
8	440	Kamigotou
9	500	Shibushi
10	175	Kushikino

(Unit: ten thousand KL)

LP gas		
1	200	Kamisu
2	250	Nanao
3	400	Kurashiki
4	450	Namikata
5	200	Fukushima

(Unit: thousand tons)



Source: JOGMEC (2022b).

Although the government recommended industry stockpiling in 1972, the first oil crisis in 1973 and the establishment of the IEA in 1974 triggered the actual legislation. Japan needed to harmonise its stockpiling policy with IEA standards, and the government obliged companies to hold 90 days of consumption in 1975. In addition to industry stockpiling, government stockpiling was introduced in 1978. With the building up of government stocks, the industry stockpiling obligation was eased to 70 days in 1987. The Ministry of Economy, Trade, and Industry (METI) has jurisdiction over oil stockpiling. The state-owned Japan Organization for Metals and Energy Security (JOGMEC) is responsible for the actual stockpiling operation.

Japan started joint oil stockpiling first with Abu Dhabi's ADNOC in 2009, then with Saudi Aramco in 2010, and Kuwait's KPC in 2020. Japan has a ticket stockpiling agreement with New Zealand, although the details are not disclosed to the public.

Table 2.2. Joint Stockpiling Agreements between Japan and Middle East Crude Exporters

Exporter	Year of Initial Deal	Volume (million barrels)
ADNOC (Abu Dhabi)	2009	6.3
Saudi Aramco	2010	8.3
KPC (Kuwait)	2020	3.1

Sources: KAPSARC (2017), METI (2020).

Chapter 3

Recommended Oil Stockpiling for Myanmar

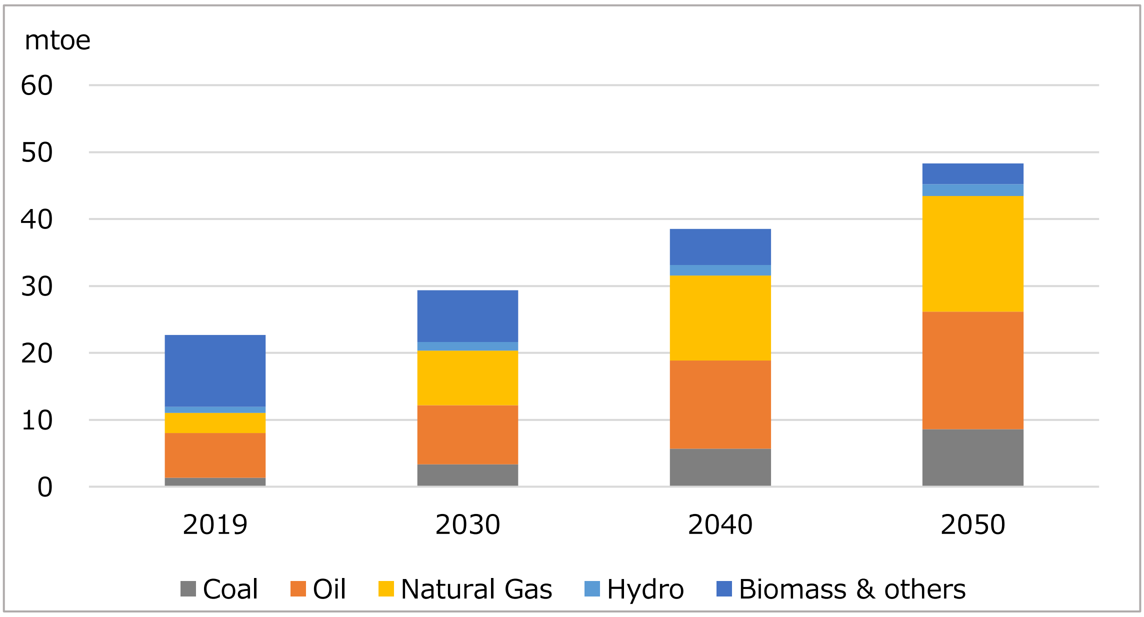
This chapter describes Myanmar's oil fundamentals and outlook. With cost estimates, this chapter also recommends an appropriate oil stockpiling system for the country regarding storage options, quantity, and the role of government and industry.

1. Oil in Myanmar

1.1. Demand Outlook

Apart from non-commercial biomass, oil is the largest energy source in Myanmar. Along with natural gas, oil is expected to remain the primary fuel in the country in the future. Oil demand will grow at 3% per annum to reach 18 million tonnes (Mt) (350 kb/d) in 2050, according to the IEEJ. As a result, the oil share in the energy mix will expand from 29% in 2020 to 36% in 2050.

Figure 3.1. Energy Mix Outlook in Myanmar

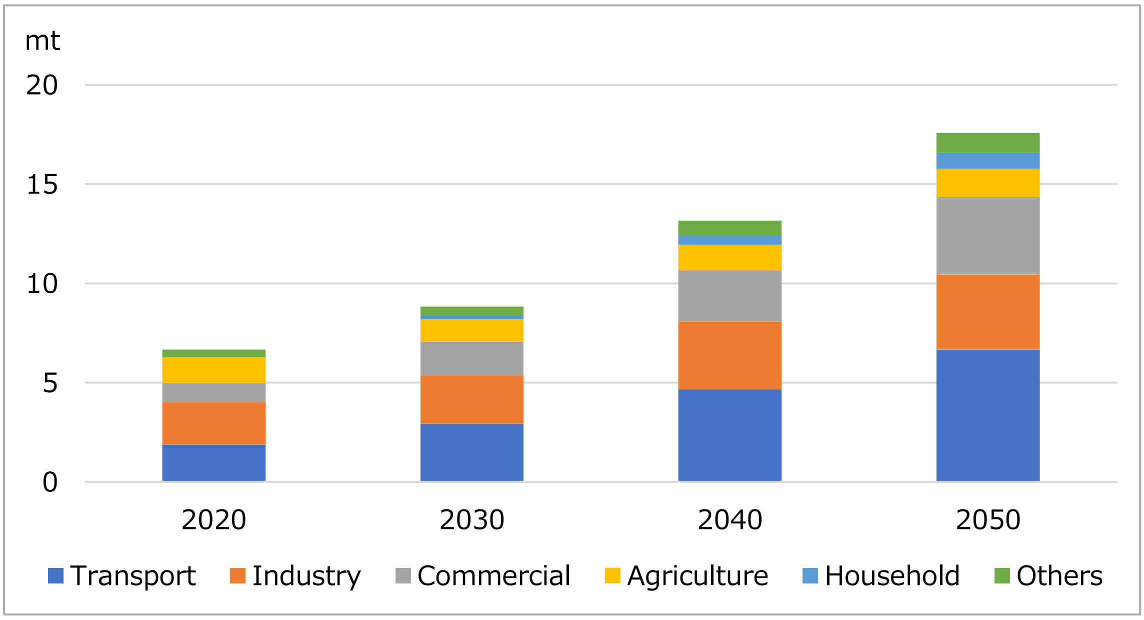


Source: IEEJ (2022).

Industry and transport are the main demand sectors of oil in Myanmar. The industry sector accounted for 32%, and the transport sector for 28% in 2020. The agriculture and commercial sectors follow at 19% and 14% in the same year. While demand growth in agriculture and industry will slow down, transport will accelerate. As a result, the transport sector will share 38%

of the total oil demand in 2050. More than 90% of the demand is currently covered by diesel and gasoline, which are most important for stockpiling in the country.

Figure 3.2. Oil Demand Outlook by Sector in Myanmar

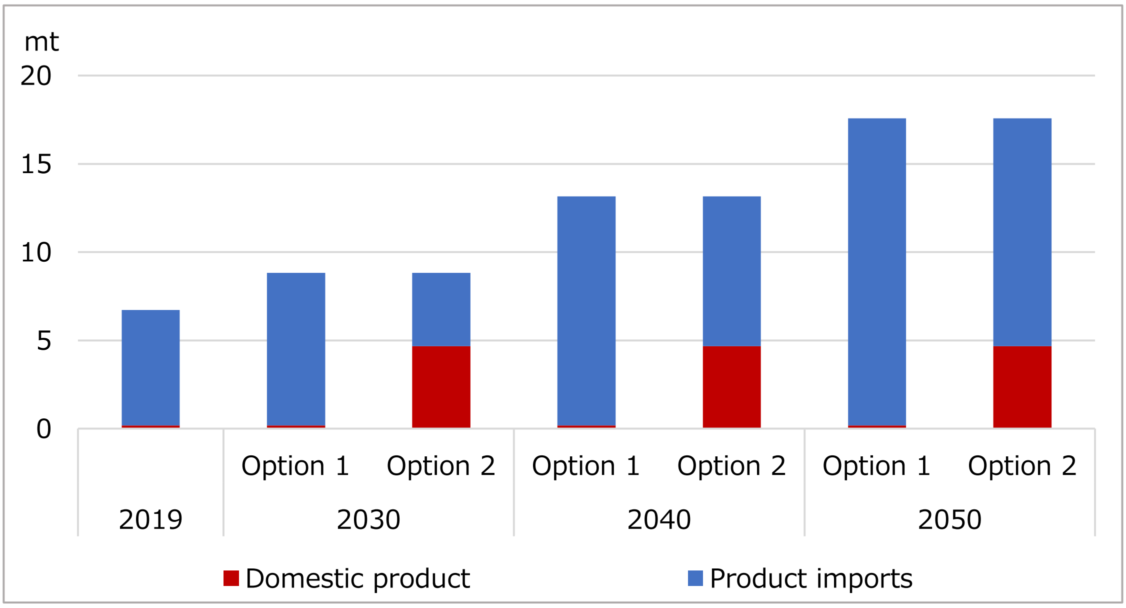


Source: IEEJ (2022).

1.2. Supply Outlook

With negligible crude production and low utilisation of refineries, imported products, mainly diesel and gasoline, meet almost all oil demand. There are two existing refineries, and two are under planning. According to the Ministry of Energy, one of the two new refineries with a crude distillation unit capacity of 5 Mt/y (100 kb/d) could be operational in 2028. Therefore, this study envisages two supply options hereafter. Option 1 considers no new refineries constructed until 2050, and imported products will meet almost all the demand. Option 2 assumes the new refinery will be operational in 2028, and products from this new refinery will meet a considerable part of the demand until 2050.

Figure 3.3. Oil Supply Outlook in Myanmar



Source: IEEJ (2022).

Table 3.1. Refineries in Myanmar

	Name	Design Capacity (kb/d)	Current Capacity (kb/d)	Start Year
Existing	Chauk	5	2	1954
	Thalyin	21	7	1982
Under planning		100		2028
		200		?

Source: Ministry of Energy (2022a).

1.3. Storages

According to the Ministry of Energy (2022a), the total storage capacity in Myanmar is about 200 million gallons (4.7 mb). All storage capacity is based on onshore tanks, mainly at existing refineries. Small capacities at depots are scattered across the country. Storage capacity covers 31 days of gasoline imports and 54 days of diesel imports. However, the IEEJ understands that the total capacity in Table 3.2 does not include capacity at Kyaukpyu Terminal operated by the China National Petroleum Corporation.

In 2019, Myanmar stocked 36 days of gasoline, 35 days of diesel, and 120 days of jet fuel (Ministry of Energy, 2022b). Although the government understands 'all private fuel terminals need to maintain a certain amount of their stocks', no specific stockpiling quantity or days have been legislated (Ministry of Energy, 2022b).

Table 3.2. Oil Storages in Myanmar

Region/State/ Refinery	Gasoline	Diesel	Other Products	Crude	Condensate
Union Territory Nay Pyi Taw	0.3	0.3	N/A		
Yangon Region	0.8	6.7			
Mandalay Region	0.9	12			
Irrawaddy Region	0.4	0.6			
Bago Region	0.6	0.8			
Magway Region	0.5	0.6			
Sagaing Region	0.5	0.7			
Tanintharyi Region	0.1	0.1			
Kachin State	0.4	0.7			
Kayah State	0.1	0.1			
Karen State	0.2	0.1			
Chin State	0.1	0.1			
Mon State	0.4	0.5			
Rakhine State	0.1	0.1			
Shan State	1	1.2			
Refinery	41	76.5	25.2	16	21
Total	47.3	90.2	25.2	16	21

Source: Ministry of Energy (2022a).

2. Appropriate Oil Stockpiling Scheme for Myanmar

2.1. Storage Options

Section 2.1.2 of the previous chapter presented storage options for onshore and offshore tanks and underground facilities. Storage cost seems varied site by site, but the IEA (2013) estimates that underground storage is cheaper than onshore tanks. The IEEJ assumes offshore tanks are the most expensive, although there is a little credible cost estimate for the public.

Important questions when pursuing cheaper options for Myanmar are whether underground facilities of caverns are available and whether storage capacity at the China National Petroleum

Corporation's Kyaukpyu Terminal can be accessed for oil stockpiling for Myanmar. Unfortunately, little open-source information is available for these questions. However, it is certainly worth exploring the possibility of these cheaper and potentially large capacities. However, this study assumes that all additional tanks will be built onshore at the new facility for a more realistic cost estimate.

2.2. Stockpiling Quantity and Quality

As of 2019, there were 36 days of gasoline stock, 35 days of diesel, and 120 days of jet fuel (Ministry of Energy, 2022b). Therefore, considering oil demand by product in 2019, the IEEJ assumes Myanmar held a total oil stock of 34 days of consumption in the same year.

Considering robust demand growth, extremely high import dependency, and substantial supply disruption risks, Myanmar should expand its stockpiling to a significant extent. While the IEA standard of 90 days of net imports could be a benchmark, there might not be a solid rationale for why 90 days are an adequate level of oil stockpiling apart from the fact that 90 days are not proven to be inadequate. Although more stocks will enhance supply security, many developing countries find it too costly to hold a 90-day stock. Thus, determining an appropriate stock quantity (days) requires balancing oil supply security and financial constraints.

This report, considering these issues, sets 60 days' consumption by 2040 as an appropriate target for oil stockpiling quantity in Myanmar. It is also sensible to establish SPR because the security oil supply justifies more government involvement, and the oil industry burden should be minimised. How the 60 days quantity is split between industry and SPR, as well as products and crude, depends on whether new refineries will be built and how each product demand will grow. As described in the previous section, option 1 assumes that no refineries will be built, and option 2 envisages new refineries will be operational in 2028. Here, all the stockpiling for option 1 is assumed to be products – 40 days met by the industry and 20 days by SPR. Option 2 is assumed to include crude and product stockpiling of 26 days owned by SPR. Product stockpiling by industry is assumed to be 34 days in option 2. Table 3.3 summarises possible oil stockpiling options in 2040 for Myanmar.

2.3. International Cooperation

While oil stockpiling is developed mainly by the importing country, Chapter 2 described international schemes, like ticket stockpiling and joint stockpiling, which offer cheaper options. However, Chapter 2 also pointed out that substantial crude demand is a prerequisite for joint crude stockpiling to attract exporters. Although crude joint stockpiling is unrealistic for option 1, it is worth considering option 2, which assumes a new refinery. On the other hand, ticket stockpiling, possibly with neighbouring ASEAN countries, seems sensible for both options. Understanding these international schemes is supplemental to pure national stockpiling development. This study suggests 5 days' ticket product stockpiling for option 1, 5 days' ticket product stockpiling, and 5 days' joint crude stockpiling for option 2.

Table 3.3. Possible Oil Stockpiling Options in 2040 for Myanmar

<table>
<tr><th rowspan="3"></th><th colspan="6">Quantity (kilo tonnes)</th><th colspan="8">Days</th></tr>
<tr><th colspan="2">Industry</th><th colspan="2">SPR</th><th colspan="2">Total</th><th colspan="2">Industry</th><th colspan="2">SPR</th><th colspan="4">Total</th></tr>
<tr><th>Option 1</th><th>Option 2</th><th>Option 1</th><th>Option 2</th><th>Option 1</th><th>Option 2</th><th>Option 1</th><th>Option 2</th><th>Option 1</th><th>Option 2</th><th colspan="2">Option 1</th><th colspan="2">Option 2</th></tr>
<tr><td>Gasoline</td><td>471</td><td>433</td><td>236</td><td>216</td><td>707</td><td>649</td><td>40</td><td>37</td><td>20</td><td>18</td><td>60</td><td rowspan="4">60</td><td>55</td><td rowspan="4">50</td></tr>
<tr><td>Diesel</td><td>1,015</td><td>933</td><td>508</td><td>466</td><td>1,523</td><td>1,399</td><td>40</td><td>37</td><td>20</td><td>18</td><td>60</td><td>55</td></tr>
<tr><td>Jet</td><td>32</td><td>30</td><td>16</td><td>15</td><td>48</td><td>45</td><td>40</td><td>37</td><td>20</td><td>18</td><td>60</td><td>55</td></tr>
<tr><td>Other products</td><td>143</td><td>0</td><td>72</td><td>0</td><td>215</td><td>0</td><td>40</td><td>0</td><td>20</td><td>0</td><td>60</td><td>0</td></tr>
<tr><td>Crude</td><td>0</td><td>0</td><td>0</td><td>400</td><td>0</td><td>400</td><td>0</td><td>0</td><td>0</td><td>32</td><td>0</td><td>0</td><td>32</td><td>10</td></tr>
<tr><td>Total</td><td>1,661</td><td>1,396</td><td>832</td><td>1,097</td><td>2,493</td><td>2,493</td><td>40</td><td>34</td><td>20</td><td>26</td><td colspan="2">60</td><td colspan="2">60</td></tr>
</table>

Source: Authors.

2.4. Estimation of Capital and Operation Costs

Estimating stockpiling costs for Myanmar is based on the stockpiling options in Table 3.3 and a set of assumptions from the IEA study (2018) with updated oil prices. Assumptions cover several components of general assumptions: oil prices, CAPEX, and OPEX. With a lack of data on existing oil stocks, these assumptions apply only to the additional stockpiling. Following the presentation of the Ministry of Energy (2022b), the existing stock is assumed to be 34 days. Thus, the cost of an additional 26 days is calculated here. Since ticket stockpiling can eliminate CAPEX and joint stockpiling can eliminate initial oil purchase costs, these schemes are cheaper than national development.

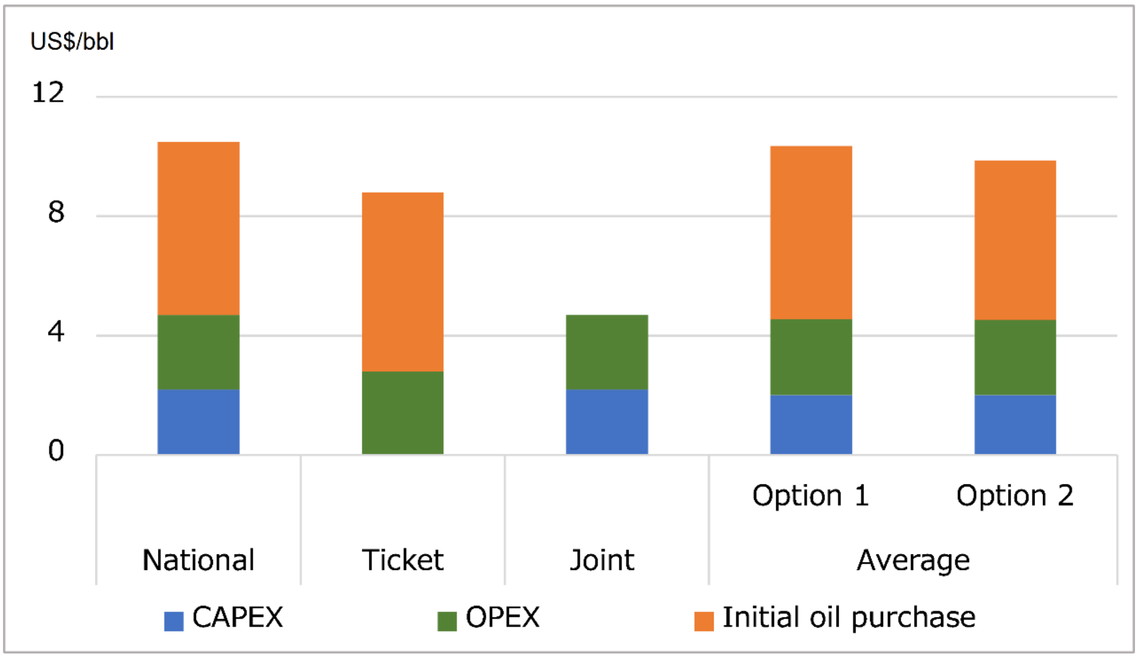
Table 3.4. Main Assumptions for Cost Estimates

Parameter		Value
General assumptions	Project life	30 years
	Interest rate	3%
	Stockpiling amount	60 days of demand (including 5 days of ticket stockpiling)
Oil purchase	Crude oil	Assumed crude price at US$108/bbl and product price at US$122/bbl (2Q 2022 market prices)
	Oil product	
CAPEX	Construction costs of storage facilities (excluding jetty)	US$150/$m^3$ (for crude)
		US$165/$m^3$ (for product)
	Construction costs of jetty	US$35 mn (for VLCC)
		US$12 mn (for product tankers)
OPEX	Land utilisation	3.5m^3/m^2
	Land lease expenses	US$0.3/$m^2$ per month
	Operating expenses	US$12/$m^3$ per year
	Refreshment interval	Every 20 years for crude
		Every 6 years for product
	Cost of alternative storage during refreshment	US$21/$m^3$ per refreshment (for crude)
		US$27/$m^3$ per refreshment (for product)
	Terminal handling cost during refreshment	US$15/mn tonnes (for crude)
		US$4/mn tonnes (for product)

VLCC = very large crude carrier.
Source: Authors.

Based on the above assumptions, the average unit cost of oil stockpiling would be US$10.9/bbl for option 1 and US$9.9/bbl for option 2. The total investment would be US$922 million for option 1 and US$710 million for option 2. While these are substantial amounts, whether Myanmar can see these costs as an insurance policy will determine the future of oil stockpiling and the country’s degree of oil security or insecurity.

Figure 3.4. Unit Cost Estimate



Note: Option 1 assumes 5 days of ticket stockpiling. Option 2 assumes 5 days of ticket stockpiling, and 5 days joint stockpiling.
Source: Authors.

Chapter 4
Recommended Road Maps of Oil Stockpiling System

1. Summary of the Discussion

The year 2022 highlights a renewed interest in oil supply security because of the war in Ukraine. IEA member countries released an unprecedented amount of oil to address supply insecurity. Therefore, this study sought appropriate stockpiling methods for Myanmar at affordable costs, appropriate stockpiling levels, and a sharing ratio between the public and private sectors.

Chapter 1 set the scene for the discussion, explaining why oil stockpiling is necessary and describing the history of oil stockpiling, mainly in IEA member countries. Oil supply was disrupted many times and will likely happen mainly due to geopolitical risks, accidents, and natural disasters. Among other countermeasures, stockpiling is considered a last resort and immensely important in securing the oil supply. Oil stockpiling has been in place for decades in many advanced economies. Some major oil-importing countries like China and India are expanding their stockpiling. The importance of oil stockpiling is well recognised in ASEAN countries, too. The IEEJ assumes that most ASEAN countries hold 20–50 days of demand, significantly lower than the level of IEA member countries.

Chapter 2 outlined the basic concept of the oil strategic stockpiling system and described a stockpiling scheme in IEA countries. Oil strategic stockpiling systems can be differentiated by ownership (industry or public); storage options (onshore, offshore, or underground); and nationality (national or international initiatives). Government intervention in the form of SPR is justified and implemented in many IEA countries due to the 'publicness' of stable oil supply. While onshore tanks by national initiatives are the mainstream, underground storage and international initiatives like a ticket or joint stockpiling offer cheaper options. Earlier studies by the IEA and ERIA concluded that the benefit of oil stockpiling exceeds the cost, given the probability of oil supply disruptions. Stockpiling systems in IEA member countries vary, depending on the oil fundamentals of each country, such as import dependency, refining capacity, and interconnection with neighbouring countries.

Chapter 3 described Myanmar's oil fundamentals and outlook and presented an appropriate oil stockpiling system. Oil demand in Myanmar will grow steadily at 3% per annum to reach 18 Mt (350 kb/d) in 2050.

Considering oil fundamentals, current stock level, infrastructure, and possible financial constraints, it seems reasonable for Myanmar to expand oil stockpiling to 60 days in 2040, mainly in the form of oil products. With the possibility of a new refinery, option 1 assumes no refinery will be built, and option 2 envisages new refineries with 5 Mt/y capacity that will be operational in 2028. The importance of oil supply stability justifies establishing SPR. The cost of building up oil stockpiling for Myanmar is estimated at US$922 million for option 1 and US$710 million for option 2. Whether Myanmar can see this substantial cost as an insurance policy will determine the future of oil stockpiling and the degree of oil security or insecurity for the country.

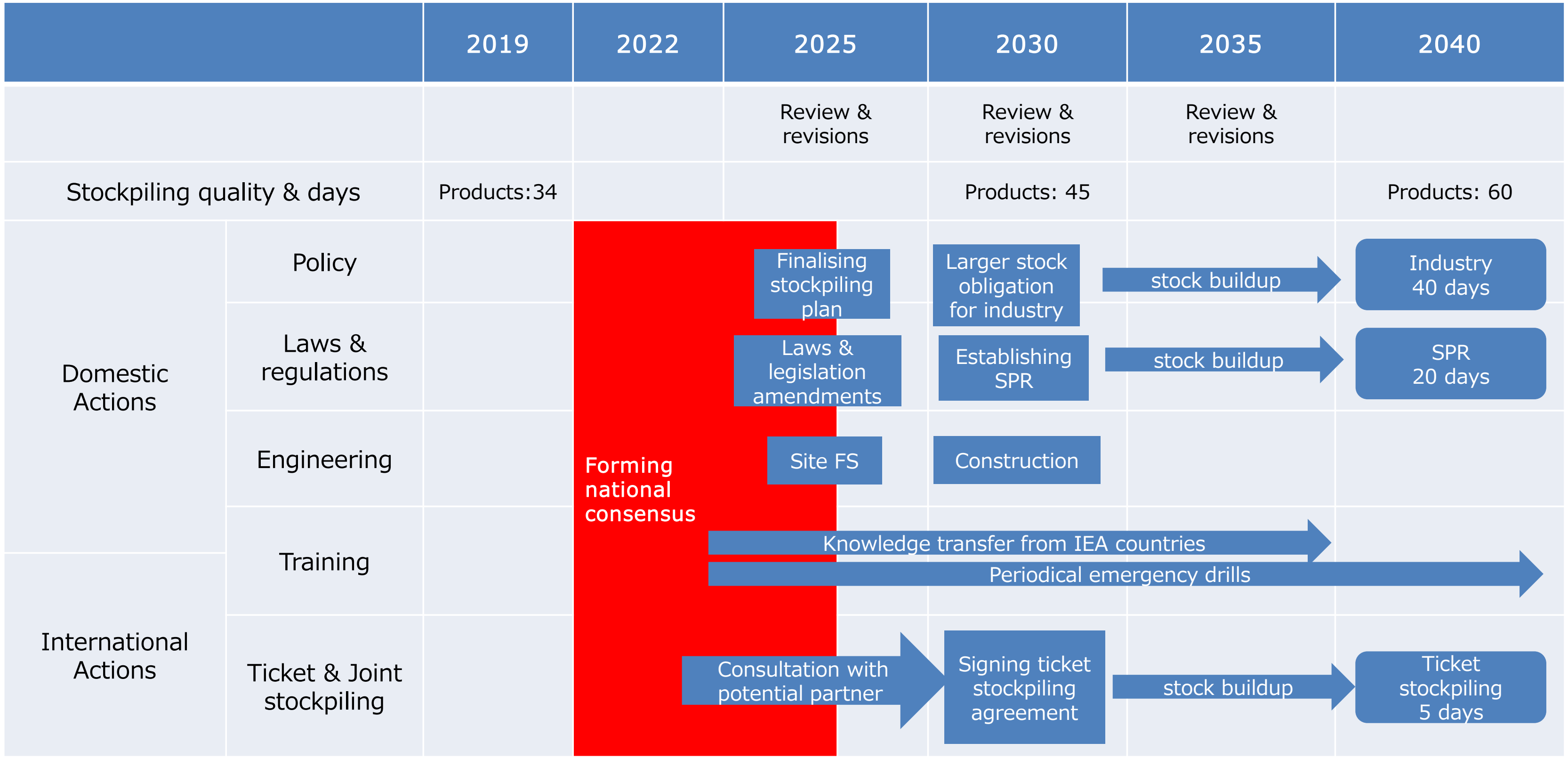
2. Recommended Road Maps

This study conducted three workshops to understand, deepen, and discuss what oil stockpiling scheme might be desirable for Myanmar. The basic scheme features 60 days of stockpiling to be achieved in 2040. ERIA suggested introducing SPR to Myanmar's Ministry of Energy. Building up stockpiling of this scale requires a lot of policy arrangements to create a necessary environment for stockpiling development. A road map would be useful to visualise what to do and when. Figure 4.1 presents a road map for option 1 and Figure 4.2 for option 2.

Before implementing any road map items, the first and probably the hardest hurdle might be forming a strong national consensus for oil stockpiling. Since the benefit of oil stockpiling becomes a reality only when oil disruptions happen, it is easy for any government to sideline and postpone oil stockpiling projects. However, many supply disruptions have always occurred and will likely happen. Therefore, the importance of fostering a mindset of oil stockpiling as an insurance policy cannot be emphasised enough in the first place. That mindset would enable broad consensus amongst all the policymakers and government agencies on why expanding oil stockpiling is necessary. The sooner and the firmer the consensus are made, the more oil security can be improved. The road maps here set the target year of 2025 for Myanmar to form a national consensus.

Building a national consensus needs detailed feasibility studies to assess the economics, engineering of stockpiling, and political, social, and environmental impacts and implications. Especially a detailed cost–benefit study specifically for Myanmar would be essential. For the sake of national consensus, the Ministry of Energy could conduct a similar and more detailed analysis to accommodate all the specificities of Myanmar. Such analysis would enable quantifying and articulating the cost and benefit of oil stockpiling. With the results of feasibility studies, government agencies could work on necessary laws and legislations, budget allocations, or other financial arrangements. As pointed out in Chapter 3, if a suitable underground structure is available, the stockpiling cost can be reduced significantly. Internationally, government agencies should assess which country could be a counterpart for ticket and joint stockpiling schemes and start initial negotiations with potential partner(s) regarding quantity, location(s), investments, and incentives.

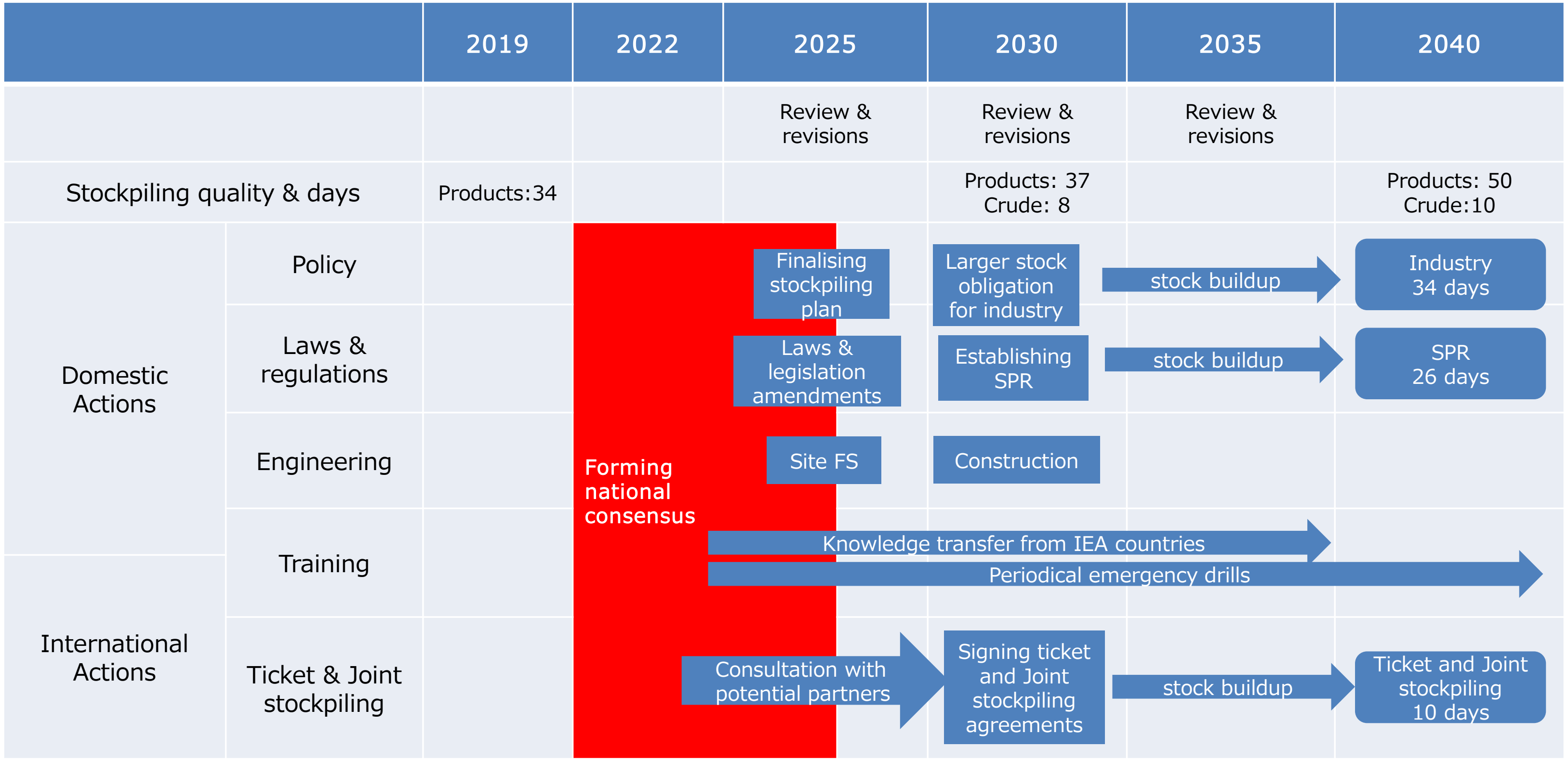
Figure 4.1. Road Map for Oil Stockpiling Development in Myanmar (Option 1)



Remark: Ticket stockpiling 5 days is a part of SPR.

Source: Authors.

Figure 4.2. Road Map for Oil Stockpiling Development in Myanmar (Option 2)



Remark: Ticket and joint stockpiling 10 days is a part of SPR.
Source: Authors.

With data, conclusions, and implications, the government is required to work on a wide range of issues, forming a concrete stockpiling policy that covers the size of oil stockpiling, stockpiling entity and its responsibility, the roles of government and industry, and incentives for industry. With a concrete policy, a detailed stockpiling plan should be published by 2025 to share the vision of the policy. Necessary laws and regulations should follow around 2025 to legislate all the policy items. Such laws would feature a more significant stock obligation for industry and the establishment of SPR. In addition, the government should adequately incentivise oil companies through tax exemptions, subsidies, and soft loans for infrastructure development. On the engineering side, feasibility studies on SPR site(s) could start shortly after the plan's publication. It is worth mentioning again that the government should pursue the possibility of underground storage and utilisation of the Kyaukpyu Terminal. Both larger stock obligations for industry and the establishment of SPR could be targeted around 2030 so that stock could be built up throughout the 2030s.

This study suggested considering ticket and joint oil stockpiling with other countries to supplement stockpiling. There are several partner countries for ticket stockpiling. For instance, Japan could offer spare storage capacity. However, considering Myanmar relies on imported oil products, not crude, higher storage costs and long shipping distances (thus, higher shipping costs) would hinder the potential economic benefits of joint stockpiling. Perhaps, neighbouring countries like Thailand and/or China might be good partners for joint stockpiling. These countries are already oil trading partners. Thailand exports products to Myanmar, China imports crude from Myanmar, and the China National Petroleum Corporation owns the Kyaukpyu Terminal. Deepening trade relationships and contributing to oil supply security enhancement, it is reasonable to seek the possibility of joint stockpiling with these countries. Since option 2 assumes new refinery development, joint crude oil stockpiling could be included. Most of the additional crude flowing into Southeast Asia will be from the Middle East. Major crude exporters like Saudi Aramco, ADNOC, and KPC already implement joint stockpiling with Asian countries. Therefore, Saudi Arabia, Abu Dhabi, and Kuwait will be obvious joint stockpiling partners for Myanmar. The Myanmar government could spend the latter half of the 2020s discussing joint stockpiling with these international partners before signing agreement(s) around 2030.

Developing human resources is also important at physical stockpiling sites, laws and regulations, monitoring, and other decision-making processes. Stock-releasing procedures in an emergency are essential for the oil stockpiling system to function properly. Emergency drilling exercises will contribute to streamlining the decision-making process on when and how oil stock should be released when supply is disrupted.

Building stockpiling is a long-term process. It is natural to assume many changes during development in economics, domestic and international politics, society, and the environment. Thus, the government should be ready to accommodate all the necessary changes and demands from relevant parties during development. Feasibility studies will need to continue, perhaps through 2040, if any delays or project changes happen. The road maps are subject to periodic revisions.

More officially, the road map could be revised every 5 years to share all the changes and a goal to achieve 60 days of stockpiling in 2040.

References

Department of Energy (DOE) (2020), 'US and Australia Strengthen Fuel Security with New SPR Arrangement', https://www.energy.gov/articles/us-and-australia-strengthen-fuel-security-new-spr-arrangement (accessed September 2022).

Department of Energy (DOE) (2022), 'SPR Storage Sites', https://www.energy.gov/ceser/spr-storage-sites#Bcsite (accessed September 2022).

Economic Research Institute for ASEAN and East Asia (ERIA) (2017), 'Oil Supply Resilience in ASEAN', https://www.eria.org/publications/oil-supply-resilience-in-asean/ (accessed October 2022).

Economic Research Institute for ASEAN and East Asia (ERIA) (2022), 'The Strategic and Economic Value of Joint Oil Stockpiling Arrangements for Middle East Exporters and ASEAN Importers', https://www.eria.org/publications/the-strategic-and-economic-value-of-joint-oil-stockpiling-arrangements-for-middle-east-exporters-and-asean-importers/ (accessed October 2022).

International Energy Agency (IEA) (1995), *IEA the First 20 Years Volume Three Principal Documents*. Paris: IEA. https://iea.blob.core.windows.net/assets/5191c983-8747-4202-897c-2c1d17831aa4/3ieahistory.pdf (accessed September 2022).

International Energy Agency (IEA) (2013), 'Focus on Energy Security: Costs, Benefits and Financing of Holding Emergency Oil Stocks', Paris, https://www.ourenergypolicy.org/wp-content/uploads/2015/04/FocusOnEnergySecurity_FINAL.pdf (accessed September 2022).

International Energy Agency (IEA) (2014), *Energy Supply Security: The Emergency Response of IEA Countries*. Paris: IEA. https://iea.blob.core.windows.net/assets/73908149-4d6e-4f10-b626-d55c60ab3bd7/ENERGYSUPPLYSECURITY2014.pdf (accessed September 2022).

International Energy Agency (IEA) (2015a), 'IEA Emergency Response System', https://twitter.com/iea/status/590907954200649728 (accessed September 2022).

International Energy Agency (IEA) (2015b), 'Map of the Oil Infrastructure in Europe', https://twitter.com/iea/status/5913160251916925952?lang=zh-Hant (accessed September 2022).

International Energy Agency (IEA) (2018),' Costs and Benefits of Emergency Stockholding', Paris, https://www.iea.org/reports/costs-and-benefits-of-emergency-stockholding (accessed October 2022).

International Energy Agency (IEA) (2022a), 'Energy Security - Reliable, Affordable Access to All Fuels and Energy Sources', https://www.iea.org/topics/energy-security (accessed January 2022).

International Energy Agency (IEA) (2022b), 'Oil Stocks of IEA Countries', https://www.iea.org/articles/oil-stocks-of-iea-countries (accessed October 2022).

International Energy Agency (2022c), Oil Market Report, August, Paris.

Japan Organization for Metals and Energy Security (JOGMEC) (1994), ‘ヨーロッパおける石油備蓄の現状’ (Current Status of Oil Stockpiling in Europe), https://oilgas-info.jogmec.go.jp/_res/projects/default_project/_project_/pdf/3/3122/199410_048a.pdf (accessed September 2022).

Japan Organization for Metals and Energy Security (JOGMEC) (2020), ‘インド：低油価のもとで戦略石油備蓄（SPR）構築（短報）’ (India Is Expanding its SPR amid Low Oil Prices), https://oilgas-info.jogmec.go.jp/info_reports/1008604/1008764.html (accessed September 2022).

Japan Organization for Metals and Energy Security (JOGMEC) (2022a), ‘国家石油備蓄方式の紹介’, https://www.jogmec.go.jp/library/stockpiling_oil_066.html (accessed September 2022).

Japan Organization for Metals and Energy Security (JOGMEC) (2022b), ‘Stockpiling System’, https://www.jogmec.go.jp/english/stockpiling/stockpiling_10_000002.html (accessed September 2022).

JTC (2022), ‘Jurong Rock Caverns’, https://www.jtc.gov.sg/find-space/jurong-rock-caverns (accessed September 2022).

King Abdullah Petroleum Studies and Research Center (KAPSARC) (2017), ‘Joint Oil Stockpiling between Middle East Exporters and Northeast Asian Importers: A Winning Formula?’ 1 April, https://www.kapsarc.org/research/publications/joint-oil-stockpiling-between-middle-east-exporters-and-northeast-asian-importers-a-winning-formula/ (accessed September 2022).

Ministry of Energy (2022a), ‘Oil Industry Information or Oil Stockpiling Road Map in Myanmar’, August.

Ministry of Energy (2022b), ‘Oil Stockpiling Updates’, 15 June, presented at The Tenth Workshop of Oil Stockpiling Road Map.

Ministry of Economy, Trade and Industry (2020), ‘Japan and the State of Kuwait Agree to Start Joint Oil Storage Project’, https://www.meti.go.jp/english/press/2020/1201_003.html (accessed September 2022).

Reuters (2019), ‘Saudi Attack Leads to Biggest Oil Supply Loss’, 17 September, https://www.reuters.com/article/us-saudi-aramco-supply-graphic-idUSKBN1W11VU (accessed October 2022).

Reuters (2020), ‘India Looks to Store Cheap Oil in United States: Oil Minister’, https://jp.reuters.com/article/us-india-oil-usa/india-looks-to-store-cheap-oil-in-united-states-oil-minister-idUSKBN2311L3 (accessed September 2022).

Reuters (2021), 'Column: China Draws on Crude Oil Stockpiles Again amid Strong Refinery Processing: Russell', https://www.reuters.com/markets/commodities/china-draws-crude-oil-stockpiles-again-amid-strong-refinery-processing-russell-2021-12-15/ (accessed September 2022).

The Institute of Energy Economics, Japan (IEEJ) (2022), 'IEEJ Outlook 2023', https://eneken.ieej.or.jp/data/9863.pdf (accessed October 2022).