ASEAN Oil Stockpiling Strategy: Analysis and Recommendations



ERIA
Economic Research Institute
for ASEAN and East Asia

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Preface

Over the past year, geopolitical tensions and disruptions to global shipping routes have reminded us that energy security can no longer be taken for granted. The recent crisis in the Middle East and disruptions around key maritime chokepoints have demonstrated how quickly external events can affect oil prices, supply chains, inflation, industrial production, and overall economic stability across countries in Southeast Asia.

While no one can predict when the next oil and energy disruption will occur, ASEAN (Association of Southeast Asian Nations) cannot afford to wait until the next crisis before strengthening its preparedness. Building resilience requires acting before emergencies arise. Energy security should therefore be viewed not merely as a sectoral concern, but as a strategic pillar of ASEAN's long-term economic resilience and competitiveness. The current crisis is a stern reminder of this need and provides the region with an opportunity to take collective action.

Recognising these challenges, this report reflects ERIA's (Economic Research Institute for ASEAN and East Asia) continued commitment to aligning its activities and functions with ASEAN's evolving priorities and most pressing challenges. The report examines practical options through which ASEAN can strengthen collective preparedness for future supply disruptions while respecting the diversity of national circumstances, policy priorities, and levels of institutional development across ASEAN Member States.

The study concludes that regional oil stockpiling should not be understood as a choice between national reserves and a common regional reserve. Rather, we find that a pragmatic hybrid approach – combining strengthened national stockpiles with regional co-operation mechanisms, including ticketing arrangements and other flexible instruments – offers the most practical and economically viable pathway. Such an approach can improve emergency preparedness, optimise existing infrastructure and refinery ecosystems, strengthen ASEAN's collective negotiating position, and enhance regional resilience without requiring a one-size-fits-all model.

Equally important, implementation should proceed in a practical and flexible manner. Progress need not wait until every element of a comprehensive regional system is in place. Interested ASEAN Member States, working together with industry leaders, oil-producing countries, and Dialogue Partners, can begin through voluntary pilot initiatives that generate practical experience and build confidence. Lessons from these early efforts can then inform the gradual development of broader regional arrangements, supported by appropriate institutional co-ordination, financing mechanisms, and technical co-operation.

ERIA is pleased to contribute this study as part of its continued support for ASEAN energy security and regional co-operation. We hope that the study will serve as a useful technical reference for ASEAN Member States, senior officials, Ministers, industry stakeholders, and development partners.

Finally, I would like to express my sincere appreciation to *Hon. Atty. Sharon S. Garin*, Secretary of the Department of Energy (DOE) of the Philippines, for providing the strong support needed to complete this study, and to all the authors, experts, ASEAN Member States, the ASEAN Secretariat, the ASEAN Centre for Energy (ACE), the ASEAN Council on Petroleum and Energy (ASCOPE), the DOE team, the International Energy Agency (IEA), and all partners who contributed to the preparation of this report. Your insights and co-operation have been essential in shaping a practical and evidence-based approach to strengthening ASEAN oil supply resilience.



Tetsuya Watanabe
President,
Economic Research Institute for ASEAN and East Asia

Foreword

Energy security remains a fundamental pillar of ASEAN's economic resilience, industrial development, trade connectivity, emergency preparedness, and social stability. While ASEAN continues to accelerate its energy transition, petroleum products will remain important to the region's transport, aviation, maritime activities, logistics, agriculture, construction, manufacturing, petrochemical industries, and emergency services in the coming decades.

Recent global energy disruptions have underscored the importance of maintaining reliable and resilient oil supply systems. The dependence of many ASEAN Member States on imported crude oil and petroleum products exposes the region to various external risks, including geopolitical developments, disruptions along critical maritime routes, shipping constraints, price volatility, and challenges in securing supplies during emergencies. These developments can have wider implications for production costs, inflation, fiscal stability, transport systems, and the overall well-being of our people.

Against this backdrop, this report comes at a timely and important moment. It provides a comprehensive analysis of issues relating to regional oil supply resilience and encourage various approaches to oil stockpiling and energy security. The study contributes to the ongoing discussion on measures that may enhance economic resilience, supply continuity, and regional preparedness. The report explores a range of possible approaches to oil stockpiling, including the use of existing refinery and commercial inventories, national stockpiling arrangements, strategic reserves, joint stockpiling mechanisms, storage options, and various forms of regional co-operation. It also discusses considerations related to implementation, participation, and institutional arrangements under different scenarios.

The report further discusses a number of technical, operational, financial, and institutional considerations associated with oil stockpiling arrangements. These include issues related to feasibility assessments, financing options, emergency response mechanisms, stock monitoring systems, and stakeholder engagement.

The Philippines is pleased to support this important initiative. It reflects extensive research and collaboration among experts and stakeholders and contributes valuable insights on issues relating to regional oil supply security and resilience.

I commend ERIA and all contributing experts for preparing this important report. I likewise express my appreciation to all organizations, institutions, and stakeholders who contributed their time, expertise, and perspectives throughout this undertaking. I trust that the findings and insights presented in this report will provide a useful reference in informing ongoing discussions to further strengthen energy security and resilience in the region.



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The publication was prepared by a team led by Han Phoumin of ERIA, under the guidance of Kensuke Molnar-Tanaka and Nuki Agya Utama. The core drafting team comprised Venkatachalam Anbumozhi, Alloysius Joko Purwanto, Kentaro Noma, Han Phoumin, and Kensuke Molnar-Tanaka. Significant contributions were provided by Satoshi Shimayoshi, Yuta Okuyama, Anna Maria Rosario D. Robeniol, Naoto Okura, Takayuki Yamanaka, Intan M. Ramli, Weerawat Chantanakome, I Gusti Suarnaya Sidemen, and Vu Thi Ngoc Ha of ERIA. Stefan Wesiak and the ERIA Publications team provided editorial and publication support in preparing this publication.

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Table of Contents

Preface		iii
Foreword		v
Acknowledgements		vi
Table of Contents		vii
List of Figures		viii
List of Tables		x
List of Boxes		xi
List of Abbreviations		xii
Executive Summary		xvi
Chapter 1	**Introduction: ASEAN Oil Security – Dependence, Vulnerabilities, and the Imperative for Regional Stockpiling**	1
Chapter 2	**Scenario-Based Comparative Analysis of ASEAN Oil Stockpiling**	28
Chapter 3	**ASEAN Oil Infrastructure Ecosystem Assessment for Stockpiling Strategy**	74
Chapter 4	**Main Messages, Roadmap, and Recommendations**	102
	Annexes	113

List of Figures

Figure 1.1	ASEAN 10's Primary Energy Consumption, Business-As-Usual (BAU) Scenario, 1990–2060 (Mtoe)	4
Figure 1.2	Comparison of ERIA, ACE, and IEA Oil Consumption Estimates for ASEAN	6
Figure 1.3	The Concept of International Ticket Stockpiling	14
Figure 1.4	The Concept of Joint Stockpiling	15
Figure 2.1	Total Petroleum Liquids Transported Through the Strait of Hormuz (mb/d)	30
Figure 2.2	Reserve Composition of Scenario-Based Comparative Analysis (days)	35
Figure 2.3	Updated Life-cycle Cost Assumptions for Oil Stockpiling (US$/barrel, %, and escalation contribution)	36
Figure 2.4	Annualised Unit Cost Escalation by Stockpiling Mechanism (US$/barrel/year)	37
Figure 2.5	Estimated Macroeconomic Benefits of Strategic Oil Stockpiling in ASEAN	45
Figure 2.6	ASEAN-Wide Cost-Benefit Screening Results	47
Figure 2.7	Cost-Effectiveness of ASEAN Oil Stockpiling Scenarios (US$/barrel/year)	48
Figure 2.8	Comparison of Cost-Effectiveness Results across Major Oil Stockpiling Studies	52
Figure 3.1	Refinery Capacity versus Domestic Oil Products Demand by Country (kbd)	79
Figure 4.1	Approach from Pilot Initiatives to Region-Wide Expansion	105

List of Tables

Table 1.1	ASEAN Member States' Primary Energy Consumption – Oil, Business-as-Usual Scenario, 2021–2060	5
Table 1.2	Pre-Crisis and Peak Crisis Shocks	7
Table 1.3	Oil Stockpiling Efforts in ASEAN Member States	11
Table 1.4	Characteristics of Oil Stockpiling in IEA Countries	12
Table 2.1	Eligibility Conditions for Existing Refinery and Commercial Stocks	33
Table 2.2	Cost Scope and Assumptions by Stockpiling Mechanism	39
Table 2.3	Annualised Cost Derivation by Stockpiling Scenario	40
Table 2.3A	Indicative Upfront Inventory-Acquisition Exposure by Scenario	41
Table 2.4	Differentiating the Effective Emergency Value of Stocks	49
Table 2.5	Transferable Elements and ASEAN-Specific Adaptation Needs	53
Table 2.6	Different Scenario Setting and Stockpiling Implications	54
Table 2.7	Sensitivity of the Estimated Avoided Economic Loss (US$ Billion per Affected Year)	55
Table 2.8	Additional Cost Sensitivities under the Three Reserve Portfolios	55
Table 2.9	Illustrative Stockpiling Pathways by ASEAN Country Archetype	57
Table A2.2.1	Share of Total Lifecycle Cost	66
Table A2.2.2	Updated Cost Assumptions	67
Table A2.2.3	Financing-Sensitive Components of Strategic Oil Stockpiling Lifecycle Costs	69
Table 3.1	Existing Crude Refinery Capacity by Country	78
Table 3.2	Installed Crude Oil Storage Capacity by Country (Estimated Based on Satellite Data)	80
Table 3.3	Distribution of Maximum Vessel Type Calling at Each Site	82
Table 3.4	Average Annual Crude Import by Maximum Vessel Type	82
Table 3.5	Vessel Type Distribution by Trade Direction in Southeast Asia	83
Table 3.6	Facilities with Confirmed VLCC/ULCC Port-Call Records	84
Table 3.7	Potentially Available Tanks in Dumai	85
Table 3.8	Summary of Locations with Infrastructure Potential	86
Table 3.9	Crude Import Volume and Source Composition by Facility	87
Table 3.10	Export Volume and Destination Composition by Facility	89

Table 3.11	Operator and Ownership Structure by Facility	91
Table 3.12	Overview of Stockpiling Regimes in Major ASEAN Countries	93
Table 4.1	Key Legal, Contractual, and Reserve-Accounting Considerations for Regional Oil Stockpiling Pilots	106
Table 4.2	Financing and Cost-Sharing Options	108
Table 4A.1	Risk Assessment Matrix	112
Table 4B.1	Operational Readiness and Deliverability Indicators	113

List of Boxes

Box 2.1	Illustrative Pilot Project Scheme A – Joint Stockpiling with Ticketing Arrangement	42
Box 2.2	Illustrative Pilot Project Scheme B – Joint Stockpiling through Joint Ownership	43

List of Abbreviations

A. Institutions, Policies, and General Terms

AAGR	Average annual growth rate
ACE	ASEAN Centre for Energy
ADB	Asian Development Bank
ADNOC	Abu Dhabi National Oil Company
AEC	ASEAN Economic Community
AIS	Automatic Identification System
AMEM	ASEAN Ministers on Energy Meeting
AMS	ASEAN Member States
APAEC	ASEAN Plan of Action for Energy Cooperation
APERC	Asia Pacific Energy Research Centre
APSA	ASEAN Petroleum Security Agreement
ASEC	ASEAN Secretariat
ASCOPE	ASEAN Council on Petroleum and Energy
ASEAN	Association of Southeast Asian Nations
BAU	Business-as-usual
BPH Migas	*Badan Pengatur Hilir Minyak dan Gas Bumi* (Downstream Oil and Gas Regulatory Agency, Indonesia)
CAPEX	Capital expenditure
CERM	Coordinated Emergency Response Measures
CN	Cetane number
CPI	Consumer price index
CPS	Current Policies Scenario
DC	Department Circular (Philippines legal instrument code)
DOE	Department of Energy (Philippines)
E&P	Exploration and production
EIA	U.S. Energy Information Administration
EIU	Economist Intelligence Unit
EMA	Energy Market Authority (Singapore)
EO	Executive Order (Philippines legal instrument code)
EPCC	Engineering, procurement, construction, and commissioning
ERIA	Economic Research Institute for ASEAN and East Asia
FAME	Fatty acid methyl ester
FID	Final investment decision

FS	Feasibility study
GDP	Gross domestic product
IEA	International Energy Agency
IMF	International Monetary Fund
IOCs	International oil companies
JOGMEC	Japan Organization for Metals and Energy Security
KEN	Kebijakan Energi Nasional (National Energy Policy, Indonesia)
LCC	Lifecycle cost
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MDTCA	Ministry of Domestic Trade and Consumer Affairs (Malaysia)
MIR	Minimum inventory requirement
MITI	Ministry of Investment, Trade and Industry (Malaysia)
MOEE	Ministry of Electricity and Energy (Myanmar)
N/A	Not applicable
ND-CP	Government Decree (Viet Nam legal instrument code)
NOC	National oil company
NOCs	National oil companies
N/T/J	National/ticket/joint stockpiling
O&M	Operation and maintenance
OECD	Organisation for Economic Co-operation and Development
OGCSS	Oil and Gas Connectivity, Security, and Sustainability
OPEC	Organization of the Petroleum Exporting Countries
OPEX	Operating expenditure
OSRM	Oil Stockpiling Roadmap
PDR	People's Democratic Republic
PP	Peraturan Pemerintah (Government Regulation, Indonesia)
PPP	Public-private partnership
QD-TTg	Prime Minister's Decision (Viet Nam legal instrument code)
RA	Republic Act (Philippines legal instrument code)
RDMP	Refinery Development Master Plan
RON	Research octane number
SOME	Senior Officials Meeting on Energy
SPR	Strategic petroleum reserve
TFC	Total final consumption
TPEC	Total primary energy consumption

B. Companies, Facilities, and Operational Terms

ATB	ATB Oil Terminal, Tanjung Bin, Malaysia
BCP	Bangchak Corporation Public Company Limited
BSRC	Bangchak Sriracha Public Company Limited
CNPC	China National Petroleum Corporation
DIT	Deepwater Independent Terminal
EFRT	External floating roof tank
EP	Exploration and Production (as used in Pertamina EP)
FSO	Floating storage and offloading
IFRT	Internal floating roof tank
IRPC	IRPC Public Company Limited
KPB	PT Kilang Pertamina Balikpapan
KPI	PT Kilang Pertamina Internasional
PAC	Pulau Ayer Chawan
PETRONAS	Petroliam Nasional Berhad
PMB	Pulau Muara Besar
PRefChem	Pengerang Refining and Petrochemical
PTT	PTT Public Company Limited
PTTGC	PTT Global Chemical Public Company Limited
RAPID	Refinery and Petrochemical Integrated Development
SBM	Single buoy mooring
SOGIP	Sipitang Oil and Gas Industrial Park
SPRC	Star Petroleum Refining Public Company Limited
SRC	Singapore Refining Company
ULCC	Ultra-large crude carrier
VLCC	Very large crude carrier
VTTI	VTTI B.V. (independent energy storage terminal operator)

C. Units and Currencies

Unit	Meaning	Unit	Meaning
bbl	Barrel(s)	bbl/ton	Barrels per tonne
bbl/yr	Barrels per year	bn	Billion
bpd	Barrels per day	IDR	Indonesian rupiah
kb/d; kbd; kbpd	Thousand barrels per day	km	Kilometre(s)
ktoe	Thousand tonnes of oil equivalent	ktoe/yr	Thousand tonnes of oil equivalent per year
mb/d	Million barrels per day	MMbbl	Million barrels
MMbbl/day	Million barrels per day	MMbbl/yr	Million barrels per year
Mtoe	Million tonnes of oil equivalent	m^3	Cubic metre(s)
RM	Malaysian ringgit	S$ / SGD	Singapore dollar
toe	Tonne of oil equivalent	toe/ton	Tonnes of oil equivalent per tonne
US$ / USD	United States dollar	US$/bbl/year	United States dollars per barrel per year

D. Country and Regional Codes

Code	Country / area	Code	Country / area
BRN	Brunei Darussalam	CAM	Cambodia
ID	Indonesia (two-letter label used in Chapter 3)	INA	Indonesia (three-letter code used in Chapter 1)
LAO	Lao PDR	MAS	Malaysia (three-letter code used in Chapter 1)
MY	Malaysia (two-letter label used in Chapter 3)	MYA	Myanmar
NZ	Saudi-Kuwait Neutral Zone	PH	Philippines (two-letter label used in Chapter 3)
PHI	Philippines (three-letter code used in Chapter 1)	PNG	Papua New Guinea
SG	Singapore (two-letter label used in Chapter 3)	SIN	Singapore (three-letter code used in Chapter 1)
TH	Thailand (two-letter label used in Chapter 3)	THA	Thailand (three-letter code used in Chapter 1)
TL	Timor-Leste	UAE	United Arab Emirates
US / U.S.	United States	VN	Viet Nam (two-letter label used in Chapter 3)
VNM	Viet Nam (three-letter code used in Chapter 1)		

Executive Summary

Why is an oil stockpiling strategy important for ASEAN?

Stable oil supply is critical for economic resilience in ASEAN. Indeed, oil supply disruptions would affect fuel availability, inflation, household purchasing power, industrial production, logistics, and economic growth more generally. Although ASEAN is accelerating its energy transition and expanding low-carbon energy systems, petroleum products will continue to play an essential role in transport, logistics, agriculture, construction, manufacturing, and petrochemicals across the region. At the same time, ASEAN's increasing dependence on imported crude oil and petroleum products exposes the region to various shocks such as maritime chokepoint risks, shipping disruptions, and higher insurance costs.

Against this backdrop, regional co-operation in ASEAN is critical for strengthening economic resilience. Appropriate oil stockpiling has become especially important in light of risks associated with the Strait of Hormuz and energy crises, as it can strengthen access, reduce avoidable costs, and improve emergency deliverability, while national governments retain authority over preparedness and release decisions.

Main messages and recommendations

This study provides analytical insights into ASEAN's oil stockpiling approach and supports practical, voluntary, and implementation-oriented co-operation on oil stockpiling.

The main recommendations identified in the study are listed in Table 1.

Table 1. Recommendations

Recommendation 1	Adopt an effective hybrid and voluntary approach to oil stockpiling.
Recommendation 2	Ensure co-operation is flexible, voluntary, and open to participation
Recommendation 3	Base the technical foundation of the strategy on the oil infrastructure ecosystem assessment.
Recommendation 4	Foster pilot initiatives and scale them regionally by developing public–private partnerships.
Recommendation 5	Evaluate selection and readiness, and establish a monitoring and evaluation strategy when preparing pilot initiatives.
Recommendation 6	Strengthen institutional co-ordination and develop legal, contractual, stock-data, and reserve-accounting instruments for pilot initiatives.
Recommendation 7	Assess feasibility, bankability, and risk when developing appropriate financing plans.
Recommendation 8	Support effective implementation by strengthening ties with the private sector, oil-producing countries, and dialogue partners.

Recommendation 9	Establish robust protocols for emergency release, delivery, and replenishment.
Recommendation 10	Monitor performance, evaluate results, and adapt arrangements.
Recommendation 11	Strengthen co-operation on upstream oil exploration and development.
Recommendation 12	Advance practical implementation through voluntary co-operation.

Source: ERIA.

Recommendation 1: Adopt an effective hybrid and voluntary approach to oil stockpiling

This study (i) assesses the economic viability of various stockpiling scenarios, (ii) evaluates the region's oil infrastructure ecosystem, and (iii) proposes practical policy actions and an implementation roadmap.

The study analyses three case scenarios using a 90-day effective reserve benchmark as a regional planning reference. Approximately 30 days of existing refinery and commercial inventories are assumed to contribute to emergency preparedness, while nationally led, balanced, and co-operative approaches are assessed for the remaining 60 days. The results indicate that the co-operative approach provides the strongest economic performance and that joint oil stockpiling can be economically beneficial. These benefits reflect avoided fuel shortages, lower emergency procurement costs and oil-price volatility, improved supply continuity, reduced inflationary pressure, and greater macroeconomic stability during supply disruptions.

A hybrid approach that combines existing refinery and commercial inventories, national stockpiling, ticket stockpiling, and joint stockpiling in a flexible manner will be central to an effective ASEAN oil stockpiling strategy.

Oil stockpiling should not be framed as a choice between national and joint reserves. ASEAN should instead advance a pragmatic, voluntary, and flexible hybrid co-operative approach. It should not impose a single model on all ASEAN Member States (AMS); rather, it should guide further technical work, including feasibility studies, location consultations, and the assessment of financing and cost-sharing options.

Recommendation 2: Ensure co-operation is flexible, voluntary, and open to participation

Interested and ready AMS should begin with small arrangements, while maintaining an open pathway for other AMS to participate later. Reserve composition and host stock volumes should be left to the discretion of the participating AMS.

Participation should respect national law, sovereignty, fiscal capacity, infrastructure readiness, commercial confidentiality, and strategic priorities. Each arrangement should proceed only when the participating governments and counterparties are satisfied with its technical, legal, financial, and operational conditions.

Recommendation 3: Base the technical foundation of the strategy on the oil infrastructure ecosystem assessment

The oil infrastructure ecosystem assessment could help identify the conditions that make a location potentially suitable for stockpiling co-operation, including refinery access, crude oil storage capacity, ports capable of handling very large crude carriers (VLCC) and ultra large crude carriers (ULCC), terminal infrastructure, logistics connectivity, emergency dispatch capability, operator readiness, regulatory preparedness, commercial feasibility, and potential for future expansion. The results show that ASEAN's refinery capacity, crude oil storage capacity, and large-vessel port access are concentrated in several major refining and logistics economies, while smaller and more import-dependent countries may have limited capacity to develop large national reserves at reasonable cost. This reinforces the need for a regional approach based on shared facilities, ticketing, joint stockpiling, and negotiated access arrangements.

Recommendation 4: Foster pilot initiatives and scale pilot initiatives regionally by developing public–private partnerships

Pilot initiative preparation should begin amongst interested and ready AMS. Then, building on the experience gained from pilot initiatives, ASEAN can explore the development of regional reserve hubs where technically, commercially, and politically feasible, taking into account the findings of the oil infrastructure ecosystem assessment for each participating AMS.

ASEAN co-operation on oil stockpiling could progress through several stages: identifying pilots; developing projects through discussion between the public and private sectors; assessing readiness; and monitoring and evaluating projects.

In the initial phase, interested and ready AMS could scope a limited number of practical pilot opportunities that respond to clearly defined energy-security and resilience needs. In the next phase, participating AMS could structure an appropriate public–private partnership where participation can improve operational capability, financing efficiency, or risk allocation.

Governments should define the public objective and regulatory treatment, while commercial and operational counterparties help design feasible ownership, service, financing, and delivery arrangements. Finally, successful models can be expanded to other groups of interested AMS and counterparties for voluntary participation.

Recommendation 5: Evaluate selection and readiness, and establish a monitoring and evaluation strategy when preparing pilot initiatives

Viable pilot initiatives should involve controlled arrangements capable of testing end-to-end emergency access, release, transport, and delivery. Measurable success criteria should be agreed upon before the start of the initiative. The pilot initiatives should assess verified accessible volume, authorisation and release time, terminal throughput, customs and cross-border clearance, delivery time and delivered volume, stock-quality compliance, safety, data reliability, payment readiness, and replenishment. The participating parties should prepare a pilot-specific feasibility and incremental assessment to monitor and evaluate the pilot based on these criteria.

Recommendation 6: Strengthen institutional co-ordination and develop legal, contractual, and reserve-accounting instruments for pilot initiatives

Legal and regulatory preparation will be essential in several areas, such as reserve access, ownership, custody, stock rotation, emergency release, allocation, replenishment, liability, customs and taxation, data protection, confidentiality and dispute resolution.

Interested AMS may prepare non-binding models to help governments and the private sector negotiate efficiently. These instruments should be adaptable to domestic law and transaction-specific requirements and should be developed with relevant government agencies, customs and tax authorities, legal experts, operators, oil companies, financiers, and insurers.

National rules concerning emergency powers, mandatory industry stocks, government access to commercial inventories, cross-border stockholding, ownership and custody, customs and taxation, data protection, foreign participation, and replenishment are important elements in this context and should be respected. Pilot-specific legal due diligence should focus on the participating host and user countries and the proposed transaction structure.

A simple confidential reporting template should be tested during the pilot stage. It should provide sufficient assurance that stocks exist, are not double counted, and can be released and delivered, while protecting commercially sensitive and national-security information. Over time, the participating AMS may develop secure monitoring arrangements for reserve status, drawdowns, replenishment, and emergency co-ordination.

Recommendation 7: Assess feasibility, bankability, and risk when developing appropriate financing plans

ASEAN should mobilise a combination of public financing, public–private partnerships, shared financing amongst participating countries, ticketing fees, producer-consumer arrangements, development finance, blended finance, export credit support, commercial storage operators, and reserve service contracts. Public budgets alone are unlikely to support the full cost of regional stockpiling.

The participating AMS and counterparties should compare feasible financing options, including public or state-owned enterprise financing, transparent ticketing or reserve-service fees, public–private partnerships, shared participant financing, producer-owned stocks, guarantees and credit enhancement, development finance, export credit, and commercial lending. Bankability requires credible counterparties, predictable revenue or payment commitments, enforceable emergency-access rights, clear risk allocation, and manageable currency, interest-rate, commodity-price, construction, operational, and demand risks.

Reserve options, site screening, and pilot design should shape discussions on cost-sharing and financing. Strategic stockpiling may require capital for inventory, construction or capacity reservation, terminals, safety and security systems, operations, maintenance, insurance, rotation, monitoring, emergency release, transport, and replenishment. Responsibilities should be allocated based on ownership, access rights, benefits, and operational control.

The chosen financing plan should also avoid double payment for the same service and remain fully aligned with the pilot's access, pricing, release, delivery, replenishment, and termination provisions. Smaller or fiscally constrained AMS should be able to consider phased participation or lower-capital contractual arrangements where these provide credible and deliverable emergency access.

Each pilot initiative should have a financing and cost-sharing plan that is consistent with its ownership structure, access rights, expected benefits, and operational responsibilities. The assessment should distinguish inventory acquisition, storage construction or reservation, terminal and logistics services, operations and maintenance, insurance, stock rotation, monitoring, emergency release, transport, and replenishment costs.

Recommendation 8: Support effective implementation by strengthening ties with the private sector, oil-producing countries, and dialogue partners

Much of ASEAN's storage, refining, shipping, trading, insurance, financing, stock rotation, and logistics capacity is commercially owned or operated. Early and structured engagement with national oil companies, international suppliers, terminal and refinery operators, logistics firms, banks, insurers, technology providers, and commodity traders is therefore necessary to identify realistic opportunities and test operational feasibility and bankability. Early market engagement can identify under-utilised tanks, available port and terminal capacity, potential host-user partnerships, and commercially realistic pilot structures.

Public–private participation should be structured transparently and, where appropriate, competitively procured, subject to safety, security, environmental, performance, transparency, and confidentiality requirements. At the regional level, ASEAN should also explore practical collaboration with dialogue partners to support technical assistance and financing such as POWERR Asia.

Recommendation 9: Establish robust protocols for emergency release, delivery, and replenishment

Participating AMS and counterparties should develop a clear and testable protocol covering the full chain from an emergency request to final delivery, replenishment, and deactivation. Since the pilot is voluntary, the protocol should be consistent with country-specific procedures, national laws, and pilot contracts, and it should distinguish policy and release decisions from commercial and physical execution.

The suggested first step is to identify a situation where assistance is required and provide a detailed request. Participating AMS requiring assistance would assess the supply shortfall, apply relevant national demand-management measures, and submit a time-stamped request through the applicable national channels. The second step is stock verification and approval of release. Host and user authorities, stock owners, terminal operators, and an agreed verifier should confirm that the stock is physically available, legally accessible, and compatible with the receiving market. An approval process that includes allocation, export or import, and the applicable release sequence would then be triggered. Approval of the release would lead to the third step of commercial confirmation and physical dispatch. Once commercial confirmation and dispatch are completed, the fourth step of replenishment, deactivation, and review would conclude the process.

Effective information sharing is essential across all steps. Participating AMS should agree on key information, such as stock category, owner, eligible user, location, volume, quality, custody, availability, reservation status, release decision, dispatch, delivery, and replenishment.

Recommendation 10: Monitor performance, evaluate results, and adapt arrangements

Participating AMS should establish an appropriate monitoring and evaluation process for pilot initiatives. The process should identify reporting schedules, verification requirements, and performance indicators. Monitoring should focus on operational readiness and deliverability rather than on the number of meetings, studies, or consultations completed. Following a pilot, participating AMS could conduct a joint evaluation with relevant operators and counterparties. The evaluation could compare actual performance with agreed readiness and success criteria, identify operational, contractual, financial, or institutional weaknesses, and determine corrective actions and retesting requirements. Based on the evidence, participating AMS could decide whether to discontinue, revise, repeat, continue, expand, or voluntarily replicate the arrangement.

Recommendation 11: Strengthen co-operation on upstream oil exploration and development

ASEAN Member States may consider strengthening regional collaboration on upstream oil exploration and development as a complementary pillar of long-term energy security. While strategic stockpiling strengthens preparedness for short-term supply disruptions, the discovery and responsible development of additional regional oil resources could enhance indigenous supply, diversify sources, and reduce exposure to external supply shocks over the longer term.

Co-operation could include joint geological and seismic studies, exchange of technical and resource data, co-ordinated exploration of prospective and cross-border petroleum basins, investment facilitation, and greater participation of ASEAN national oil companies and private-sector partners. Where commercially and technically viable, joint or co-ordinated upstream activities could help

unlock underexplored resources, share exploration risks and costs, strengthen regional technical capabilities, and improve the resilience of ASEAN's petroleum supply system.

Such co-operation should remain voluntary, commercially driven, consistent with national sovereignty and applicable laws, and aligned with ASEAN's broader energy-security and energy-transition priorities. Upstream collaboration should therefore complement, not substitute for, strategic stockpiling, demand-side preparedness, supply diversification, and emergency response arrangements.

Recommendation 12: Advance practical implementation through voluntary co-operation

Implementation of the ASEAN oil stockpiling strategy should be based on the voluntary participation of interested ASEAN Member States and proceed through practical co-ordination arrangements that avoid duplication and focus on areas of shared interest in advancing regional oil stockpiling co-operation.

The ASEAN Centre for Energy (ACE), the ASEAN Secretariat, relevant ASEAN sectoral and sub-sectoral bodies could play key roles to facilitate the translation of the results of pilot projects into practical oil security co-operation, based on their respective mandates.

International organisations such as the Economic Research Institute for ASEAN and East Asia (ERIA) and the International Energy Agency (IEA) could provide analytical and technical assistance, while the ASEAN Council on Petroleum and Energy (ASCOPE) could provide operational and commercial expertise. Such support could cover analytical work, feasibility assessment, policy design, monitoring methodology, industry expertise, financing facilitation, emergency response exercises, and producer-consumer co-operation options.

Chapter 1

Introduction: ASEAN Oil Security – Dependence, Vulnerabilities, and the Imperative for Regional Stockpiling

1. Introduction

The global energy architecture has been undergoing its most volatile systemic shock since the 1970s. The ongoing conflicts in the Persian Gulf, the main source of Asian oil and natural gas supply, have resulted in a severe disruption of maritime transit through the Strait of Hormuz, which has completely transformed the dynamics of global energy supply. This supply disruption also triggered an immediate and historic price shock. Brent crude oil prices, which remained within the stable range of $60–$65 per barrel during the pre-conflict period, rapidly escalated past $100 per barrel, reaching an intra-month peak of $126 per barrel in March 2026. For the Association of Southeast Asian Nations (ASEAN), a region characterised by surging demographic growth, rapid industrialisation, and a structurally embedded net import dependency on crude oil, this crisis represents a profound economic and strategic challenge (ERIA, 2026b).

Although alternative land-based transit routes – such as Saudi Arabia's East-West Pipeline and the United Arab Emirates' Habshan–Fujairah pipeline – have been maximised to bypass the Hormuz Strait, their collective throughput capacity of 3.5 to 5.5 million barrels per day (bpd) (IEA, 2026d) remains structurally insufficient to compensate for a prolonged disruption of the Persian Gulf. Compounding the volume deficits, global maritime shipping has faced soaring protection costs. War-risk insurance premiums for oil tankers transiting the Gulf of Oman and adjacent waters increased by more than fourfold in terms of cost per voyage, forcing shipping lines to either absorb prohibitive costs or re-route vessels. This re-routing adds 10–14 days to transit times to Asian ports, reducing global shipping capacity and further escalating landed crude costs.

While recent diplomatic efforts and the lifting of temporary sanctions have facilitated a marginal restoration of production and supply, various analyses indicate that full-scale recovery and market stabilisation will take several years, leaving rapidly industrialising and oil-importing regions like ASEAN exposed to prolonged structural volatility.

2. Objectives, Approach, and Methodology

This study seeks to establish an analytical foundation for the ASEAN oil stockpiling strategy and to support practical, voluntary, and implementation-oriented co-operation on oil stockpiling. This strategy bridges analytical discussions and practical implementation, providing policy recommendations for the implementation of an ASEAN oil stockpiling strategy roadmap. Key recommendations cover potential areas of co-operation, necessary conditions, the importance of pilot initiatives, the strengthening of institutional co-operation, and insights into several other critical issues that policymakers must consider.

This study has four chapters:

- Chapter 1: Introduction: ASEAN Oil Security– Dependence, Vulnerabilities, and the Imperative for Regional Stockpiling
- Chapter 2: Scenario-based comparative approach on ASEAN oil stockpiling strategy
- Chapter 3: ASEAN oil infrastructure ecosystem assessment for oil stockpiling strategy
- Chapter 4: Main policy message, roadmap, and recommendations

Chapter 1 starts with an overview of the energy security and oil demand of ASEAN Member States (AMS) before discussing the importance and potential roles of oil stockpiling, the state of oil stockpiling policies in AMS, existing models of stockpiling, the role of the ASEAN Petroleum Security Agreement (APSA), and prerequisites for developing joint oil stockpiling in ASEAN.

Chapter 2 focuses on a scenario-based comparative analysis of oil stockpiling. Drawing on the principles of cost–benefit analysis, this chapter analyses three oil stockpiling scenarios and shows that a co-operative regional approach yields superior economic outcomes than a nationally led approach or a balanced approach incorporating elements of both.

The chapter uses a 90-day effective reserve benchmark as a regional planning reference, consistent with established international oil security practices (IEA, 2022). Assumptions include, but are not limited to, gross domestic product (GDP), oil prices, infrastructure costs, operating expenditures, and financing costs. Although beyond the scope of this chapter, a more detailed analysis specific to ASEAN based on comprehensive national level baselines of AMS could be explored. Such an approach would allow more precise adjustments of the stockpiles or the co-operative regime to suit the ASEAN context.

Chapter 3 maps the physical and institutional foundations for oil stockpiling co-operative in ASEAN. The assessment of the oil infrastructure ecosystem includes the status of infrastructure development, current trade flow patterns, operator structures of relevant terminals, and each country's regulatory framework for oil reserves. The chapter provides a set of conditions that qualify a location as a potential stockpiling site from the perspective of existing infrastructure and other factors related to refinery access, crude oil storage capacity, and port access for specialised ships used for transporting oil. Logistics connectivity and geopolitical risk could also be included to refine the assessments. This framework provides evaluation criteria that governments and industry stakeholders can use for implementation.

Finally, Chapter 4 discusses the main findings and recommendations of the study, along with an implementation roadmap for an ASEAN oil stockpiling strategy. The 12 main recommendations outline the key elements required for effective implementation of an ASEAN oil stockpiling strategy. Effective implementation will begin with pilot projects in partnership with the private sector and then expand to region-wide initiatives.

The chapter emphasises the importance of applying the strategy and its recommendations within the framework of local contexts and laws, respecting each AMS involved in a joint stockpiling arrangement rather than requiring regional conformity. It discusses the preparatory steps required for a pilot project, how to monitor and evaluate such a project, and what is necessary to scale the project if it is successful.

3. Energy Security and Oil Demand in ASEAN

The energy consumption of the ASEAN-10, without Timor-Leste,[1] has been increasing for several decades. According to the *Energy Outlook and Energy Saving Potential in East Asia 2025* of the Economic Research Institute for ASEAN and East Asia (ERIA, 2026a), total primary energy consumption (TPEC) increased from 219 million tonnes of oil equivalent (Mtoe) in 1990 to 611 Mtoe in 2021, growing at an average annual rate of 3.3%. In 1990, oil was the largest source of energy, accounting for nearly 39% of TPEC; by 2021, this had decreased to around 27%. However, its consumption rose from about 84 Mtoe to 167 Mtoe during the period, equivalent to an average annual growth rate of 2.2%.

In 1990, the second-largest energy source was the 'others' category, consisting mainly of traditional biomass. Traditional biomass consumption fell from 72 Mtoe, or 33% of TPEC, in 1990 to 63 Mtoe, or 10.4% of TPEC, in 2021, representing an average annual decline of 0.4%. In contrast, modern renewables expanded quickly. Solar and wind grew fastest, rising from only 0.01 Mtoe in 1990 to 5.52 Mtoe in 2021, or nearly 25% per year on average. Electricity imports also increased substantially, from negligible levels to 4.12 Mtoe, while coal and hydropower grew at average annual rates of 9.4% and 6.0%, respectively.

Figure 1.1 shows that, under the business-as-usual (BAU) scenario in ERIA (2026a) – which reflects the current goals, action plans, and policy frameworks of each of the 10 AMS – TPEC is projected to grow by an average of 3.3% per year from 2021 to 2060. Biofuels are expected to grow the fastest, at 5.9% annually, followed by geothermal energy at 4.1% and solar and wind power at 4.0%. Oil and natural gas consumption are each projected to rise by 3.6% per year, while coal growth is expected to be more moderate, at 2.9% annually.

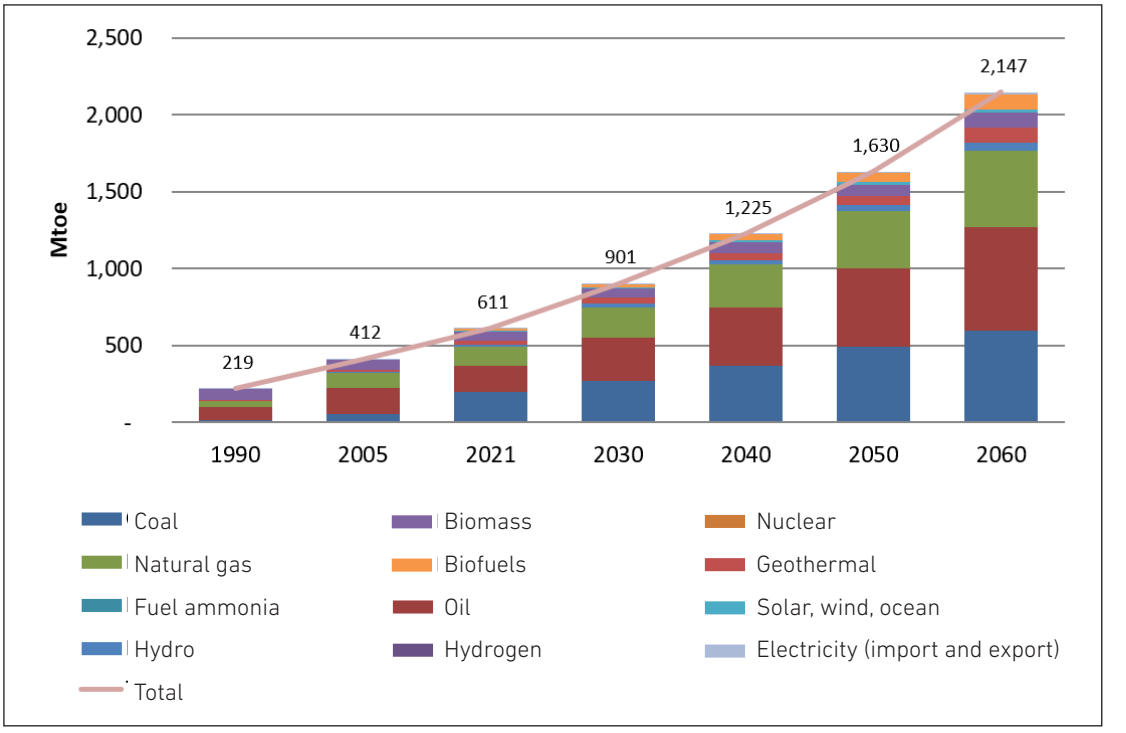
By 2060, biomass, biofuels, solar, wind, ocean energy, and electricity (export and import) are projected to make up around 11% of the total, increasing at an average annual rate of 2.6% from 2021 to 2060. By 2060, hydropower is projected to contribute only about 2.4%, while geothermal energy is expected to account for nearly 5%.

Oil is expected to remain the largest source of energy in 2060, accounting for about 31% of TPEC, followed by coal at 28% and natural gas at 23%. Between 2021 and 2060, oil consumption is expected to increase at an annual rate of 3.65%, i.e. slightly faster than natural gas (3.62%) but significantly faster than coal (2.87%). In this BAU scenario, the rise in oil consumption is expected to be mainly driven by strong growth in energy consumption by the transport sector, i.e. 3.9% annually between 2021 and 2060, which is higher than that of the industry sector (3.6%), other sectors (2.8%), and non-energy uses (1.2%). Oil consumption is projected to rise from 167 Mtoe in 2021 to 675 Mtoe in 2060.[2]

[1] Timor-Leste joined ERIA's Energy Outlook working group in 2026. Timor-Leste's energy outlook will be included in the ERIA Energy Outlook 2027.

[2] These figures equate to 1,225 million barrels of oil in 2021 and 4,950 million barrels of oil in 2060, or 195 million kilolitres of oil in 2021 and 787 million kilolitres of oil in 2060.

Figure 1.1. ASEAN-10's Primary Energy Consumption, Business-as-Usual Scenario, 1990–2060
(Mtoe)



ASEAN = Association of Southeast Asian Nations, Mtoe = million tonnes of oil equivalent.
Source: ERIA (2026a).

Finally, in terms of barrels of oil per day, in the BAU scenario, ASEAN can be expected to consume around 5,747 thousand barrels per day (kbd) by 2030 and around 13,562 kbd by 2060 (Table 1.1). AMS can be grouped into three categories in terms of oil consumption levels. The first category comprises Indonesia, which is the largest oil-consuming country in the region, accounting for about 32% of the total oil consumption in 2030 and almost 37% by 2060. The second group includes Malaysia, the Philippines, Thailand, and Viet Nam, whose total share will reach around 57% by 2030 but drop to around 51% by 2060. The third group includes Brunei Darussalam, Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, Singapore, and Timor-Leste,[3] whose total oil consumption is expected to be 11% by 2030 and 12% by 2060.

[3] In Table 1.1, the figure for Timor-Leste is only available for 2021 (historical data).

Table 1.1. ASEAN Member States' Primary Energy Consumption – Oil, Business-as-Usual Scenario, 2021–2060

(bpd '000)

Country/Region	2021	2030	2040	2050	2060
Total ASEAN	**3,364**	**5,747**	**7,653**	**10,292**	**13,562**
Brunei Darussalam	26	35	40	43	47
Cambodia	65	95	157	246	397
Indonesia	698	1,847	2,608	3,656	4,960
Lao PDR	25	33	53	84	133
Malaysia	479	777	993	1,222	1,516
Myanmar	84	158	228	325	475
Philippines	385	633	890	1,224	1,691
Singapore	246	312	400	503	585
Thailand	902	1,132	1,132	1,299	1,492
Timor-Leste*	4	**	**	**	**
Viet Nam	450	724	1,152	1,690	2,266

ASEAN = Association of Southeast Asian Nations, bpd = barrel per day.

Note: Totals may not be exact due to rounding.

*Source: US Energy Information Administration (n.d.).

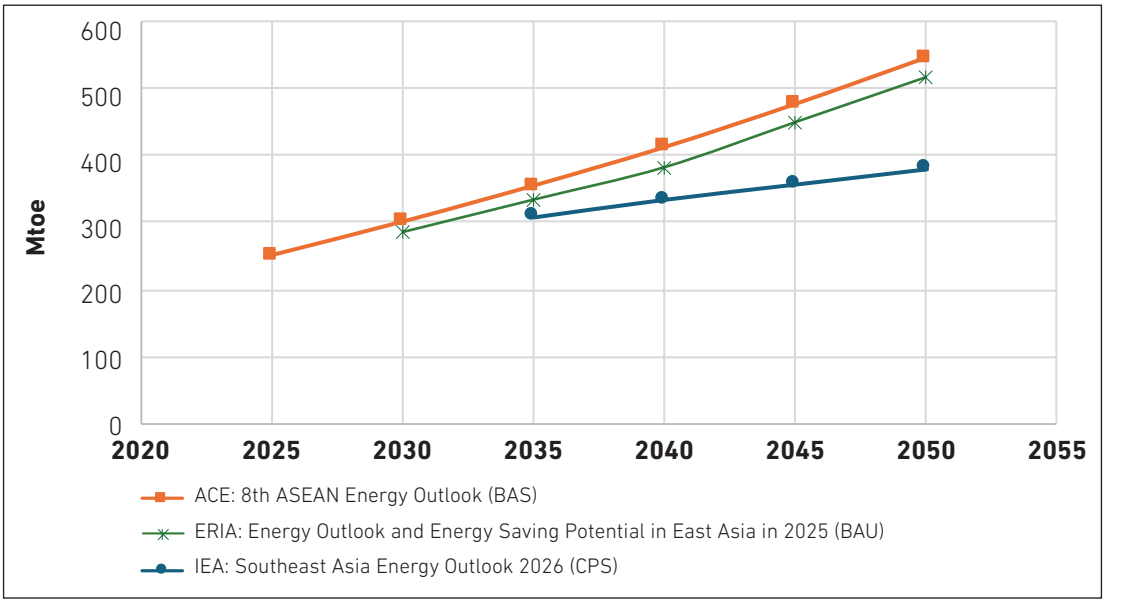
**Estimate not available.

Source: ERIA (2026a).

As shown in Figure 1.2, the estimates of future oil consumption for the ASEAN region in the BAU scenario from ERIA (2026a) fall between the projections of the Baseline Scenario (BAS) in the *8th ASEAN Energy Outlook* of the ASEAN Centre for Energy (ACE, 2024) and the Current Policies Scenario (CPS) of the International Energy Agency (IEA, 2026c). Values from the BAU scenario of ERIA (2026a) and the BAS of ACE (2024) are similar, while the values from IEA (2026c), which are the lowest of the three, deviate after 2035.

IEA (2026c) does not examine a BAU pathway. Instead, it examines the CPS, which accounts for measures already embedded in existing laws and regulations, and assumes that constraints (e.g. limited infrastructure, financing, or policy support) slow the deployment of new and emerging technologies. Compared with its two other scenarios, i.e. the Stated Policies Scenario and the Announced Pledges Scenario, the CPS is the scenario with the highest percentage of fossil fuel use (and the highest carbon dioxide (CO_2) emissions) in IEA (2026c). Nevertheless, the IEA's CPS still produces more optimistic future values than ERIA's BAU scenario or ACE's BAS for climate indicators, including a slower increase in oil demand in the ASEAN region.

Figure 1.2. Comparison of ERIA, ACE, and IEA Oil Consumption Estimates for ASEAN



ACE = ASEAN Centre for Energy, ASEAN = Association of Southeast Asian Nations, ERIA = Economic Research Institute for ASEAN and East Asia, IEA = International Energy Agency, BAS = Baseline Scenario, BAU = business as usual, CPS = Current Policies Scenario, Mtoe = million tonnes of oil equivalent

Sources: ERIA (2026a); ACE (2024); and IEA (2026c).

4. Impacts of Oil Insecurity and the Importance of Oil Stockpiling

As the demand for oil is increasing rapidly, global prices have a direct impact on ASEAN economies. Table 1.2 shows how vulnerable the imported oil supply is to fluctuations and shocks in oil prices, as well as the resulting increase in risk premiums for insurance.

Table 1.2. Pre-crisis and Peak Crisis Shocks

Parameter	Pre- 2026 Strait of Hormuz Crisis Baseline	Peak 2026 Strait of Hormuz Crisis Shock (Additional information)	Sources
Brent crude price (US$/bbl)	$60.00–$65.00	$126.00 (actual observed value by 28 April 2026)	Saunokonoko and Ambrose (2026)
Hormuz tanker traffic volume	About 20 million bpd	3.5 to 5.5 million bpd (estimated available capacity on alternative routes via Saudi Arabian pipeline to the Red Sea and via UAE pipeline to the Port of Fujairah)	IEA (2026d)
Average global disruption	Negligible	Middle East crude production curtailed by 8 million bpd and further 2 million bpd curtailment of the region's condensate and natural gas liquids production as of 10 March 2026	IEA (2026a)
Insurance war-risk premium	0.20%–0.25% of vessel's value	1.00%–1.50% of vessel's value (increase of more than fourfold in terms of cost per voyage – observed values in the days preceding 13 March 2026)	EIU (2026)

bbl = barrel, bpd = barrels per day, UAE = United Arab Emirates.

Source: ERIA's compilation.

ACE (2026) described how the supply shock caused by the 2026 crisis in the Hormuz Strait has affected many areas. Petrol prices at the pump rose quickly, while other shortages took longer to affect consumers in the region. A rapid assessment by ERIA identified three channels through which the oil shocks are impacting economic growth in AMS (ERIA, 2026b):

(i) **Import costs and trade balances**: Net energy-importing nations in ASEAN have seen their import bills swell, leading to a sharp deterioration in their trade balances and putting different downward pressure on national currencies. For instance, in March 2026, several AMS experienced depreciations of 3%–5%.[4]

(ii) **Fiscal deficits and subsidies**: Governments that use state-directed fuel subsidies face a difficult fiscal trade-off. They must either absorb the soaring costs within the state budget, increase the national debt, or raise regulated retail fuel prices. This would share more of the shock impact with consumers, which would reduce their buying power and could lead to public unrest.

(iii) **Imported inflation**: Rising energy prices rapidly increase costs in industrial manufacturing, transport logistics, and agricultural fertiliser production (because of their links to natural gas and urea). This drives core inflation upward, forces central banks to raise interest rates, and dampens real GDP growth across the bloc. For instance, in March 2026, some countries saw their consumer price index increase by more than 4% (Takeda and Loh, 2026).

[4] ERIA's calculation of the currency rate depreciation of the countries from 28 February to 20 July 2026 based on Morningstar financial service data (Morningstar, n.d.).

The channel of impact varies considerably across the region based on the unique energy profiles of AMS. For example, Singapore remains a leading refining, trading, and bunkering hub in ASEAN, and it does not provide fuel subsidies to consumers or industries to protect its economy from oil shocks. Instead, it experienced an immediate surge in the cost of raw crude inputs. While complex refining margins initially widened due to tight product markets, the extreme volatility disrupted maritime logistics and inflated container freight rates, directly impacting the city-state's trade-dependent economy.

Once a member of the Organization of the Petroleum Exporting Countries (OPEC), Indonesia is now a substantial net oil importer. The supply shocks immediately strained the state budget due to the wide gap between the high international price of crude and artificially low domestic prices for subsidised fuels like Pertalite (RON 90 gasoline) and bio-solar diesel (CN 48 diesel fuel blended with fatty acid methyl ester (FAME)). To avoid a fiscal crisis, the government provided Rp100 trillion (about US$5.9 billion) in extra energy subsidies by reducing spending at undisclosed government agencies (Reuters, 2026a).

According to Malaysia's Department of Statistics, Malaysia exported RM174.6 billion (S$57 billion) worth of oil and gas products in 2025 (*The Straits Times*, 2026). This total included RM103.55 billion in refined products and RM71.05 billion in crude oil and liquefied natural gas (LNG). At the same time, Malaysia imported RM152 billion (Lai, 2026), resulting in a surplus of more than RM22.6 billion. However, this surplus was largely offset by the cost of its domestic blanket fuel subsidy system, which had already reached RM40 billion by 2026 (Reuters, 2026b). The fiscal cost of subsidising retail petrol at record-high international prices cancelled out much of the upstream windfall, highlighting the need for targeted subsidy reforms.

In contrast, countries such as the Philippines and Thailand are highly dependent on imported oil to sustain their industrial and transport sectors. The Philippines faced immediate inflationary pressure, which accelerated increases in transport fares and electricity rates, testing the limits of its monetary policy. Thailand experienced a sharp widening of its current account deficit, forcing the government to draw down its state oil fund to stabilise domestic diesel prices.

The vulnerabilities exposed by the ongoing crisis in the Middle East show that market forces alone cannot guarantee energy security during major geopolitical disruptions (ASEAN, 2026; ACE, 2026). Therefore, ASEAN must transition from a reactive posture to a proactive model by creating institutionalised regional oil stockpiling as part of a co-ordinated regional resilience strategy (ERIA, 2026b).

5. The Strategic Triad for ASEAN Oil Stockpiling

Oil security is fundamentally about maintaining uninterrupted physical access to supply sources at an affordable price. International benchmarks, established primarily by the IEA, dictate that industrialised nations should maintain strategic petroleum reserves (SPR) equivalent to at least 90 days of their net oil imports. Different AMS currently hold varying stock levels or targets based on their national contexts, which are not necessarily linked to the international benchmark.

A co-ordinated regional stockpiling mechanism – combining physical crude reserves, underground rock caverns, and shared refined product storage – would provide a reliable supply buffer. If maritime chokepoints like the Strait of Hormuz or the Malacca Strait face disruptions, a regional reserve with a significant number of stockpiling days would give ASEAN refiners and utilities enough lead time to source alternative supplies from West Africa, the Americas, or domestic regional basins without experiencing immediate fuel shortages.

From a macroeconomic perspective, an oil stockpile serves as an insurance policy against supply shocks. When international oil prices spike, access to a regional stockpile allows Member States to release oil into the domestic market at pre-crisis cost baselines.

This intervention acts as a countercyclical economic buffer by:

- preventing sudden spikes in industrial input and freight logistics costs;
- shielding state budgets from sudden, unbudgeted subsidy outlays, allowing governments to maintain funding for healthcare, education, and infrastructure – preventing a more structural or permanent human development and economic crisis; and
- preventing capital flight and preserving currency stability by reducing the need for urgent, large-scale United States (US) dollar purchases to fund expensive spot-market oil imports.

A strategic oil reserve is a critical tool for ensuring a smooth, stable, and orderly energy transition that contributes to climate mitigation efforts being taken by AMS. An unmanaged energy crisis often forces countries to fall behind on their climate goals. Unexpected spikes in oil prices cause economic shocks that put countries' capacity to maintain their climate mitigation goals at risk. By smoothing these price increases, a strategic stockpile reduces the economic pressure for a country to revert to carbon-intensive fuel sources like coal.

In the multi-decade process of achieving net zero goals by mid-century, lower-emission petroleum applications serve as a vital link to a low-carbon future. However, for oil to function effectively as a bridge, its supply must be insulated from severe geopolitical and price shocks. Strategic stockpiling ensures this required baseline continuity, preventing the structural economic chaos that historically derails climate policies. Southeast Asia's energy landscape is heavily anchored by state-owned national oil companies. The revenues generated from traditional oil operations are vital to financing the region's broader low-carbon energy deployment. Operational cash flows of national oil companies directly finance new low-carbon investments in geothermal, offshore wind, utility-scale solar, and green hydrogen projects, bridging the green finance gap identified in the ASEAN Strategy for Carbon Neutrality (ASEAN, 2023).

Furthermore, price volatility harms the investment climate for renewable energy. High inflation and rising interest rates elevate the cost of capital, making it harder to finance capital-intensive projects like solar energy, wind farms, and regional grid infrastructure (ERIA, 2026b). By stabilising the macro-economy, a strategic stockpile helps maintain a favourable investment environment for the transition to green energy. When macroeconomic conditions are predictable, institutional investors and international climate funds are far more willing to commit the long-term, low-cost capital essential for building out ASEAN's green energy grids.

Finally, these storage facilities can be future-proofed. Underground caverns and storage tanks built today for crude oil and refined products can be engineered for later conversion to store low-carbon alternatives, such as liquid biofuels, synthetic next generation biofuels, or green ammonia (Patrahau and van Geuns, 2024). This dual-use capability means that the massive capital expenditures deployed for contemporary energy security double as foundational infrastructure for a fully decarbonised future, preventing assets from becoming stranded and directly supporting the long-term deployment of clean fuels.

6. Development of Oil Stockpiling in ASEAN

To integrate regional oil stockpiling co-operation into ASEAN's broader energy and economic integration agenda, it should align with the **ASEAN Economic Community (AEC) Strategic Plan 2026-2030**, which supports the ASEAN Community Vision 2045: Our Shared Future (Association of Southeast Asian Nations [ASEAN], 2025), and the ASEAN Plan of Action for Energy Cooperation (APAEC) 2026-2030. The AEC Strategic Plan emphasises strengthening economic resilience, regional connectivity, and energy security. Regional oil stockpiling co-operation could contribute to these objectives by improving preparedness for oil supply disruptions, strengthening cross-border supply chains, and mitigating the economic impacts of fuel shortages on regional trade and economic activities.

Operationally, this initiative falls under the APAEC 2026–2030 – specifically Programme Area No. 2: Oil and Gas Connectivity, Security, and Sustainability. The institutional foundation for this co-operation is the ASEAN Framework Agreement on Petroleum Security (APSA). Originally designed as a mutual assistance pact, APSA requires oil-surplus Member States to prioritise supplying oil-deficit members during an emergency. However, APSA lacks a mandatory, physical regional stockpile to back up this promise (Ganguli, 2026). Integrating a co-ordinated stockpiling framework into the APAEC would transform APSA from a declaration of intent to a well-funded, operational energy security mechanism that can be translated into a fully financed and active regional system designed to maintain energy flows across AMS during a crisis. The system should be based on shared emergency reserves, active cross-border trading, and financial support to manage sudden energy supply shortages.

The importance of oil stockpiling as a policy tool to tackle supply insecurity is widely recognised by AMS. All AMS legislate and carry out oil stockpiling, with most of the oil held by players in the industry. Some countries are considering more government involvement. Indonesia plans to introduce energy buffer reserves, where the government provides oil. However, the plan is postponed due to budget constraints. The Philippines is also introducing SPR through Department Circular No. DC2021-09-0028,[5] including a minimum inventory requirement of 15 days' worth of petroleum products for all oil companies operating in the country (Circular No. 2011-03-0002 of 2011).[6] Stockpiling rules and implementation vary by country (Table 1.3). Many countries require oil companies to stockpile different amounts of oil in reserve, depending on the type of oil product or business segment (e.g. importer, refiner, or distributor). For example, Indonesia requires oil companies to have some storage capacity but does not set a specific amount of oil to be stockpiled, and the exact amount of the stockpile is rarely disclosed.

[5] Department of Energy Circular No. DC2021-09-0028 dated 26 October 2021 Establishing the Philippine Strategic Petroleum Reserve Program.

[6] Department of Energy Circular No. DC-2011-03-0002 dated 28 February 2011 Providing for the Increase of the Minimum Inventory Requirements of All Oil Companies and Bulk Suppliers Operating in the Philippines

Table 1.3. Oil Stockpiling Efforts in ASEAN Member States

Component	BRN	CAM	INA	LAO	MAS	MYA	PHI	SIN	THA	VNM	TLS*
Oil products Stockpiling Policy	N/A	N/A	Yes	N/A	N/A	Yes	Yes	N/A	Yes	Yes	N/A
Infra-structure ownership	Private	Private	Private	Private	Private	National, Private	Private	N/A	Private	National, Private	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	N/A
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	Refined Oil (Products)
Strategic Petroleum Reserves/ National Mandatory Stocks	No	Currently doing FS on SPR	Currently drafting Bill on Energy Buffer Stock	Currently under dis-cussion	No	Currently emer-gency stock of 60 days (by MOEE)	Currently doing FS on SPR	No	Currently doing Study on SPR	Yes	No
Target	N/A	Private: 30-40 days for products, and 25-42 days for crude SPR: 35 days of con-sumption (Products & Crude) by 2035	Private: 30 days of con-sumption SPR: 30 days of con-sumption	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 con-sumption 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	N/A

AMS = ASEAN Member States, ASEAN = Association of Southeast Asian Nations, BRN = Brunei Darussalam, IDN = Indonesia, KHM = Cambodia, LAO = Lao PDR, MMR = Myanmar, MOEE = Ministry of Electricity and Energy (Myanmar), MYS = Malaysia, N/A = not applicable, PHI = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam, SPR = strategic petroleum reserves, TLS = Timor-Leste.

Sources: For ASEAN-10, edited by ERIA based on ACE (2021). For Timor-Leste: Government of Timor-Leste (n.d.), www.timor-leste.gov.tl; and Insights Global (n.d.), TankTerminals.com. www.tankterminals.com (accessed 4 August 2026).

For comparison, Table 1.4 shows the characteristics of the current oil stockpiling policies in IEA countries. Amongst IEA countries, some countries (like the US) hold only government stockpiles (SPR), while some European countries have stockpiles managed by an association of oil companies. Countries like Japan and the Republic of Korea (henceforth, Korea) have both government and private stockpiling systems (Table 1.4).

Table 1.4. Characteristics of Oil Stockpiling in IEA Countries

Country	Stockpiling Operator	Stockpiling Days	Starting implementation year	Stockpiling Release Procedure
United States	• Government	94 (crude oil and product)	1975 (under US Energy Policy and Conservation Act 1975)	• Released by competitive bidding • Price is determined by bidding.
Germany	• Association* funded by private industry	117 (crude oil and product)	1968*	• Association members have the right to receive stockpiled oil based on their share in the association's operations.
France	• Government • Private industry	102 (crude oil and product)	1968*	• Private industry stockpiling is released in the early stages of an emergency.
Netherlands	• Association* funded by private industry	143 (crude oil and product)	1968*	• Stockpiling volume above IEA obligation is released by bidding.
United Kingdom	• Private industry	49 (crude oil and product)	1976 (under UK Energy Act 1976)	• No government stock • No public stockpiling agency
Italy	• Private industry	99 (crude oil and product)	1968*	• Private industry releases stockpiling on a voluntary basis based on the government's recommendation.
Japan	• Government • Private industry	136	1975 (under Japan Oil Stockpiling Act 1975)	• The government relaxes the mandated days of private stockpiling. • Government stock is released by government order.
Republic of Korea	• Government • Private industry	78	1979 (led by the Korean National Oil Corporation (KNOC))	• The government relaxes the mandatory days of private stockpiling. • Government stock is released by government order.

IEA = International Energy Agency.

*Agreement of the six members of the European Economic Community (Belgium, France, Germany, Italy, Luxembourg, and the Netherlands) to maintain a minimum level of crude oil stocks and oil products corresponding to 65 days of domestic consumption.

Source: ERIA.

7. Existing Stockpiling Models

Several Member States are exploring commercial arrangements whereby national oil companies lease storage tanks to major Middle Eastern exporters (e.g. Saudi Aramco or Abu Dhabi National Oil Company). These state-owned exporters store large volumes of crude oil in Southeast Asia, keeping it close to major demand centres while retaining the option to release it locally during a supply emergency.

Although a fully centralised ASEAN stockpile does not yet exist, several foundational initiatives are underway. The ASEAN Plus Three (ASEAN+3) Oil Stockpiling Roadmap was initially formulated by the Oil Stockpiling Working Group in 2008 and was approved at the ASEAN+3 Ministers on Energy Meeting in 2010. It was established to improve oil stockpiling systems, ensure energy security, and protect Member States against volatile international oil prices. Developed in partnership with China, Japan, and Korea, this framework provides technical capacity building and policy advice through organisations like the Japan Organization for Metals and Energy Security.

Broadly speaking, there are three models of regional stockpiling, which may be categorised as (i) national initiatives, (ii) international ticket stockpiling, and (iii) joint stockpiling.

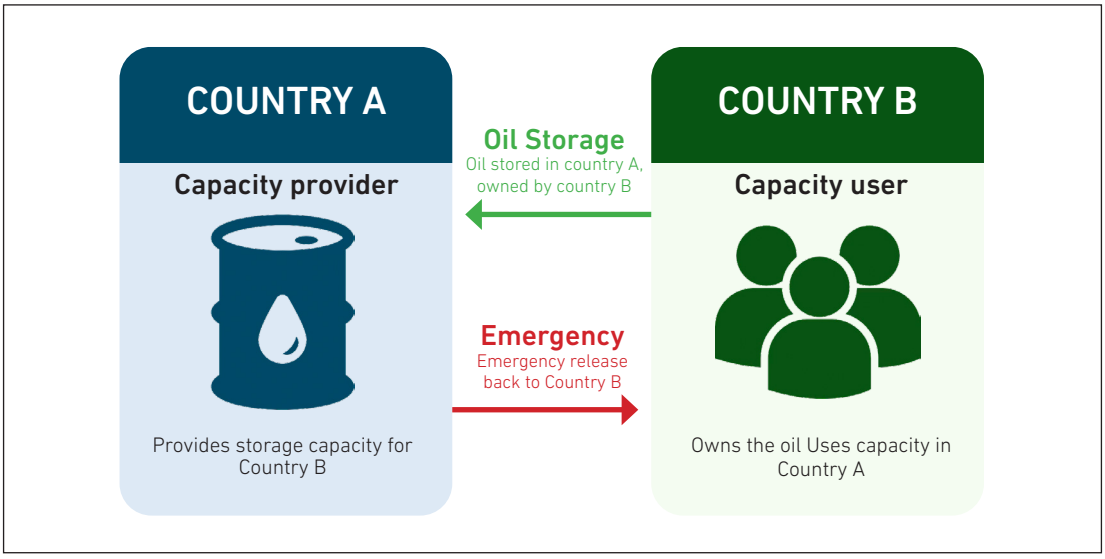
7.1. National stockpiling

National oil stockpiling mainly aims to prevent shortages of oil for domestic use, and the domestic oil industry or government is the main body responsible for developing, maintaining, and releasing stockpiled oil. Most of the world's oil stockpiles were created independently by oil companies and governments. Within the oil industry, it is common to keep a specific amount of stock to balance supply and demand. Advanced economies usually developed oil stockpiling based on industry stock. For instance, Japan initiated stockpile development in 1972 when the government advised oil companies to keep enough oil to cover 60 days of imports. In 1975, the law required oil companies to keep a supply of imported oil that would last for 90 days. In 1973, following the first oil crisis, the Organisation for Economic Co-operation and Development (OECD) created the IEA to coordinate energy security and policy amongst its member countries. Emergency response systems and oil stockpiling have been key parts of the IEA's work. IEA member countries must keep a stockpile that covers 90 days of net imports. In the 1970s, there was more demand for government intervention in oil stockpiling, leading several countries to create government oil reserves. The US established its SPR in 1975, and Japan followed in 1978. Although oil stockpiling in IEA member countries follows IEA guidelines, each member country legislates on, invests in, and owns the facility and stocked oil.

7.2. International ticket stockpiling

Ticket stockpiling refers to '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, 2026b). As shown in Figure 1.3, tickets are tools used to outsource stockpiling to other countries. If the ticket stockpiling is conducted between two countries, both governments typically agree on a specific amount to be stockpiled before the agencies – usually oil companies or designated entities responsible for oil stockpiling – in each country sign a contract. The ticket stockpiling system has been widely used in Europe. In Asia and the Pacific, Japan implements ticket stockpiling for New Zealand based on an agreement reached in 2007 by the respective governments. Based on this agreement, a Japanese oil company and the Government of New Zealand signed a contract, under which New Zealand pays a ticket fee and the Japanese oil company promises to supply petroleum products to New Zealand during emergencies.

Figure 1.3. The Concept of International Ticket Stockpiling



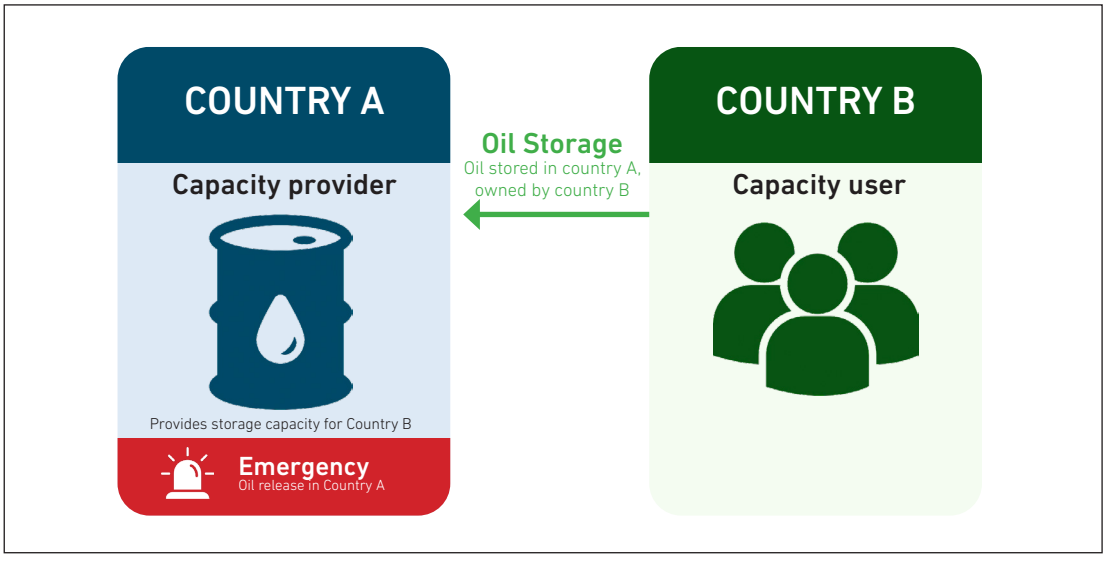
Source: ERIA.

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

7.3. Joint stockpiling

Another form of international oil stockpiling is joint stockpiling with a crude oil exporter. The exporter stores its crude oil in the importing country in return for giving that country the first drawing rights during an emergency. The exporter may store oil without charge, as long as the reserves can be called upon during an emergency. The reserves can be classified into strategic and commercial categories, allowing an importing country to add to their SPR at a lower cost. The exporter benefits from the commercial use of the storage facilities close to key consumption centres and growing new market areas. Figure 1.4 illustrates the concept of joint stockpiling.

Figure 1.4. The Concept of Joint Stockpiling



Source: ERIA.

Korea led the way in joint stockpiling with crude oil exporters by signing a deal with Kuwait in 2006 to store 2 million barrels of crude oil at the Korea National Oil Corporation's facilities. In 2016, it made another deal with Iran to store 2 million barrels of crude oil. In 2009, Japan made an agreement with the United Arab Emirates on joint stockpiling and now has similar agreements with Saudi Arabia and Kuwait. In 2017, India entered into an agreement with the United Arab Emirates.

Although the specifics of the agreements are unknown, the main set-up is that the importing country pays for the capital and operating costs, while the exporting country retains ownership of the oil. The importing country does not need to purchase the oil but still has the first drawing right to the oil during an emergency. Such joint stockpiling benefits both exporters and importers.

Joint stockpiling gives exporters better access to the demand market at a low cost. Once the tank is replenished, exporters who joint stockpile their crude oil together in importing countries can deliver the crude oil immediately, without needing long-haul transport. Joint stockpiling provides crude oil exporters a low-cost method of defending their market share in ASEAN. Being close to the markets makes them more competitive than their short-haul competitors. For consumers, this represents substantial savings in shipping and insurance costs. In return, importing countries can expand their oil reserves without paying the main part of the stockpiling costs up front.

KAPSARC (2017) listed three more benefits for national oil companies in exporting countries that join a stockpiling arrangement. First, they can sell crude oil cargos at spot prices from their joint storage facilities, such as in Asia, where customers in East Asia are willing to purchase on the spot market. Second, joint oil stockpiling offers volume flexibility. This means that oil stored in a depot can be leased and delivered in smaller or customised quantities, using smaller vessels that are suitable for many refining centres and ports in Asia. Finally, the leased storage facilities can be used by the exporting countries' national oil companies as trading hubs, where they can serve a variety of customers in the region.

Several studies have shown how oil stockpiling helps reduce price fluctuations. Galkin et al. (2025), for example, showed how oil importers can choose to use a strategic buffer by releasing their oil reserves to stabilise the market. Bordoff, Halff, and Losz (2018) demonstrated that strategic stocks can be used to stabilise oil prices by reducing price spikes and smoothing price fluctuations until the private sector adjusts to sudden supply disruptions, resulting in economic benefits. Datta and Amarnath (2025) argued that storage facilities typically stabilise oil markets by minimising critical market deficiencies.

Finally, oil stockpiling could also be used by national oil companies in exporting countries to help them control more of the downstream integration of the supply chain and secure their market share. For the host (importer) countries, having crude oil stockpiled within their territory or nearby allows them to quickly access crude shipments when unexpected events occur. This helps local refineries optimise their mix of different types of crude oil.

However, data analysed in KAPSARC (2017) showed that financial returns in the refining sector have probably been small or even negative, especially compared with the income from upstream exploration and production activities. Stevens (2016) explained that after a refinery is built, it must operate its units at full capacity to remain profitable. Operating below capacity greatly increases fixed costs, which rapidly reduces profitability. However, operating at full capacity risks causing a market oversupply, which lowers refinery profits, especially when crude prices are rising.

8. ASEAN Petroleum Security Agreement (APSA)

APSA is a regional co-operation agreement between all AMS, established on 1 March 2009. It is a revised version of the Agreement on ASEAN Energy Cooperation, established by AMS in June 1986. APSA was created to help manage the emergency response system for crude oil and oil products when the supply is either too large or too small. In 1999, the ASEAN Ministers on Energy Meeting agreed to modify the original APSA to include both short-term and mid- to long-term emergency response measures. They also created detailed procedures to share crude oil and product supplies amongst member countries during an emergency.

The objectives of APSA are to provide short- and long-term emergency response measures, enhance the oil supply security of AMS, and minimise vulnerability during emergencies. This is based on the voluntary and commercial participation of AMS. For short-term actions, APSA advises member countries to lower their oil demand during normal conditions, avoid rapid growth in demand, and gather relevant information and data before requesting regional oil sharing (Kobayashi and Anbumozhi, 2015). In addition to these efforts during normal conditions, member countries also undertake a Coordinated Emergency Response Mechanism (CERM) if an emergency occurs. APSA's long-term measures are notable because they include the liberalisation of oil and natural gas markets and the use of commercial and voluntary stockpiling as key ways to ensure regional energy security.

APSA provides procedures for CERM or a co-ordinated oil-sharing system amongst member countries. CERM is initiated by a country in distress. It activates when there is a 10% supply disruption in the normal domestic oil supply lasting for 30 days. If this happens, the country in distress will try to handle the disruption by using other energy sources or reducing oil consumption as much as possible. If such measures do not work, the country may request CERM assistance.

At the 48th ASEAN Summit in May 2026, the Leaders agreed to tackle critical issues concerning the activation of APSA.

9. Challenges in Implementing National and Joint Stockpiling

In practice, emerging economies in ASEAN do not yet commonly hold emergency oil reserves. In contrast, IEA member countries must hold oil stocks equal to at least 90 days of net imports. ERIA (2022) analysed the costs and benefits of holding oil stockpiles to verify the effectiveness of the proposed measures, i.e. national reserves, ticketing, and joint-oil stockpiling, in Indonesia, the Philippines, and Viet Nam (ERIA, 2022). The analysis included costs such as the capital expenditure needed to build the reserves, the cost of purchasing the oil, and the cost of operating and maintaining the stockpiles. The benefits included the avoided disruption costs, meaning the prevented losses to the economy's GDP and the avoided net import costs of oil. The study assumed supply disruptions in the Middle East and the South China Sea, as well as natural disasters in the importing countries. Using a Monte Carlo simulation (with 1,000 simulations for each country), the study found that the expected benefits of oil stockpiling exceeded the costs in Indonesia, the Philippines, and Viet Nam.

Stelter and Nishida (2013) conducted another study that examined the costs and benefits of holding emergency oil stocks in Asia. The costs in their study – including set-up costs for the storage facilities, operating and maintenance costs, refreshment costs, and land costs – varied depending on the size and type of storage facilities (e.g. above-ground tanks and underground caverns) and the composition of the stocks (crude oil or products). Economic benefits were mainly estimated by offsetting oil supply losses and thereby reducing potentially significant oil price increases, using a large series of simulations over a 30-year period. However, that study did not quantify the benefits at the country level because these benefits mainly depended on a country-specific economic situation, such as the energy intensity of its GDP and the oil intensity in total primary energy supply. Their analysis showed that holding emergency oil stocks provided significant economic benefits of about US$41 per barrel every year. They also found that the acquisition costs of oil accounted for the largest share in overall costs related to emergency oil stockpiles.

It is recognised that establishing strategic oil reserves at the national or regional level is important to mitigate sudden disruptions in oil supply. However, the requirement to hold oil stock beyond a specified duration may present implementation challenges for some countries due to financial and technical constraints. The joint oil stockpiling model, which will be discussed in more detail in the next chapter, has the potential to address these issues.

Joint oil stockpiling faces three major technical challenges:

(i) **Infrastructure deficits and storage geologies**: Building storage facilities that can hold 90 days of import capacity requires massive capital investment. Many AMS lack the deep underground salt domes or stable hard-rock formations needed to build cost-effective underground rock caverns, forcing them to rely on more expensive above-ground tank farms.
(ii) **Refinery configuration mismatches**: Crude oil is not a uniform commodity; it ranges from light, sweet varieties to heavy, sour blends. ASEAN's refineries are highly specialised, calibrated to specific combinations of sulphur content and gravity parameters. A regional stockpile must match these diverse refinery specifications, as storing the wrong type of crude oil could leave regional refineries unable to process it efficiently during an emergency.
(iii) **Storage degradation and product turnover**: Crude oil and refined petroleum products degrade over time, suffering from oxidation, stratification, and moisture accumulation. Managing a strategic reserve requires constant product rotation and high-velocity supply co-ordination to ensure stored fuels remain usable without disrupting commercial markets.

Other challenges include financial burdens and the problem of free riders. The financial cost of building and maintaining a strategic stockpile is substantial and must be shared. Wealthier countries like Singapore, which have low direct import needs, or net exporters like Malaysia and Brunei, use different fiscal incentives compared with developing net importers like the Philippines or Viet Nam. It is thus necessary to develop an equitable cost-sharing model.

There are different ways of financing the acquisition and maintenance of emergency stocks, as demonstrated by Stelter and Nishida (2013). Significant differences are observed in the way IEA member countries finance their oil stockpiling. IEA (2026b) noted that ticketing, an arrangement where the seller agrees to hold (or reserve) a specific amount of oil on behalf of the buyer in return for an agreed fee, was a flexible and cost-effective way for companies or agencies to meet their obligations. Holding oil stockpiles provides benefits not only to the stockpiling countries but also to other countries with no stake in the stockpile (Shin and Savage, 2021). In their simulation, Stelter and Nishida (2013) showed that the use of IEA oil stocks was equivalent to about US$3.5 trillion of avoided costs over a 30-year period to IEA and non-IEA net importing countries. Such ripple effects to neighbouring countries or regions could be explained by the international public goods aspect of oil stockpiling based on the trident narrative of energy security, economic resilience, and climate change mitigation.

10. Strategies and Prerequisites in Developing Regional Oil Stockpiling Systems

Since successful regional co-operation on stockpiling must address current institutional challenges as well as economic development and energy security needs, it is crucial for countries to understand each participating country's resources in order to create effective co-operation. From this viewpoint, the following prerequisites and essential steps are identified as effective strategies for formulating a regional oil stockpiling system, whose implementation can be supported by Article 6 of APSA.

10.1. Acquiring accurate and timely inventory

A key challenge for AMS is creating an accurate and timely data collection system on public and private oil holdings. In most AMS, data on energy supply and demand are not well developed because, until recently, oil supply security was not a major policy concern. As oil demand is growing rapidly, it is urgent to establish a transparent system for gathering and sharing accurate oil consumption data from both public and private sources in a timely manner. Knowing the correct volume and location of oil inventory is critical for oil stockpiling and preparing emergency plans, including APSA.

Since oil is used in many sectors and economic activities across ASEAN, gathering data on oil consumption requires collaboration between different government departments and private organisations. It is also important to organise and control the data once they are collected. After collecting the data, they should be organised and maintained to allow easy access and use. In this respect, Article 5 of APSA, which outlines the institutional framework for the Coordinated Emergency Response Measure (CERM), designates ACE as the permanent organisation responsible for maintaining and analysing the data. The framework should also specify how often data are collected and reported. If the oil supply is disrupted, the government or the oil company must decide where to send the limited supply available. If precise data are not available, the oil may be delivered to the incorrect location. If data are not provided quickly, the decision will take more time or be made without trustworthy information.

Accurate data remain important after the stockpiling development plan is made because they provide a key reference for revising the outlook on oil supply and demand. To set a specific numerical target, it is necessary to develop the most accurate oil supply and demand forecast early in the oil stockpiling process. The oil stockpiling target is usually set as a specific number of days of net oil imports. However, in AMS, where imports keep growing, the days-of-import target is not indicative of the absolute number of imports. Therefore, it is difficult to determine the size of stockpiling facilities without first establishing a clear planning period. Ensuring a reliable oil supply demand is essential when planning oil stockpiling within a limited time frame.

Finally, it is important to determine the point when a supply shortage occurs and triggers emergency responses. Under APSA, a 'critical shortage' is defined as a shortfall of at least 10% of the normal domestic requirements for a continuous period of at least 30 days or as prescribed by the ASEAN Ministers on Energy Meeting (AMEM). This critical shortage definition must be clearly explained and applied in the processes of data collection, monitoring, and reporting described above.

10.2. Establishing physical storage facilities for stockpiling

To increase physical storage capacity, the refinery capacity in each AMS needs to be examined. Refinery construction is the most effective means of increasing a country's oil storage capacity and inventory. Because refineries have storage tanks for their commercial operations, placing a stockpiling base next to these facilities helps save administrative costs for operation and maintenance by combining these tasks with commercial storage operations. In fact, having storage tanks for stockpiling within or near a refinery is the most effective and efficient means of expanding stockpiling capacity. Geographical proximity between refineries and storage facilities minimises the time lag between the release of crude oil stockpiling and the supply of oil products to consumers. It also lowers the risk of disruption to how crude oil is transported to the refinery. Building a stockpiling base near the refinery, therefore, is considered the most cost-effective means of strengthening oil-stockpiling capacities.

10.3. Planning the type of products to be stockpiled

The type of plan needed for oil stockpiling is determined by the kind of oil to be stored. Oil can be stockpiled in the form of crude oil or refined oil products. The specific type of oil needs to be determined by weighing the advantages and disadvantages of both kinds of stockpiling. Storing crude oil is the easiest way to create a stockpile because different grades of crude oil can be stored together, eliminating the need for separate tanks for each grade. In oil product storage, each storage facility must be kept separate, often requiring different kinds of tanks. Storing crude oil also allows some flexibility in refining specific products because refineries can adjust the output of the oil product to a degree during the refining process. If there is a severe shortage of diesel oil, for instance, refiners can produce more diesel oil than gasoline and kerosene from a single barrel of crude oil. Quality decreases over time when storing oil products, so it is important to rotate the inventory periodically. In the case of crude oil stockpiling, however, quality degradation is very limited, as crude oil can be stored for decades without incurring additional expenses from rotating inventory.

Conversely, oil product stockpiling helps ensure operational readiness. Since, with limited exceptions, crude oil is not directly consumed, releasing stockpiled oil products can expedite the process of refining crude oil into finished petroleum products. This is particularly true in emergencies involving a disruption to local supply, such as during a typhoon, an earthquake, or other similar natural disasters. These events can affect both the local supply and the distribution network. In such cases, there is little time to replace the lost oil supply, so releasing the oil product stockpile would be very effective and helpful. Similarly, it is sensible to store crude oil if the country has enough refining capacity. Otherwise, the stockpiled oil will have to be oil products. The location of the oil stockpiling base may vary depending on the kind of stockpiled oil. If crude oil is stockpiled, the location of the storage facility will be close to the refinery. If refined products are stockpiled, the storage facility will be close to a large city where demand is high. When developing a stockpiling plan, it is important to carefully consider the kind of oil to be stored.

10.4. Identifying the responsible party for governing the stockpiling

It is essential to determine who will be responsible for developing and storing the oil stockpile. Amongst the IEA countries, countries like the US hold only government stockpiling (SPR) while some European countries hold stockpiling through an association of oil companies. Other IEA countries like Japan and Korea have both government and private stockpiling systems. In the context of AMS, where national oil companies often dominate the refining and marketing sectors, deciding how to include them will be an important policy issue.

10.5. Conducting emergency exercises

Regardless of the stage of advancement in oil stockpiling, it is important to conduct emergency exercises as these can identify problems, issues, and weaknesses in a country's oil supply and stockpiling system. Conducting regular exercises also contributes to better emergency response measures by creating the opportunity for people in charge of emergency response to meet and become familiar with each other. In an emergency, the speed and accuracy with which relevant organisations share critical information is a key factor in achieving an effective emergency response. The Asia Pacific Energy Research Centre (APERC) has conducted several structured exercises in selected AMS. Thailand conducts annual emergency exercises assuming a particular crisis scenario. People from many parts of government participate in the exercises using role playing. Such efforts serve to strengthen the country's emergency response capacity. To support this, it is necessary to consider whether appropriate governance structures should be established under the terms of reference of APSA or the CERM working group.

10.6. Securing finance

Stockpiling development requires substantial capital investment, whereas its economic benefits are hard to quantify. Securing financing for stockpiling development is, therefore, a difficult task. In the context of oil stockpiling development in IEA countries, these countries collectively face the risk of significant oil supply disruptions. Following the initial oil crisis in 1973, mobilising domestic resources to develop a stockpiling system was relatively straightforward. In the context of AMS, however, establishing such a strong incentive is challenging. Since stockpiling development constitutes a policy of energy security, it is advisable for each national government to allocate funds for its development.

To obtain funding, it is essential to present concrete justification for why the country must prioritise stockpiling development. Visual or quantitative material should be developed to raise the priority of stockpiling development in the budget allocation of each country. If government sources cannot be obtained, private funding should be sought. The government may impose regulations on the oil industry to hold a specific level of inventory by requiring investment in a stockpiling facility and building up an inventory. However, the government may still be required to provide economic incentives to the industry to facilitate such developments.

If sufficient capital cannot be obtained from domestic public financial sources, foreign sources will become a viable alternative. The introduction of foreign investment may be achieved through several means. The most straightforward method is to acquire foreign equity investments in an oil stockpiling organisation. This serves as an invitation for foreign investment in a newly established organisation dedicated to the operation and maintenance of stockpiling. Another approach to promoting foreign investment is to invite foreign companies to invest in oil supply–chain infrastructure projects on the condition that they will provide extra storage for oil stockpiling. Given that ASEAN is one of the prospective future oil markets alongside China and India, it is a very attractive region for international oil companies.

Faced with risks related to oil supply disruptions, ASEAN needs to prepare oil stockpiling as an emergency response system as it becomes more dependent on imported oil. Past studies have shown that oil stock draws would be the most effective way to mitigate economic damage caused by oil supply disruptions and would benefit not only oil stockpiling countries but also other countries without oil stockpiles. However, a regional co-operation mechanism for oil stockpiling has not yet been established to cope with emergency situations. This study, therefore, attempts to identify a way to strengthen the formation of a co-operative framework for oil stockpiling in ASEAN. Defining the benefits of regional oil stock is also a complex task.

A net-importing country experiencing high inflation may want to draw down the regional stockpile when crude oil prices reach a specified critical threshold. Conversely, a net-exporting country or a fiscally conservative AMS may argue that reserves should be preserved for a total cessation of physical supply. Resolving these conflicting national priorities requires a clear understanding of locational advantages, tangible economic benefits, and non-monetary public goods. At the Asia Zero Emission Community (AZEC) Plus Online Summit on 15 April 2026, the Leaders declared that emergency oil stocks should be regarded as a form of insurance against the adverse impacts of potential oil supply disruptions, possibly avoiding or mitigating the effects of such disruptions.

11. Towards a Co-operative Regime for a Regional Petroleum Reserve Strategy in ASEAN

Establishing a co-ordinated regional oil stockpiling framework is no longer an optional policy goal for ASEAN, but a strategic necessity for the region's economic future. By aligning this effort with the economic integration goals of the AEC Blueprint and the energy security priorities of the APAEC, ASEAN can build a resilient buffer against global oil supply disruptions and associated price volatility. Overcoming the technical hurdles of infrastructure deployment and the institutional challenges of regional governance will require strong policies and innovative financing.

As mentioned in Section 1.5., a co-ordinated regional stockpiling mechanism – integrating physical crude oil reserves, underground rock caverns, and shared refined product storage – would provide a reliable supply buffer. Therefore, the optimal long-term policy objective of ASEAN's regional strategy should be the establishment of a co-operative regime concerning petroleum stockpiling or oil reserves. Within this co-operative framework, AMS would develop a regional petroleum stockpiling and associated facilities to be used collectively by all member countries. In this context,

the issue of stockpiling is regarded as a matter of international interaction and co-operation amongst AMS.

The co-operative regime is the opposite of the non-co-operative regime – specifically, a hypothetical scenario in which AMS undertake efforts independently to build their own reserves. In a non-co-operative regime, each country may ultimately accumulate substantial stockpile reserves, as, in the absence of any reserve-sharing mechanisms or assurances that neighbouring states will participate in reserve-building, an individual AMS must depend solely on its own reserves to mitigate the negative macroeconomic impacts of oil price shocks. Such a regime may result in the excessive construction of reserve facilities, i.e. an aggregate level of reserves in the region that significantly exceeds the optimal requirement (Hogan, 1983; Oliveira, Zahur, and Wu, 2023).

At the other extreme, as explained by Hogan (1983), is the scenario in which oil importing countries presume that oil reserves have the characteristics of international public goods and expect a free ride on the stockpiles held by other market participants. In other words, each country anticipates that other countries will build a stockpile and may share that reserve in the event of a supply disruption or crisis. This situation could result in inadequate or insufficient development of oil stockpiling, causing significant losses during crises involving disruptions in oil supply. Co-operation is anticipated to emerge as the dominant force, rather than free riding, since, in the long term, economies are likely to recognise that their willingness to engage in stockpiling influences the decisions of other economies (Leiby, Bowman, and Jones, 2002).

A co-operative regime would therefore allow the region to achieve greater benefits than the sum of individual countries acting alone (Leiby and Bowman, 2000; Leiby, Bowman, and Jones, 2002). Oliveira, Zahur, and Wu (2023) emphasised that the advantage of co-operation lies in the sharing of reserves, thereby preventing excessive stockpiling that may occur under a non-co-operative regime.

While the concept of national oil stockpiling, as explained in Section 1.7.1, may fall within the non-co-operative regime, the concept of international ticket stockpiling (Section 1.7.2) and joint oil stockpiling (Section 1.7.3) should be classified within the co-operative regime.

Beyond the mere implementation of ticket stockpiling and joint oil stockpiling, a comprehensive co-operative regime will require at least the following considerations:

(i) The region's long-term supply and demand potential, including an assessment of current and future conditions or a strategy related to regional oil production capacity, oil importation, and refining capacity.
(ii) Current and future regional oil and petroleum infrastructure development, including a network of stockpiling facilities integrated into a single regional supply chain.
(iii) The role of government interventions in terms of price setting and stockpiling in relation to the functions of the private sector (Wright and Williams, 1982).
(iv) Co-ordinated regional mechanisms for stockpile accumulation and drawdown that account for uncertainty in the duration of interruptions, the timing of stockpile management (Teisberg, 1981), and the economic impacts of supply curtailment (Chao and Manne, 1982).
(v) Co-ordinated regional policies for both oil prices (tariffs) and stockpiles (Teisberg, 1981).

Finally, a co-operative regime within ASEAN should optimise the scale of the regional stockpiling needed and minimise the costs associated with its development and operation. It should also mitigate the economic losses and increased oil import or acquisition costs incurred during future crises, while securing benefits from the sale of oil or its refined products.

While this regime should become the goal of the ASEAN region's strategy regarding oil stockpiling or reserves, this report recommends starting with select strategic models where the full participation of all AMS would be achieved progressively. It is crucial to adequately prepare for and start implementation of the models with the participation of one, two, or three AMS. Even at such small-scale implementation, benefits are expected to be experienced throughout the region, as the use of an oil stockpile in any part of the region will affect supply across all other areas. Increasing the scale of implementation is expected to enable AMS to reap the substantial potential benefits of a fully co-operative response to an oil emergency.

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Chapter 2

Scenario-Based Comparative Analysis of ASEAN Oil Stockpiling

1. Introduction

Oil supply security remains a strategic priority for the Association of Southeast Asian Nations (ASEAN). Despite accelerating clean energy deployment and long-term decarbonisation efforts, petroleum products continue to play a central role in transport, aviation, shipping, fisheries, agriculture, construction, manufacturing, petrochemicals, logistics, and selected power systems. A serious oil supply disruption would therefore have economy-wide consequences extending beyond the energy sector. It could affect inflation, household purchasing power, fiscal balances, industrial production, trade flows, logistics costs, and investor confidence.

Building on Chapter 1, which identifies ASEAN's structural oil dependence, exposure to maritime supply routes, and uneven national stockholding capacity, this chapter translates those strategic risks into a common reserve-volume and cost comparison. Oil accounts for about 28% of ASEAN final energy consumption, underscoring the economy-wide exposure to disruptions transmitted through crude oil and petroleum-product markets (ACE, 2026). For consistency, all reserve-volume and cost calculations in this chapter use 5.0 million barrels per day (mb/d) as the ASEAN-wide planning demand base. This denominator is applied uniformly to the aggregate of all 11 ASEAN Member States (AMS) and should not be interchanged with figures based on different years, fuels, or accounting definitions elsewhere in the report.

ASEAN's exposure to oil supply risk is shaped by three structural factors. First, the region remains a major oil-consuming and oil-importing region. Second, many ASEAN economies are connected to international crude and petroleum product markets through maritime routes that are vulnerable to geopolitical and logistical disruptions. Third, energy demand in Southeast Asia remains closely linked to economic growth, urbanisation, industrialisation, and expanding transport activity (IEA, 2024a).

The Strait of Hormuz illustrates the scale of external supply risk. The United States (US) Energy Information Administration (EIA) identifies it as one of the world's most important oil chokepoints, with limited alternative routes in the event of disruption. Figure 2.1 shows the observed oil flows through the strait averaged around 20 mb/d in 2024, equivalent to about one-fifth of global petroleum liquids consumption (US EIA, 2025a, 2025b). For Asian economies, including AMS, a major interruption along this route could transmit rapidly through higher crude prices, shipping costs, insurance premiums, delayed cargoes, and petroleum-product market volatility. Other external and regional chokepoints, including Bab el-Mandeb, the Suez Canal, and the Strait of Malacca, can transmit similar supply, freight, and insurance shocks. This study therefore considers both external and ASEAN maritime disruptions.

For this scenario-based comparative analysis, based on the idea of cost–benefit analysis in this chapter, these observed flow data establish the scale of exposure, while the disruption itself is modelled as a reference stress scenario. The scenario assumes a complete or near-complete blockage of oil movements through the Strait of Hormuz, or an interruption of comparable regional scale. It is deliberately severe to test whether strategic reserves could protect ASEAN against a high-impact shock and should not be interpreted as an observed closure.

Against this risk, emergency reserves give governments time to release stocks, co-ordinate response measures, secure replacement cargoes, stabilise domestic supply, and protect critical sectors.

This chapter employs a scenario-based comparative analysis approach, based on the idea of cost–benefit analysis of ASEAN reserve portfolios. The term 'hybrid' in oil stockpiling describes a portfolio that may combine eligible refinery and commercial stocks, additional national stockpiling, ticket stockpiling, and joint stockpiling. The analysis does not establish a final ASEAN policy model or predetermine the preferred reserve composition. Instead, it compares three case scenarios that progressively vary the balance between national control and co-operative arrangements while maintaining a common planning benchmark. This approach recognises ASEAN's diversity in market size, fiscal capacity, storage infrastructure, import dependence, and institutional readiness.

Figure 2.1. Total Petroleum Liquids Transported Through the Strait of Hormuz
(mb/d)



mb/d = million barrels per day, Q = quarter.

Note: The circular symbols below the data points distinguish observation years only and do not represent an additional analytical variable.

Source: ERIA based on US EIA (2025a, 2025b).

This chapter discuses ASEAN-level results only. Country-level tables are not included because the purpose of this chapter is to evaluate the regional economic rationale for stockpiling, not to rank individual Member States or expose national differences, since oil stockpiling is a regional resilience issue with collective benefits.

This discussion in this chapter is purely based on an analytical perspective and does not aim to establish an official ASEAN reserve obligation, an agreed host location or implementation mechanism, or a binding emergency-release rule.

2. Rationale for ASEAN Hybrid Reserve Co-operation

An oil stockpile creates economic value by reducing the severity of supply disruptions. Even a temporary shortage can trigger price spikes, shipping delays, fuel rationing, emergency procurement costs, and production losses. These effects are especially important for ASEAN because the region depends heavily on road transport, maritime trade, aviation, food distribution, and energy-intensive industrial activity (IEA, 2025a; ERIA, 2016a).

A purely national stockpiling approach gives governments substantial control over reserve ownership and release decisions. However, it is the most capital- and financing-intensive option because it requires direct crude or product acquisition, dedicated storage tanks, terminal facilities, pipelines, jetties, land, maintenance, insurance, security, stock rotation, and financing. At the 5.0 mb/d planning base, one additional day of national stockpiling carries an annualised cost of about US$53.0 million, and the 45-day national component in scenario 1 costs about US$2.385 billion per year. The fiscal implication is therefore significant, particularly for economies with limited existing infrastructure or borrowing capacity (ERIA, 2026; Section 2.4.2).

A hybrid reserve co-operation approach offers a more practical pathway. It recognises that part of the emergency reserve base already exists in refinery and commercial inventories and supplements this base through three additional mechanisms.

First, additional national stockpiling provides direct sovereign control over reserve assets. This is important for national emergency preparedness, but it is the highest-cost mechanism.

Second, ticket stockpiling provides contractual access to oil stocks held by another party. It can reduce capital expenditure (CAPEX) because the participating country does not need to build all storage infrastructure domestically. Ticket arrangements can also serve as a transitional mechanism while ASEAN develops more advanced regional reserve institutions.

Third, joint stockpiling allows participating countries or partner entities to share infrastructure, financing, and reserve access arrangements. In some models, crude ownership may remain partly with an exporting country or commercial partner, while ASEAN economies secure emergency access rights. This reduces the cost of oil ownership and storage duplication.

A further benefit is stronger collective bargaining power. If AMS negotiate separately, the reserve volumes, storage opportunities, and emergency access commitments offered to oil-exporting partners may be fragmented and too small to secure the most favourable terms. A co-ordinated ASEAN approach could aggregate prospective demand and suitable storage capacity into a larger and more commercially credible regional proposition. Participating Member States could then negotiate collectively on inventory volumes, storage fees, ownership arrangements, emergency drawdown rights, replenishment obligations, pricing principles, product specifications, and the duration of supply commitments.

For oil-exporting partners, including governments, national oil companies, and commercial suppliers, placing exporter-owned crude oil or petroleum products in approved ASEAN storage facilities could position stocks closer to a large and growing market, support long-term producer–consumer relationships, and improve readiness to supply the region. For ASEAN, the arrangement could bring physical stocks closer to demand centres without requiring participating governments

to finance the full value of the inventory. ASEAN's bargaining power would arise not simply from negotiating as a political group, but from offering credible regional scale, appropriate infrastructure, co-ordinated demand, and clear emergency access arrangements. Realising this advantage would require voluntary participation, transparent governance, commercially workable terms, confidentiality protections, and legally enforceable rules on access, release, replenishment, and dispute settlement.

Hybrid reserve co-operation is especially relevant for ASEAN because the region includes large oil-consuming economies, trading hubs, emerging importers, and smaller economies with different levels of infrastructure readiness. A regional approach can pursue a common resilience objective while retaining flexibility in implementation.

3. Analytical Framework – Scenario-based Comparative Analysis

The model adopts a 90-day effective reserve benchmark for planning and scenario comparison. This is consistent with established international oil-security practice, including the International Energy Agency (IEA) requirement for member countries to hold emergency stocks equivalent to at least 90 days of net oil imports (IEA, 2025a, 2025b). AMS are not subject to that IEA obligation. Accordingly, this study does not apply the IEA compliance formula: it uses 90 days of average ASEAN oil demand, based on the common 5.0 mb/d planning denominator, as a regional analytical reference only.

The 90-day benchmark serves three purposes. First, it provides a widely recognised reference point against which the scale and cost of ASEAN preparedness can be assessed and compared with international practice. Second, it represents a meaningful response window during which governments could release emergency stocks, arrange alternative cargoes, reroute shipments, address refinery and product-distribution constraints, and introduce temporary demand management measures. Third, holding the benchmark constant across the three scenarios allows the analysis to isolate the cost implications of changing the reserve composition rather than changing the assumed level of protection.

The benchmark does not imply that every AMS should build or own 90 days of public stocks. In this study, it represents effective regional coverage comprising about 30 days of existing refinery and commercial inventories and 60 days of additional strategic reserves. Actual national contributions could vary according to import dependence, domestic production, refining capacity, existing inventories, fiscal capacity, infrastructure readiness, and exposure to supply disruptions. The 90-day figure should therefore guide regional planning and scenario comparison, while implementation remains voluntary and adaptable to national circumstances.

The model assumes that about 30 days of eligible refinery and commercial inventories may contribute to the effective reserve base. Using ASEAN oil demand of about 5.0 mb/d, the additional 60-day reserve requirement corresponds to about 300 million barrels (MMbbl) of strategic reserves. Combined with an illustrative 150 MMbbl, equivalent to 30 days of eligible existing inventories, the effective 90-day benchmark corresponds to about 450 MMbbl of oil coverage. The cost analysis

therefore focuses on the additional 60-day requirement. Recognising eligible industry stocks as part of the effective reserve base avoids overstating new investment needs, but the 30-day layer remains a regional planning assumption rather than a determination that every barrel held by industry qualifies as an emergency reserve.

In practice, existing refinery and commercial inventories should count towards the assumed 30-day stock level only if they meet the eligibility criteria in Table 2.1. The stocks must be legally accessible, physically available, not counted elsewhere, compatible with emergency needs, and deliverable within the required timeframe. For the purpose of this regional analysis, the study assumes that AMS have 30 days of eligible existing stocks. In actual implementation, normal operating minimums, pipeline fill, tank bottoms, stocks already committed to customers, stocks in transit without guaranteed diversion rights, and stocks that cannot be released or delivered promptly should be excluded.

Table 2.1. Eligibility Conditions for Existing Refinery and Commercial Stocks

Eligibility test	Minimum condition for counting towards effective coverage
Legal accessibility	A law, regulation, licence condition, contract, or emergency order provides an enforceable right to release or redirect the stock.
Actual availability	The stock exists physically and is additional to minimum operating requirements, tank bottoms, pipeline fill, and unavoidable working inventory.
No double counting	The same barrel is not counted simultaneously as national, commercial, ticketed, jointly held, in transit, or committed to another user.
Quality compatibility	Crude grade or product specification is compatible with the intended refinery, terminal, transport system, and emergency demand.
Emergency deliverability	The stock can be authorised, loaded, transported, cleared, and delivered within the required emergency timeframe and at an adequate throughput.
Verification and reporting	Quantity, quality, location, ownership, encumbrances, and access rights can be confidentially verified and periodically updated.
Replenishment and continuity	The arrangement identifies how withdrawn stock will be replenished and how normal supply obligations will be managed.

Source: ERIA, based on comments from the ASEAN Council on Petroleum, the ASEAN Centre for Energy, the ASEAN Secretariat, and ASEAN Member States in 2026.

The 30-day assumption provides a transparent ASEAN-wide starting point informed by the stockholding ranges reviewed in Chapter 1 and previous ERIA assessments; it is not a finding that every Member State currently holds 30 days of legally accessible reserves. During implementation, the eligible contribution would be country- and facility-specific and could be higher or lower after verification. The 30-day layer is an accounting assumption for effective coverage, not a requirement that a disruption must last 30 days before strategic stocks can be used, nor a mandatory rule that commercial stocks must always be released before national, ticketed, or jointly held stocks. The release sequence would depend on the national authority, contractual rights, stock location, product requirements, and the applicable emergency arrangements.

For policy comparison, the study defines current arrangements as the status quo comparator. This comparator comprises verified national government stocks, mandatory or voluntarily held industry stocks, commercially available inventories that meet the eligibility conditions specified in Table 2.1, existing storage and terminal assets, domestic production and refining capability,

national emergency-response measures, and applicable ASEAN mechanisms, including the ASEAN Petroleum Security Agreement (APSA) and Coordinated Emergency Response Measures (CERM). The term 'business as usual', when used in energy demand projections, is not intended as a substitute for this policy baseline.

The model is consequently incremental in scope: the eligible existing-stock layer of about 30 days and associated operational capacity are treated as part of current arrangements, whereas the quantified costs relate primarily to the additional 60-day strategic reserve portfolio. The estimated avoided loss should likewise be interpreted as the additional protection attributable to effective reserve access beyond the verified baseline response. Since comparable AMS data on existing stocks, assets, release powers, and response performance are not yet complete, this chapter does not assign a single monetary value to current protection. Country-level feasibility analyses should first verify the baseline and then calculate incremental costs and benefits net of existing capacity, planned investments, and measures that have already been funded.

The additional 60-day requirement is allocated differently across three scenarios (Figure 2.2).

Scenario 1: National-led approach (high national stock case) allocates 45 days to additional national stockpiling, 5 days to ticket stockpiling, and 10 days to joint stockpiling. This scenario provides the highest degree of national control but also generates the highest cost.

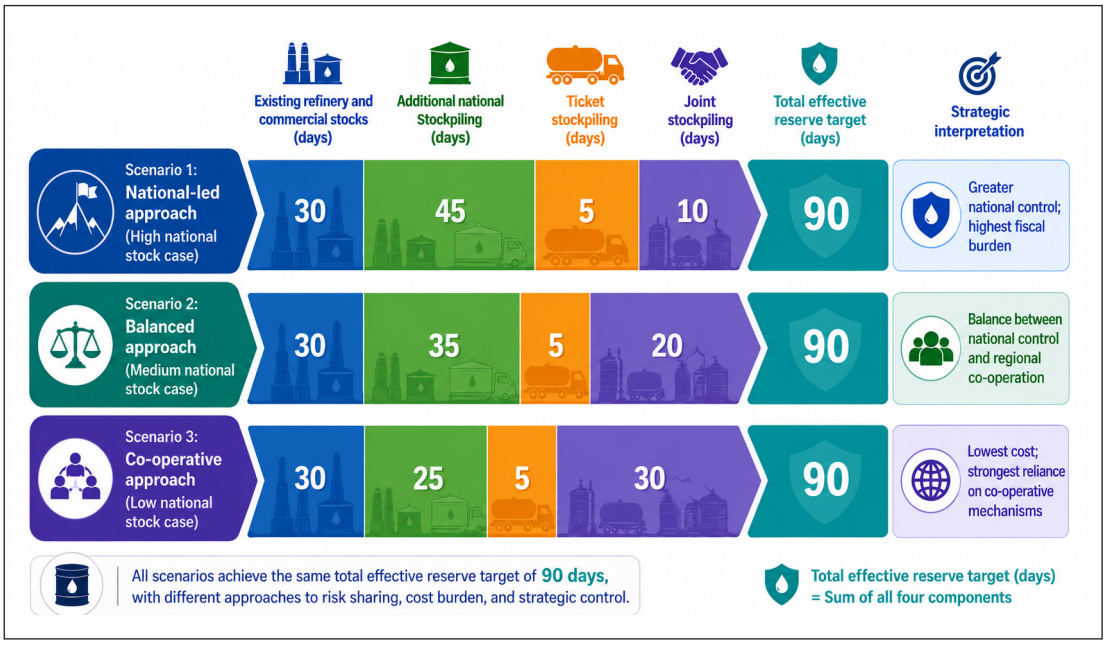
Scenario 2: Balanced approach (medium national stock case) allocates 35 days to additional national stockpiling, 5 days to ticket stockpiling, and 20 days to joint stockpiling. This scenario balances national responsibility with regional co-operation.

Scenario 3: Co-operative approach (low national stock case) allocates 25 days to additional national stockpiling, 5 days to ticket stockpiling, and 30 days to joint stockpiling. This scenario relies most strongly on regional co-operation and produces the lowest cost.

The allocations are stylised analytical portfolios rather than recommended national quotas. Ticket stockpiling is held constant at 5 days as a limited supplementary or transitional layer. The model then reallocates 10-day increments from national to joint stockpiling between scenarios to isolate the effect of reserve composition on cost while keeping the additional reserve volume fixed at 60 days. Actual national, ticket, and joint contributions would be determined through country- and project-specific assessment, voluntary negotiation, and verification of effective emergency value. This scenario structure allows the analysis to compare the benefits and disadvantages of different reserve portfolios while holding the effective 90-day target constant. Therefore, differences in results are driven mainly by the composition of the reserve portfolio rather than by differences in total reserve ambition.

The ASEAN aggregate covers all 11 Member States, including Timor-Leste following its admission to ASEAN (ASEAN, 2025). Timor-Leste is incorporated using the same reserve-day structure and methodological assumptions, ensuring a consistent regional calculation.

Figure 2.2. Reserve Composition of Scenario-Based Comparative Analysis
(days)



Source: ERIA.

4. 'Cost' of Oil Stockpiling in the Scenario-based Comparative Approach

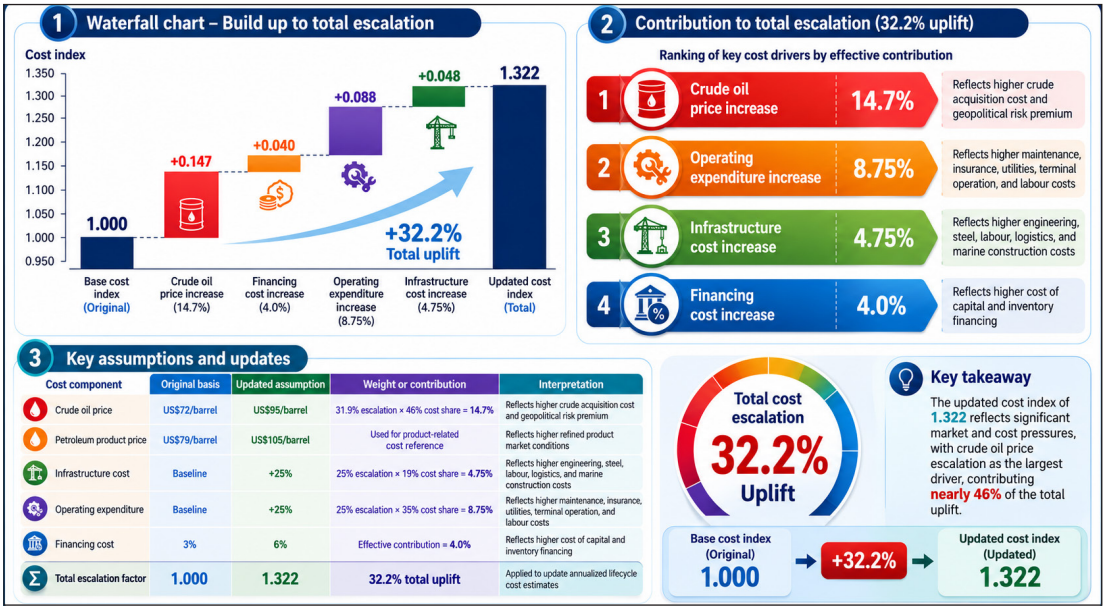
Within the framework established in the previous section, the scenario-based comparative analysis will be conducted based on the cost–benefit concept. This section will first address the cost component, followed by an examination of the benefits.

The concept of cost in this analysis refers to the annualised life-cycle cost associated with maintaining strategic oil reserves. Unless specified otherwise, monetary values are expressed in 2026 US dollars and annualised over an assumed 30-year project life. The unit cost is expressed in US dollars per barrel per year (US$/bbl/year). It thus represents the annualised cost of holding 1 barrel of reserve capacity throughout the project duration, rather than the one-time purchase price of crude oil or the complete upfront project budget.

The life-cycle cost approach follows the general analytical structure developed in previous ASEAN and East Asian stockpiling studies conducted by the Economic Research Institute for ASEAN and East Asia (ERIA), while applying current assumptions for oil prices, infrastructure costs, operating expenditure (OPEX), and financing costs (ERIA, 2016b, 2017, 2022). It covers five principal components: (i) crude oil or petroleum-product acquisition; (ii) storage tanks and related infrastructure; (iii) terminals, jetties, pipelines, and supporting facilities; (iv) operation, maintenance, insurance, utilities, and stock management; and (v) financing, replacement, and stock rotation costs.

To reflect post-2022 market conditions, the analysis adjusts the ERIA cost structure for higher oil prices, construction costs, OPEX, and financing costs (Figures 2.3 and 2.4). The crude oil benchmark increases from US$72 per barrel to US$95 per barrel. Crude oil is used as the common price benchmark for reserve-acquisition costs because the analysis compares alternative stockpiling configurations at the ASEAN-wide level rather than determining the precise crude oil and petroleum-product mix for each Member State. A common benchmark ensures consistency across the national, ticket, and joint stockpiling scenarios and avoids introducing differences caused by country-specific refinery structures and product requirements.

Figure 2.3. Updated Life-Cycle Cost Assumptions for Oil Stockpiling
(US$/barrel, %, and escalation contribution)



Note: Cost escalation assumptions affect reserve costs only. Benefit estimates are calculated separately using the avoided gross domestic product (GDP) loss methodology.

Source: ERIA.

The assumed crude oil price of US$95 per barrel is deliberately conservative. It is sufficiently high to reflect a stressed oil-market environment and captures a substantial part of the underlying acquisition-cost exposure associated with both crude oil and petroleum products. Although finished petroleum products may attract an additional premium related to refining and distribution, the utilisation of a benchmark of US$95 per barrel, together with the study's higher assumptions for infrastructure, operation and maintenance (O&M), and financing, provides a prudent estimate for strategic screening purposes. Introducing a separate finished-product price would require additional assumptions regarding the composition of gasoline, diesel, jet fuel, and other products, each of which has different specifications, refining margins, storage requirements, and regional price differentials.

The crude oil assumption should therefore not be interpreted as implying that all ASEAN reserves would be held exclusively in crude oil or that crude and finished products have identical prices. In practice, the appropriate reserve composition will depend on refinery compatibility, domestic

product demand, storage infrastructure, and emergency distribution capacity. A subsequent feasibility study should examine alternative crude-product mixes and undertake product-specific price sensitivity analysis. For the present ASEAN-wide comparison, however, the US$95-per-barrel crude benchmark offers a transparent, conservative, and consistently applicable basis for comparing the relative costs of the three stockpiling scenarios.

Figure 2.4: Annualised Unit Cost Escalation by Stockpiling Mechanism
(US$/barrel/year)

Cost components (US$/bbl/year)	National stockpiling	Ticket stockpiling	Joint stockpiling
Original ERIA unit cost (ERIA, 2022)	8.0	5.9	3.8
Oil acquisition escalation	14.7%	14.7%	0.0%
Infrastructure escalation	4.75%	0.0%	4.75%
O&M escalation	8.75%	8.75%	8.75%
Financing escalation	4.0%	4.0%	4.0%
Total escalation factor	32.2%	27.45%	17.5%
Revised unit cost (US$/bbl/year)	10.6 US$/bbl/year	7.5 US$/bbl/year	4.5 US$/bbl/year

bbl = barrel, ERIA = Economic Research Institute for ASEAN and East Asia, O&M = operation and maintenance.

Source: ERIA.

It should be noted that 'inventory-price exposure' refers to the direct escalation of oil acquisition costs for national stocks, which includes a price and carrying-cost component embedded in the ticket fee for ticket stockpiling, and is considered zero in the central joint-stockpiling case because the inventory is assumed to remain under producer or partner ownership. If the participating Member States jointly purchase or own the inventory, an additional acquisition-cost component would need to be included.

Construction costs and OPEX are each increased by 25%. The escalation assumption for infrastructure CAPEX and OPEX/O&M is supported by recent international evidence showing sustained post-2020 cost inflation in construction and energy infrastructure markets. Global construction cost inflation increased substantially in 2022 and continued during 2023–2025, while energy infrastructure projects faced persistent pressure related to material costs, skilled labour shortages, supply chain constraints, procurement delays, insurance costs, and higher financing costs (Turner & Townsend, 2023, 2025; IEA, 2024b, 2025c, 2025e; OECD, 2024). The 25% adjustment is therefore applied as a conservative proxy for broad post-2020 CAPEX and OPEX/O&M escalation rather than as a project-specific engineering estimate. Financing costs increase from 3% to 6%. These common assumptions are applied uniformly across the ASEAN-wide screening model

solely to preserve comparability; they are not country-specific estimates and should be replaced by national and project quotations during feasibility studies. Detailed calculations are provided in Annexes 2.2 and 2.3.

The mechanism-specific unit costs applied in this study are central results developed for ASEAN-wide strategic screening (Table 2.2). They provide a consistent basis for comparing the relative cost implications of national stockpiling, ticket stockpiling, and joint stockpiling under the three reserve scenarios. The estimates are expressed in US$/bbl/year and represent the annualised life-cycle cost of maintaining 1 barrel of reserve capacity over the assumed project period.

The central results are derived from the unit-cost assumptions used in previous ERIA oil stockpiling studies, updated to reflect changes in market and financing conditions. The updating methodology incorporates higher crude oil prices, increased infrastructure costs, higher O&M expenditure, and tighter financing conditions. Applying these adjustments produces estimated annualised costs of US$10.6/bbl/year for national stockpiling, US$7.5/bbl/year for ticket stockpiling, and US$4.5/bbl/year for joint stockpiling. The detailed assumptions, escalation factors, and calculations are presented in Annex 2.2.

These results should be interpreted as analytical reference values rather than fixed market prices, commercial quotations, or investment-grade project costs. Actual costs may differ significantly depending on the design and location of each arrangement. Relevant factors include the ownership of the oil inventory, the balance between crude oil and petroleum products, the use of existing or newly constructed storage facilities, capacity utilisation, contract duration, financing terms, insurance requirements, stock rotation arrangements, verification procedures, and the allocation of operational and administrative responsibilities. The central screening case does not credit uncommitted future storage or terminal projects; committed or under-construction capacity may be incorporated only after its timing, technical suitability, commercial availability, and emergency deliverability are verified.

Generalised numerical cost ranges are not provided in this study as sufficiently robust lower and upper bounds require project-specific data and a systematic sensitivity analysis of the underlying cost components. During the feasibility and pilot design stages, low, central, and high cost scenarios should be developed using engineering assessments, commercial quotations, contractual terms, and market information obtained from storage operators, oil suppliers, terminal owners, logistics companies, insurers, financiers, and other prospective participants.

The annualised unit costs primarily represent the cost of maintaining reserve readiness. Certain expenses may arise only when stocks are released during an emergency and are therefore treated separately from recurring stockholding costs. These may include emergency loading and handling, marine or inland transportation, customs and import charges, commodity settlement at the time of drawdown, temporary storage or distribution expenses, and post-release replenishment. The magnitude and allocation of these costs will depend on the nature of the disruption, the ownership structure, the delivery route, the destination market, and the contractual responsibilities of the stock owner, host country, participating user, producer partner, and facility operator.

Table 2.2. Cost Scope and Assumptions by Stockpiling Mechanism

Mechanism	Central estimate (US$/bbl/year)	Recurring annualised cost elements included	Additional or event-specific costs
National stockpiling	10.6	Inventory ownership and carrying cost; storage and terminal infrastructure; financing; O&M; stock rotation; security; insurance; verification; and administration	Emergency loading and handling; marine or inland freight; customs and import charges; extraordinary distribution costs; and post-release replenishment
Ticket stockpiling	7.5	Reservation or access fee; stock verification; allocated storage and O&M costs; and insurance or financing exposure, where included in the ticket fee	Commodity purchase or settlement at drawdown; freight; customs; emergency handling; delivery to the user market; and replenishment
Joint stockpiling	4.5	Shared storage and infrastructure; O&M; stock rotation; monitoring; insurance; financing of the participant's allocated share; and governance and access administration	Inventory acquisition where the stock is not producer-owned; emergency dispatch; freight; customs; user-specific delivery; and replenishment

ERIA = Economic Research Institute for ASEAN and East Asia, O&M = operation and maintenance.

Note: The central estimates are strategic screening assumptions derived from updated ERIA unit-cost benchmarks. Actual costs should be determined through project-specific feasibility studies, engineering assessments, commercial quotations, and contractual negotiations.

Source: ERIA, based on comments from the ASEAN Council on Petroleum, the ASEAN Centre for Energy, the ASEAN Secretariat, and ASEAN Member States in 2026.

4.1. Average stockholding cost under the stockpiling scenarios

To compare the annualised cost of the stockpiling strategies, this study applies a weighted life-cycle cost approach to estimate the average stockholding cost associated with each scenario. The methodology recognises that different stockholding mechanisms – national stockpiling, ticket stockpiling, and joint stockpiling – have distinct cost structures arising from differences in oil ownership arrangements, infrastructure requirements, financing obligations, and operational expenditures. By combining these mechanisms in varying proportions, each scenario generates a different overall cost profile.

The average stockholding cost is calculated as follows:

$$\text{Average cost} = \frac{(N \times C_N) + (T \times C_T) + (J \times C_J)}{60}$$

where:

N= additional national stockholding days;
T= ticket stockholding days;
J= joint stockholding days;
C_N= life-cycle cost of national stockpiling;
C_T= life-cycle cost of ticket stockpiling; and
C_J= life-cycle cost of joint stockpiling.

In this formula, life-cycle cost refers to the annualised cost of maintaining 1 barrel of reserve capacity for 1 year. It includes oil acquisition where applicable, storage infrastructure, O&M, insurance, security, stock rotation, and financing. The mechanism-specific inputs are US$10.6/bbl/year for national stockpiling, US$7.5/bbl/year for ticket stockpiling, and US$4.5/bbl/year for joint stockpiling. Annex 2.2 provides the detailed derivation.

4.2. Annualised cost derivation from reserve-day allocations

At the assumed ASEAN oil demand of 5.0 mb/d, one additional reserve day represents 5 MMbbl. Applying the rounded annualised unit costs therefore gives a cost per reserve day of US$53.0 million for national stockpiling (5 million × US$10.6), US$37.5 million for ticket stockpiling (5 million × US$7.5), and US$22.5 million for joint stockpiling (5 million × US$4.5). Table 2.3 applies these conversion factors to the reserve-day allocation in each scenario.

Dividing each scenario's total annualised cost by the common additional reserve volume of 300 MMbbl produces average annualised costs of US$9.33, US$8.31, and US$7.29 per barrel per year under scenarios 1, 2, and 3, respectively. These are the unit-cost values used in the ASEAN-wide cost–benefit analysis in Section 2.6.

Table 2.3. Annualised Cost Derivation by Stockpiling Scenario

Scenario	Reserve mix N / T / J (days)	Mechanism costs N + T + J (US$ billion/year)	Total cost (US$ billion/year)	Average cost (US$/bbl/year)
Scenario 1: National-led	45 / 5 / 10	2.385 + 0.188 + 0.225	2.798 (≈2.80)	9.33
Scenario 2: Balanced	35 / 5 / 20	1.855 + 0.188 + 0.450	2.493 (≈2.49)	8.31
Scenario 3: Co-operative	25 / 5 / 30	1.325 + 0.188 + 0.675	2.188 (≈2.19)	7.29

bbl = barrel of oil.

Notes: N/T/J = national/ticket/joint stockpiling. Totals use rounded unit costs; unrounded inputs change results by less than 0.4%. These are strategic screening estimates, not final project budgets.

Annualised life-cycle costs do not by themselves show the initial inventory-financing exposure. At the US$95 per barrel benchmark, the gross reference value of the full 300-million-barrel additional reserve volume is US$28.5 billion. Under the central ownership assumptions, participating governments finance the nationally owned component, while ticketed stock is reserved contractually and joint stock is assumed to remain producer- or partner-owned. Table 2.3A presents the indicative national inventory-acquisition exposure before storage and terminal capital expenditure.

Source: ERIA.

Table 2.3A. Indicative Upfront Inventory-Acquisition Exposure by Scenario

Scenario	National stock (days / million bbl)	Ticket and joint stock (days / million bbl)	Indicative national inventory value at US$95/bbl
Scenario 1: National-led	45 days / 225	15 days / 75	US$21.4 billion
Scenario 2: Balanced	35 days / 175	25 days / 125	US$16.6 billion
Scenario 3: Co-operative	25 days / 125	35 days / 175	US$11.9 billion

bbl = barrel of oil.

Note: The table shows indicative oil-inventory acquisition exposure only. It excludes land, tanks, terminals, jetties, pipelines, project development, financing fees, and event-specific release and replenishment costs. Complete upfront investment must be determined through site-specific engineering, ownership design, and commercial quotations. If participating Member States jointly purchase the joint stock, the associated inventory value would be added to their upfront exposure.

Because ticket stockpiling remains fixed at 5 days, the cost difference across scenarios is driven by reallocating reserves from national to joint stockpiling. Each 10-day reallocation represents 50 million barrels: it reduces national stockpiling cost by about US$530 million per year, increases joint stockpiling cost by US$225 million per year, and produces a net annual saving of about US$305 million. Scenario 3 therefore saves about US$610 million per year, or 21.8%, relative to scenario 1 while maintaining the same additional 60-day reserve volume.

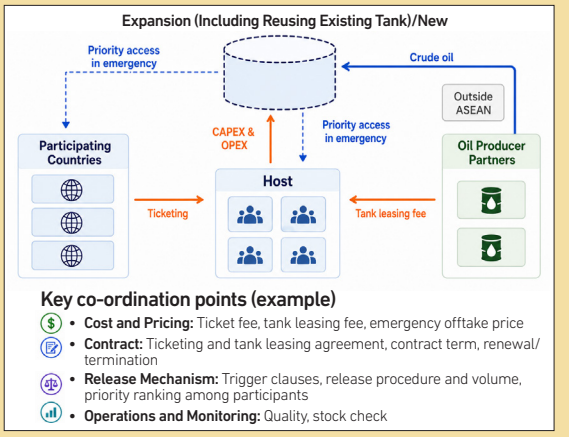
Source: ERIA.

The denominator of 60 in the day-weighted formula represents the additional 60 days of reserve coverage, equivalent to 300 MMbbl at 5.0 mb/d. The day-weighted calculation is therefore dimensionally equivalent to dividing the total annualised cost by 300 MMbbl. Dividing a cost stated in US$ billion directly by 60 reserve days would not, by itself, produce a US$/barrel/year measure. The cost differences reflect the ownership and infrastructure arrangements described in Section 2.2: national stockpiling bears the full acquisition and infrastructure burden; ticket stockpiling purchases contractual access; and joint stockpiling shares infrastructure and, in some models, inventory ownership. Joint stockpiling therefore carries the lowest unit cost in this screening analysis.

To illustrate how these mechanism-specific cost differences may translate into implementation, Boxes 2.1 and 2.2 present two indicative pilot schemes. The first combines joint stockpiling with ticketing or contractual access, while the second illustrates a deeper joint-ownership model. These boxes are implementation illustrations only; they are not inputs used to derive the US$7.5 or US$4.5 unit costs or the ASEAN-wide scenario results. They do not predetermine participants, host locations, reserve volumes, ownership structures, or contractual terms.

Box 2.1. Illustrative Pilot Project Scheme A – Joint Stockpiling with Ticketing Arrangement

Box 2.1. Expansion (Including Reusing Existing Tank)/New



ASEAN = Association of Southeast Asian Nations, CAPEX = capital expenditure, OPEX = operational expenditure.

Source: ERIA.

Under this scheme, a host country provides or expands storage capacity, including the possible reuse of existing tanks. An oil-producing partner supplies or owns the crude oil, while participating ASEAN Member States secure priority access to the stored oil during emergencies through ticketing or contractual access arrangements.

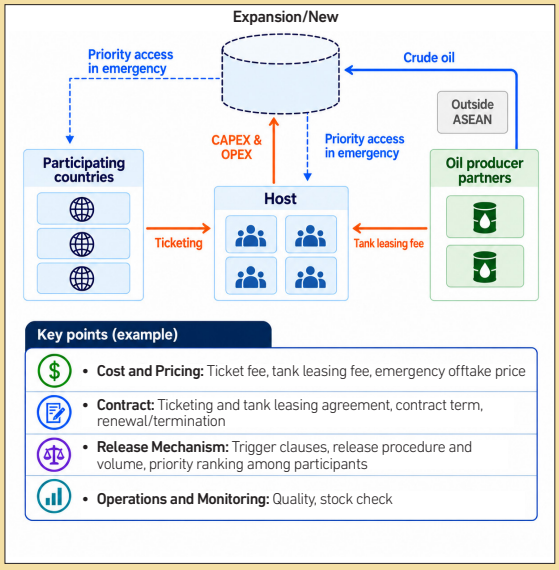
The participating countries may pay a ticketing fee or access fee, while the oil-producing partner may pay a tank leasing fee to the host country.

The host country may receive compensation for storage services, operations, maintenance, and related facility costs.

This model can reduce the financial burden on participating countries because they do not need to fully own the oil inventory or construct dedicated storage infrastructure. It may be suitable as an early pilot because it combines contractual emergency access with practical use of existing or expanded storage facilities.

Box 2.2. Illustrative Pilot Project Scheme B – Joint Stockpiling through Joint Ownership

Box 2.2. Expansion/New



ASEAN = Association of Southeast Asian Nations, CAPEX = capital expenditure, JV = joint venture, OPEX = operational expenditure.

Source: ERIA.

Under this scheme, participating countries and the host country jointly share part of the cost, access rights, and possibly ownership of reserve capacity.

The host country provides storage infrastructure, while participating countries contribute to CAPEX, OPEX, or capacity reservation costs according to an agreed ownership or access-sharing formula. An oil-producing partner may supply crude oil and lease storage capacity from the host country. Emergency release rights, cost settlement, and replenishment obligations would be governed by a joint agreement amongst the participating parties.

This model provides a deeper form of co-operation than ticketing because participating countries share not only emergency access rights but also part of the cost and governance responsibilities.

It may offer stronger long-term resilience but requires clearer rules on ownership, decision-making, emergency release procedures, pricing, liability, taxation, insurance, and dispute settlement.

5. 'Benefit' of Oil Stockpiling in the Scenario-based Comparative Analysis

In this analysis, the economic value of oil stockpiling is demonstrated through the avoided macroeconomic losses. This approach treats emergency reserves as a form of strategic insurance: their value derives from preserving economic activity when a severe supply disruption occurs rather than from generating an ordinary commercial return. In the primary analysis, the benefit is expressed on an annualised basis because the macroeconomic impact is derived from an annual gross domestic product (GDP) growth downgrade. A large-scale disruption can lower the GDP growth path for the affected year and leave the level of GDP below the pre-disruption baseline in subsequent years, even after growth conditions begin to normalise.

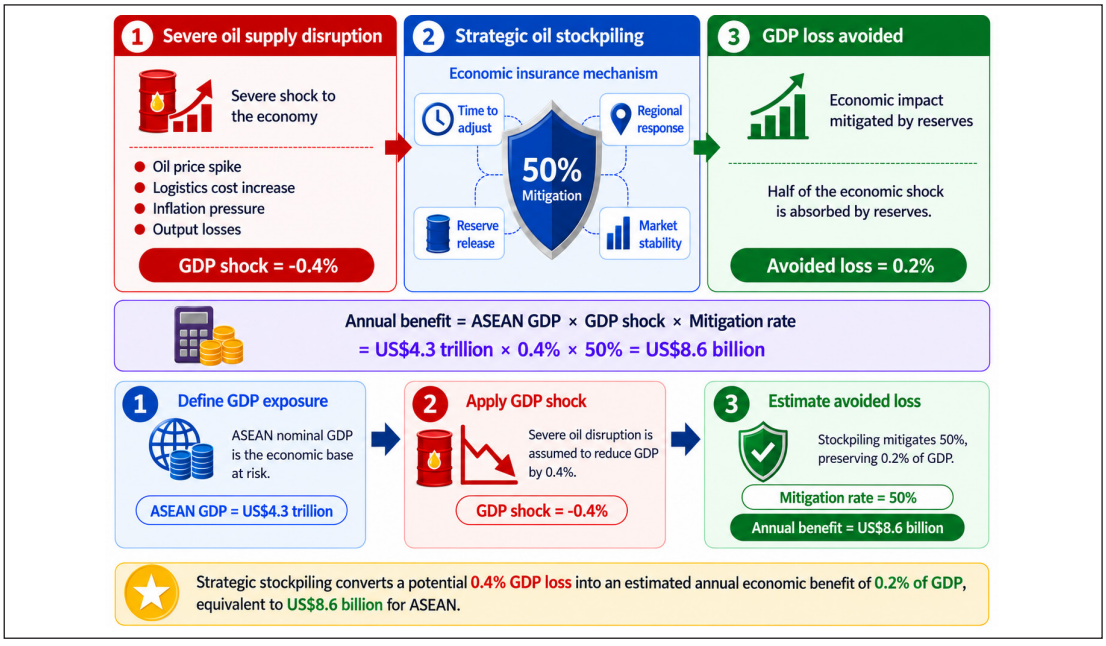
Recent developments in global energy markets illustrate the economic importance of energy security. For the purpose of this study, ASEAN nominal GDP is assumed at about US$4.3 trillion based on recent Asian Development Bank (ADB, 2025) and International Monetary Fund (IMF, 2025d) estimates. In its 2026 *Asian Development Outlook,* ADB projected that developing Asia and the Pacific would grow by 5.1% in 2026 under a scenario assuming early stabilisation of geopolitical tensions in the Middle East (ADB, 2026). However, as the conflict intensified and concerns over energy-market disruptions increased, the regional growth outlook was subsequently revised downward to 4.7%, reflecting heightened risks associated with higher oil prices, increased shipping and insurance costs, disrupted trade routes, and tighter financial conditions (Reuters, 2026). This downward revision demonstrates the vulnerability of regional economic growth to energy-related shocks and provides an important reference point for assessing the economic value of energy security measures.

Against this backdrop, this study assumes that a complete or near-complete blockage of the Strait of Hormuz, or a disruption of comparable scale, could reduce ASEAN's annual economic growth by about 0.4 percentage points. The assumption uses the ADB growth downgrade as a macroeconomic reference for a severe Middle East energy shock. It captures the combined effects of higher oil prices, emergency fuel procurement, shipping and insurance escalation, delayed cargoes, industrial production losses, inflationary pressures, and weaker business and consumer confidence. It is a reference stress assumption for strategic screening, not a claim that ADB modelled the exact stockpiling scenario used in this chapter.

The analysis further assumes that an effective oil stockpiling co-operation approach can mitigate about 50% of the economic losses associated with such a disruption. This reflects the ability of strategic reserves to provide immediate physical supply, reduce the severity and duration of shortages, and give governments time to secure alternative imports, implement contingency measures, stabilise fuel markets, and co-ordinate regional responses.

Based on ASEAN nominal GDP of about US$4.3 trillion, an annual GDP impact of 0.4% under the reference disruption scenario would imply an estimated economic loss of about US$17.2 billion in the affected year. Assuming that effective strategic reserves mitigate 50% of that loss, the estimated annual avoided economic loss is about US$8.6 billion (Figure 2.5), equivalent to 0.2% of ASEAN GDP. It should be understood as the annualised macroeconomic value preserved, conditional on the occurrence of the reference disruption, rather than as a claim that a Hormuz closure occurs annually or as a probability-weighted expected annual benefit.

Figure 2.5. Estimated Macroeconomic Benefits of Strategic Oil Stockpiling in ASEAN



ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product.

Source: ERIA.

Interpretation note: The figure presents the study's macroeconomic insurance logic and the US$8.6 billion result. 'Annual benefit' refers to the estimated annualised economic loss avoided in an affected year under the severe reference disruption scenario, based on an annual GDP-growth downgrade and a 50% mitigation assumption. It does not mean that the disruption occurs every year or that the result is probability weighted.

The annualised avoided-loss estimate represents the combined value of avoiding fuel shortages and emergency procurement, limiting shipping and insurance cost escalation, reducing transportation and logistics disruption, protecting industrial output, moderating inflationary pressure, and preserving investor confidence. The economic effect of a growth downgrade can extend beyond the immediate disruption because a lower growth rate reduces the GDP level relative to the original baseline; even if subsequent growth rates return to the same path, the level gap may remain. The realised value would nevertheless depend on the scale and duration of the disruption, the timing of release, legal accessibility, quality compatibility, logistics throughput, the share of stock physically delivered, and the effectiveness of national and regional responses.

The assumed 50% mitigation rate is a neutral central screening assumption rather than an empirically estimated ASEAN coefficient. It provides a transparent midpoint for comparing reserve portfolios and is tested against 25% and 75% cases in Section 2.8.2. It does not imply that reserves will always offset half of every disruption. The effective mitigation rate could be lower when authorisation, loading, customs, refining, or distribution is delayed, or higher when stocks are well located, quality-compatible, rapidly released, and supported by co-ordinated demand and logistics measures. An ASEAN-specific factor should be developed later from simulation exercises, operational tests, disruption-duration analyses, and observed delivery performance.

The estimated annual economic loss avoided is compared with the annualised cost of maintaining each reserve portfolio. This allows the three reserve scenarios to be assessed on the same annual basis. The results apply only to the reference disruption scenario and should therefore be interpreted as a scenario-based benefit–cost analysis, not as a probability-based estimate of expected annual returns. A separate probability-weighted analysis could be conducted later to estimate the average annual value before a disruption occurs.

The reference case represents a severe disruption affecting the annual ASEAN growth path; it does not prescribe a single closure duration, annual frequency, or oil-price trajectory. Its transmission channels include reduced crude and product availability; higher spot-purchase, freight, and insurance costs; temporary rationing; disruptions in transport and logistics; production losses in oil-dependent sectors; inflationary pressures; and effects on confidence. These channels are represented through the assumed GDP impact rather than added as separate benefit categories, thereby avoiding double counting. The estimate is an avoided-output measure; it is not a separate calculation of consumer surplus, fiscal savings, or distributional welfare.

The 50% mitigation assumption reflects the combined contribution of timely reserve release and complementary responses, including the use of eligible commercial inventories, demand restraint, fuel switching where technically feasible, domestic production or refinery adjustments, cargo rerouting, product substitution, and ordinary market adjustment. Stockpiling alone should not be credited with the full mitigation effect unless operational testing demonstrates that result. A subsequent probability-weighted model should specify the duration and frequency of the disruption, price paths, sector exposure, non-stock response assumptions, and the share of mitigation causally attributable to each measure.

6. ASEAN Region-wide Cost and Benefit of Scenario-based Comparative Analysis

Figure 2.6 presents the ASEAN region-wide cost and benefit of scenario-based comparative analysis. Under the reference disruption scenario, the annual economic benefit of US$8.60 billion exceeds the annualised life-cycle cost under each reserve portfolio. Because all scenarios use the same effective 90-day planning benchmark, the estimated annual benefit is held constant so that differences in net benefit and the benefit–cost ratio reflect differences in the reserve composition and recurring stockholding cost. These are conditional scenario results, not a forecast that the reference disruption will recur annually.

Under scenario 1: national-led approach (high national stock case), ASEAN would incur an annualised life-cycle cost of about US$2.80 billion per year. Against the estimated annual avoided economic loss of US$8.60 billion under the reference disruption scenario, this produces a net annual benefit of US$5.80 billion and a scenario-based benefit–cost ratio of 3.07. This is the highest-cost scenario because it relies most heavily on nationally owned and financed stocks.

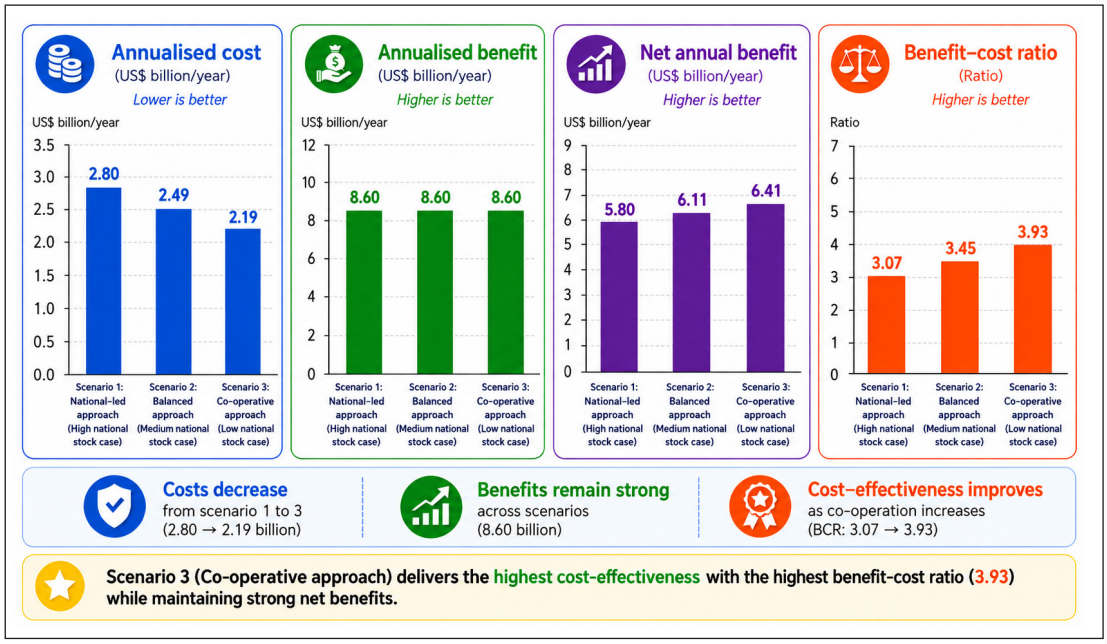
Under scenario 2: balanced approach (medium national stock case), the annualised cost declines to about US$2.49 billion per year. The same annual avoided economic loss produces a net annual benefit of US$6.11 billion and a scenario-based benefit–cost ratio of 3.45. This scenario maintains a substantial national reserve component while increasing the role of lower-cost co-operative arrangements.

Under scenario 3: co-operative approach (low national stock case), the annualised cost declines further to about US$2.19 billion per year. The same estimated annual avoided economic loss produces a net annual benefit of US$6.41 billion and a scenario-based benefit–cost ratio of 3.93. The result indicates that, where accessibility, deliverability, and quality compatibility are credible, a larger joint-stockpiling share can reduce the recurring cost of achieving the same reserve benchmark.

The cost shift reflects the composition of reserves. As shown in Section 2.4.1, each 10-day reallocation from national to joint stockpiling saves about US$305 million annually. Scenario 3 therefore costs about US$610 million, or 21.8%, less per year than scenario 1 while maintaining the same effective 90-day benchmark.

Three policy insights follow. First, under the severe reference disruption assumptions, annual avoided economic losses exceed annualised reserve costs in all three scenarios. Second, national stockpiling preserves direct control but carries the largest fiscal burden, while ticketing can provide a transitional access mechanism. Third, joint stockpiling offers the largest central cost reduction, provided that legal access, stock verification, quality compatibility, emergency release, customs, logistics, replenishment, confidentiality, and dispute settlement are credible and enforceable. Probability analysis is useful as a complementary sensitivity but does not replace the conditional annual macroeconomic comparison used in the central case.

Figure 2.6. ASEAN-Wide Cost-Benefit Screening Results

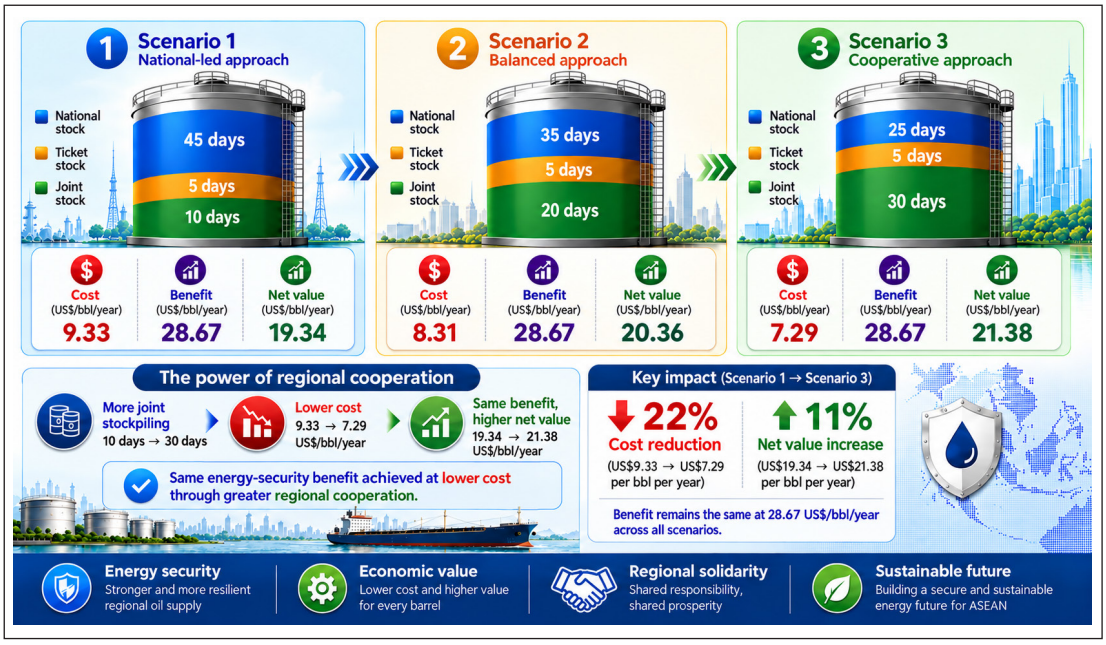


BCR = Benefit–cost ratio

Source: ERIA.

Interpretation note: 'Annualised benefit', 'net annual benefit', and 'benefit–cost ratio' are conditional scenario measures under the severe reference disruption assumptions. They compare the annualised macroeconomic value preserved with the annualised life-cycle cost of each reserve portfolio. Probability-weighted expected value is a complementary metric, not the controlling interpretation of this graph.

Figure 2.7. Cost-Effectiveness of ASEAN Oil Stockpiling Scenarios
(US$/barrel/year)



ASEAN = Association of Southeast Asian Nations, bbl = barrel of oil.

Source: ERIA.

Interpretation note: The figure communicates the scenario comparison clearly and uses a consistent annual US$/bbl basis for both costs and benefits. The US$28.67 benefit represents the annualised avoided economic loss per barrel under the reference disruption scenario. Actual performance still depends on legal access, release delay, quality compatibility, throughput, and the proportion of stock physically delivered.

On a per-barrel basis, annualised stockholding cost declines from US$9.33 in scenario 1 to US$8.31 in scenario 2 and US$7.29 in scenario 3, while the estimated annual benefit remains US$28.67 per barrel in every case. Net economic value consequently rises from US$19.34 to US$20.36 and US$21.38/bbl/year, respectively. These calculations clearly show how the reserve composition changes the cost and net value under the same reference disruption assumptions.

Relative to scenario 1, scenario 3 reduces the annualised stockholding cost by 21.9% (about 22%) and increases the net economic value by 10.55% (about 11%). Because reserve volume and the assumed benefit are held constant, the gain arises entirely from the lower-cost reserve composition.

These results support further testing of voluntary ASEAN joint stockpiling arrangements, including pilots that preserve national flexibility while verifying cost sharing, reserve access, governance, and end-to-end operational performance. They do not establish that a lower-cost co-operative portfolio provides energy security equivalent to nationally controlled stocks.

6.1. Extended analysis for effective emergency value of national, ticketed, jointly held, and existing stocks

The above scenario model assigns an identical emergency protection to each barrel, as its purpose is to isolate the cost effect attributable to reserve composition. This is a reasonable first-stage simplification: applying different effectiveness assumptions at the same time as different costs would make it difficult to identify whether results were driven by price or by operational performance. For implementation, however, nominal barrels should be converted into effective emergency value (Table 2.4).

A practical formulation is: effective emergency volume = nominal eligible volume × legal-access factor × physical-availability factor × quality-compatibility factor × timely-delivery factor. Each factor ranges from zero to one. A barrel has full emergency value only when it is legally callable, physically available, compatible with the receiving system, and deliverable within the required time.

Table 2.4. Differentiating the Effective Emergency Value of Stocks

Stock category	Accessibility	Deliverability	Quality compatibility	Reason for differentiated value
National strategic stock	Generally high when the competent authority has clear release power and the stock is unencumbered.	Depends on terminal, refinery, pipeline, port, road, and distribution readiness.	High only when crude grade or product specification matches emergency needs.	Direct control is a strength, but domestic infrastructure failure or geographic concentration can reduce value.
Ticketed stock	Depends on enforceable reservation, trigger, priority, non-cancellation, and cross-border rights.	Depends on seller performance, location, competing claims, shipping, customs, and destination capacity.	Contract should specify grade, product, substitution, and quality tolerances.	Lower capital burden, but effective value can be reduced by counterparty and delivery risk.
Jointly held or producer-owned stock	Depends on ownership, host-user rights, allocation, authorisation, pricing, and emergency priority.	Can be high when stock is located near users and supported by prearranged dispatch; can be lower if multiparty approval delays release.	Requires refinery/product compatibility across intended users and agreed substitution rules.	Shared assets can reduce cost, but governance and logistics must be tested end to end.
Refinery and commercial stock	Counts only if emergency access is legally assured and normal commercial obligations do not prevent release.	May already be integrated into the market, but working-stock requirements and customer commitments reduce freely available volume.	Often aligned with normal market demand, although crude and product composition may not match the affected location.	Useful first layer, but only verified, non-duplicated, callable, and deliverable volumes should count.

Source: ERIA, based on comments from the ASEAN Council on Petroleum, the ASEAN Centre for Energy, the ASEAN Secretariat, and ASEAN Member States in 2026.

Accordingly, the scenario comparison applies equal nominal emergency protection to each eligible barrel, while Table 2.4 identifies the legal, physical, quality, and delivery factors that should be incorporated into the pilot design and subsequent feasibility studies.

Equal nominal coverage does not establish equivalent energy-security performance. National, ticketed, jointly held, and commercial stocks may differ substantially in terms of sovereign control, legal enforceability, allocation reliability, physical accessibility, delivery time, product quality, and exposure to simultaneous infrastructure or market disruptions. The lower-cost portfolios should therefore be regarded as potentially more cost-efficient only after the effective-volume factors are verified. Pilot and feasibility assessments should compare both annualised cost and delivered emergency performance, including callable volume, authorisation-to-delivery time, throughput, product compatibility, competing claims, and end-to-end release reliability.

6.2. Voluntary participation, contribution-linked access, and release governance

Voluntary participation does not imply unrestricted access to stocks financed, hosted, or contracted by third parties. In a pilot arrangement, drawdown rights should be linked to a verified contribution, such as inventory ownership, a ticket or capacity payment, hosted storage, reciprocal supply, logistics support, or another mutually agreed commitment. Wider market spillovers cannot be eliminated, but the strategic free-rider risk can be mitigated through the implementation of eligibility criteria, proportional allocation mechanisms, priority access provisions, replenishment obligations, and transparent cost sharing arrangements amongst participating parties.

Decisions regarding release should remain with the competent national authorities and the applicable ASEAN processes, including APSA and CERM where relevant. Any pilot agreement should specify the disruption trigger, initiating authority, consultation and authorisation process, allocation amongst users, priority rules, pricing and payment, customs treatment, delivery responsibilities, replenishment, confidentiality, and dispute settlement. Where participating countries hold different views, no party should be compelled to release or receive stocks outside its legal and contractual commitments; pre-agreed rules should determine the volume that may be called, the order of priority, and the consequences of non-performance. This chapter does not assign new operational responsibilities to the ASEAN Secretariat, the ASEAN Centre for Energy (ACE), or the ASEAN Council on Petroleum and Energy (ASCOPE) beyond their approved mandates.

The ASEAN aggregate includes Singapore within the common 5.0 mb/d planning base, but the analysis does not assume that Singapore will introduce a statutory reserve obligation, host a regional stockpile, or make commercial inventories available during an emergency. Any role as a storage, trading, ticketing, or logistics hub would be voluntary, commercially negotiated, and subject to domestic policy, operator agreement, confidentiality, and enforceable emergency-access arrangements. Only stocks meeting the eligibility conditions in Table 2.1 would count towards effective coverage.

7. Comparison with Previous Oil Stockpiling Studies

7.1. Benchmarking ASEAN results against previous studies

Previous IEA and ERIA studies generally find that emergency reserves can generate economic value exceeding life-cycle costs, although their geographical scope, reserve configurations, disruption assumptions, probability treatment, and modelling methods differ. The present analysis updates that evidence for ASEAN's 11-member composition, post-2022 cost conditions, and alternative reserve-sharing arrangements, but it should be read as strategic screening rather than as a direct replication of the IEA probabilistic model.

7.2. Comparison of cost-effectiveness results

A useful basis for comparison is the annualised economic value generated per barrel of reserve capacity (Figure 2.8). This approach allows results from different studies to be evaluated on a consistent basis despite differences in reserve volumes, country coverage, and modelling frameworks.

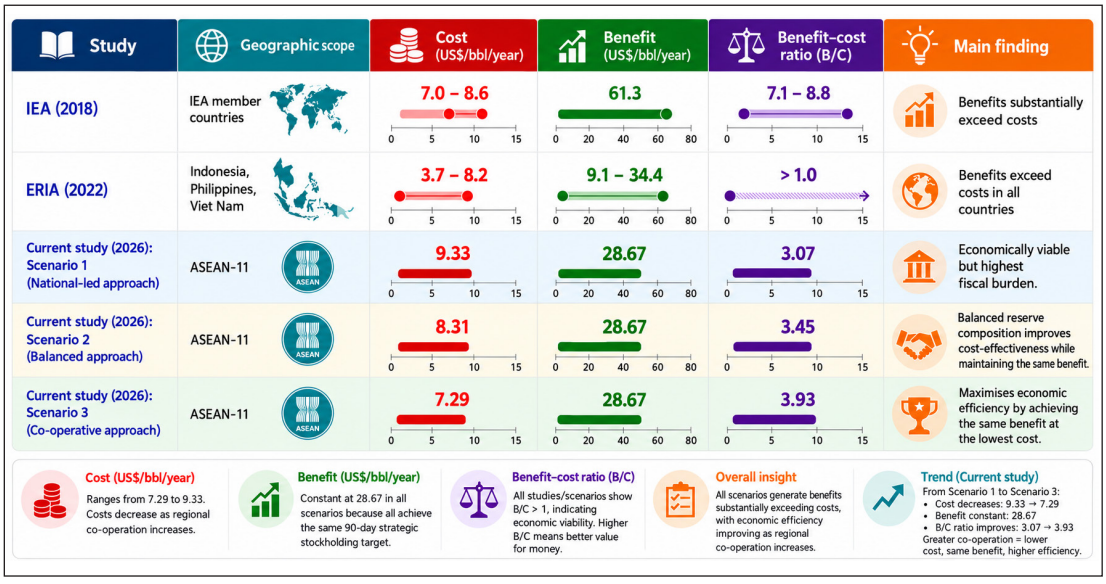
The comparison is indicative rather than strictly like for like. IEA (2018), ERIA (2022), and the present analysis use different geographical coverage, reserve configurations, disruption assumptions, stockholding structures, and benefit methodologies. IEA (2018) applied probabilistic disruption modelling over a 30-year horizon, ERIA (2022) examined selected ASEAN economies and joint stockpiling, and this study uses an ASEAN-wide avoided-loss approach with a common 90-day benchmark. Figure 2.8 should therefore be read as a comparison of the magnitude and direction of results, not of directly equivalent estimates.

The comparison reveals several important observations. First, all three studies support the rationale for stockholding, but their methods differ. The IEA applied probability-weighted disruption modelling, ERIA (2022) used study-specific regional and bilateral cases, and this study applies a conditional annualised avoided-GDP-loss approach under a severe reference disruption scenario. The results should therefore be compared for direction and order of magnitude rather than treated as strictly like-for-like estimates.

Second, although the current study incorporates significantly higher oil prices, infrastructure costs, operating expenditures, and financing costs than earlier analyses, the benefit–cost ratios remain strongly positive. The co-operative approach produces a benefit–cost ratio of 3.93, while even the most expensive national-led approach achieves a ratio of 3.07. These results indicate that the economic justification for strategic reserves remains robust despite the higher costs associated with post-2022 market conditions.

Third, the estimated annualised costs in this study are broadly consistent with the range reported by the IEA. The annualised cost of the co-operative approach (US$7.29/bbl/year) falls close to the lower end of the IEA range, while the national-led approach (US$9.33/bbl/year) is only slightly above the upper bound of the IEA estimate. Given the substantial increases in oil prices, construction costs, and financing costs since the IEA analysis, the ASEAN hybrid approach remains economically competitive by international standards.

Figure 2.8. Comparison of Cost-Effectiveness Results Across Major Oil Stockpiling Studies



ASEAN = Association of Southeast Asian Nations, B/C = benefit–cost ratio, bbl = barrel of oil, ERIA = Economic Research Institute for ASEAN and East Asia, IEA = International Energy Agency.

Source: ERIA, based on IEA (2018); and ERIA (2022).

Interpretation note: The studies are not methodologically like for like. The IEA applied probability-weighted modelling, while the current study applies a conditional annualised avoided-GDP-loss approach under a severe reference disruption. The comparison is therefore indicative and should be used for direction and order of magnitude rather than exact equivalence.

Fourth, the comparison indicates, under the common nominal-coverage and cost assumptions, that portfolios with a larger co-operative share may have lower annualised stockholding costs than a predominantly national portfolio. ERIA (2022) similarly found lower life-cycle costs for joint stockpiling amongst the mechanisms examined. In the current ASEAN-wide screening, increasing the joint-stockpiling share from 10 days under the national-led approach to 30 days under the co-operative approach reduces the annualised stockholding cost from US$9.33 to US$7.29 per barrel. This is a cost result, not evidence of equivalent sovereign control or operational effectiveness; those dimensions require the effective-value and delivery tests set out in Sections 2.6.1 and 2.8.

7.3. Transferability of northeast Asian joint-stockpiling experience to ASEAN

Northeast Asian joint-stockpiling arrangements are used as practical references because they demonstrate that producer-owned or commercially held oil may be stored in importing markets while emergency access and commercial rotation are regulated through contractual agreements. They are not used as a ready-made blueprint for ASEAN. The ASEAN region has more diverse legal systems, market structures, geography, refinery configurations, and emergency-response mandates; therefore, several elements require institutional and commercial adaptation (Table 2.5).

Table 2.5. Transferable Elements and ASEAN-Specific Adaptation Needs

Model element	Transferability	ASEAN adaptation required
Producer- or supplier-owned stock located in the consuming region	Transferable in principle	Confirm host law, title, custody, tax and customs treatment, sanctions exposure, and emergency access rights.
Use of existing commercial tanks and stock rotation	Transferable where capacity and quality are suitable	Protect operational minimums, avoid double counting, define losses and quality management, and confirm terminal throughput.
Priority access or purchase rights during emergencies	Transferable through contract	Define ASEAN/national trigger, priority amongst multiple users, allocation, pricing, payment security, release authorisation, and dispute resolution.
Long-term producer-consumer relationship	Transferable as a strategic objective	Preserve voluntary participation, ASEAN centrality, commercial confidentiality, supplier diversification, and national sovereignty.
Single host-single producer bilateral governance	Requires substantial adaptation	ASEAN pilot initiatives may involve multiple users, operators, and authorities, and must align with APSA/CERM and national emergency powers.
Crude-focused model	Transferable only where refinery compatibility exists	Some Member States may require product stocks, substitution rights, or a mixed crude-product portfolio because refinery and distribution capacity differs.
Release from one major terminal or hub	Requires geographic and logistics adaptation	Archipelagic, landlocked, remote, and disaster-prone markets require route diversity, receiving infrastructure, domestic distribution, and contingency delivery plans.

APSA = ASEAN Petroleum Security Agreement, ASEAN = Association of Southeast Asian Nations, CERM = Coordinated Emergency Response Measures.

Source: ERIA, based on comments from the ASEAN Council on Petroleum, the ASEAN Centre for Energy, the ASEAN Secretariat, and ASEAN Member States in 2026.

The study therefore borrows the commercial logic of shared infrastructure, producer ownership, rotation, and priority access, while leaving the institutional form, participants, volumes, stock type, location, pricing, and release procedures to ASEAN and national consultation and to pilot-specific negotiation.

8. Limitations and Complementary Analysis

This analysis is intended as comparative tool rather than a feasibility study, an investment-grade site assessment, or a full probabilistic risk model. The following subsections broaden the assessment through alternative disruption cases and sensitivities related to parameters, delivery, probability, and country archetypes or grouping, while the central case remains the conditional annualised comparison described above.

8.1. Different scenario setting

Different disruptions create different stock requirements. A maritime supply interruption may increase the value of stocks already inside ASEAN, while a refinery outage may make finished products more valuable than crude. A natural disaster or domestic distribution failure may leave regional stocks physically available but unable to reach the affected market. The following cases should therefore be used in pilot design and subsequent probability-weighted analysis (Table 2.6).

Table 2.6. Different Scenario Setting and Stockpiling Implications

Disruption case	Main transmission channel	Reserve or response most valuable	Key operational sensitivity
External maritime chokepoint disruption	Reduced crude/product inflow; higher freight and insurance; cargo delays	Stocks already located inside ASEAN; diversified ports and suppliers	Shipping availability, release timing, and refinery compatibility
ASEAN maritime chokepoint or major-port disruption	Regional rerouting, congestion, delayed cross-border delivery	Distributed storage, alternative ports, product stocks near demand	Route diversity, terminal capacity, and customs contingency
Refinery outage	Crude may be available but cannot be converted into required products	Finished-product reserves, refinery substitution, and product swap arrangements	Product specification, alternative refinery capacity, and inland distribution
Terminal, tank-farm, pipeline, jetty, power, or cyber failure	Stored stock becomes inaccessible or throughput is reduced	Geographically diversified sites and redundant loading/transport systems	Business continuity, physical/cyber security, and alternative dispatch
Natural disaster	Simultaneous damage to storage, ports, roads, demand centres, and communications	Distributed and disaster-resilient product stocks; mobile and multimodal delivery	Facility resilience, emergency access, receiving capacity, and last-mile delivery
Domestic product-distribution disruption	National or regional supply exists but cannot reach consumers or critical sectors	Product stocks near demand centres and prearranged trucks, barges, depots, and priority users	Allocation, last-mile logistics, rationing, and critical-sector continuity
Compound or prolonged disruption	Multiple routes/facilities affected; replenishment delayed; repeated drawdowns	Diversified stock type, location, supplier, and transport mode; demand measures	Sustained throughput, replenishment, prioritisation, and financial capacity

ASEAN = Association of Southeast Asian Nations.

Source: ERIA, based on comments from the ASEAN Council on Petroleum, the ASEAN Centre for Energy, the ASEAN Secretariat, and ASEAN Member States in 2026.

8.2. Determination of avoided economic loss

The avoided economic loss depends mainly on two assumptions: the scale of the annual GDP impact caused by the reference disruption and the proportion of that impact that can be mitigated through effective strategic reserves. To assess the influence of these assumptions, Table 2.7 presents alternative combinations of GDP impact and mitigation rate.

The central case assumes that a severe oil supply disruption could reduce ASEAN's annual economic output by 0.4% and that timely access to strategic reserves could mitigate 50% of the resulting loss. Based on ASEAN nominal GDP of about US$4.3 trillion, this produces an estimated avoided economic loss of US$8.6 billion in the affected year.

The sensitivity analysis is intended to illustrate how the estimated economic value of stockpiling changes under different assumptions. It does not predict the precise impact of a future disruption. A smaller economic shock or a lower mitigation rate would reduce the estimated avoided loss, while a more severe disruption or a more effective emergency response would increase it.

Table 2.7. Sensitivity of the Estimated Avoided Economic Loss
(US$ billion per affected year)

Assumed annual GDP impact	25% mitigation	50% mitigation	75% mitigation
0.2%	2.15	4.30	6.45
0.4%	4.30	**8.60**	12.90
0.6%	6.45	12.90	19.35

ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product.

Note: Calculations are based on ASEAN nominal GDP of about US$4.3 trillion. The central reference case, comprising a 0.4% annual GDP impact and a 50% mitigation rate, is shown in bold.

Source: ERIA.

To identify the principal cost-side drivers, Table 2.8 varies one parameter at a time while retaining the 5.0 mb/d planning baseline, the 60-day additional reserve volume, and the three reserve compositions. The values are screening calculations rather than commercial quotations.

Table 2.8. Additional Cost Sensitivities Under the Three Reserve Portfolios

Parameter	Lower / central / higher cases	Annualised cost range across scenarios 3–1	Main finding
Crude oil benchmark	US$75 / US$95 / US$115 per bbl	US$2.03 billion–US$2.54 billion / US$2.19 billion–US$2.80 billion / US$2.33 billion–US$3.04 billion	Largest effect on the national-led case because it owns the greatest inventory volume.
CAPEX and O&M escalation	+10% / +25% / +40%	US$2.05 billion–US$2.62 billion / US$2.19 billion–US$2.80 billion / US$2.32 billion–US$2.96 billion	Raises all costs, but the ordering of the three portfolios remains unchanged.
Financing rate	4% / 6% / 8%	US$2.13 billion–US$2.73 billion / US$2.19 billion–US$2.80 billion / US$2.22 billion–US$2.84 billion	The national-led case remains most exposed to higher financing costs.

bbl = barrel of oil, CAPEX = capital expenditure, O&M = operation and maintenance.

Note: Ranges are presented from scenario 3 to scenario 1. Central values correspond to the assumptions used in the main analysis. Minor differences from the rounded headline totals arise from unrounded unit-cost inputs.

Source: ERIA.

The one-at-a-time cost sensitivities do not exhaust the relevant uncertainty. Subsequent feasibility studies should test combined low, central, and high cases for crude and petroleum-product prices, exchange rates, discount and financing costs, construction and operating expenditure, stock acquisition and rotation, degradation and losses, insurance and security, transportation and emergency handling, facility utilisation, delivery delay, disruption frequency, severity and duration, and simultaneous or compound disruptions. They should also assess differentiated or phased coverage levels, priority petroleum products, essential-demand coverage, and combined stock and non-stock response packages.

Aggregate ASEAN results do not show how costs, benefits, risks, and liabilities are distributed amongst Member States. A next-stage distributional assessment should estimate country-level affordability and avoided losses; distinguish host, user, owner, operator, and transit-country obligations; test foreign-exchange and fiscal exposure; and examine free-riding, cross-subsidisation, host-country liability, and access during simultaneous requests. Any solidarity, compensation, or risk-sharing mechanism should be voluntary, contribution-linked, transparent, and negotiated by participating parties rather than assumed in the regional screening model. These priorities are consistent with recent ASEAN consultations, which emphasised national diversity, practical delivery, voluntary participation, and the need for country-specific verification before investment decisions.

Operational performance can be screened separately from cost. Under the central macroeconomic assumptions, delivering only 50%, 75%, or 100% of the planned effective volume would preserve about US$4.30 billion, US$6.45 billion, or US$8.60 billion, respectively, assuming the avoided-loss effect scales proportionately. The release delay should be quantified from the point of authorisation to the delivery at the affected market and tested at project-specific thresholds such as 7, 14, and 30 days. Because the relationship between delay and macroeconomic loss is contingent on the nature of the disruption, stock location, refinery operations, and distribution constraints, no arbitrary delay coefficient is incorporated into the central model.

The results demonstrate that the economic value of strategic reserves is sensitive to both the severity of the disruption and the effectiveness of the emergency response. The actual mitigation rate would depend on whether stocks are legally accessible, physically available, compatible with refinery and product requirements, released without significant delay, and delivered to the affected markets in sufficient volume.

Operational limitations may therefore reduce the effective contribution of nominal reserve volumes. Delays in authorisation, loading, customs clearance, transportation, refining, or domestic distribution could weaken the effectiveness of mitigation efforts. Conversely, well-located and quality-compatible stocks, supported by clear release procedures, prearranged logistics, and co-ordinated demand-management measures, could increase the effectiveness of the reserve response.

The analysis does not assign an annual probability to the reference disruption. A probability-weighted result would be calculated by multiplying the conditional avoided loss by the estimated probability of the disruption, but a defensible ASEAN-wide annual frequency for a complete or near-complete Hormuz blockage, or a comparable compound event, has not yet been established. A probability-weighted analysis would therefore answer a different question – the expected annual value before the timing of a disruption is known – and should be developed separately using data on disruption frequency, severity, duration, and interactions. It is complementary to, rather than a replacement for, the central conditional scenario comparison.

8.3. Differentiated stockpiling pathways for ASEAN country archetypes

The common regional benchmark provides a consistent basis for comparing the three ASEAN-wide portfolios (ERIA, 2022) and should not be applied mechanically to every Member State. Implementation should begin with national exposure, eligible existing stocks, refinery and storage capability, geography, fiscal capacity, and emergency-delivery requirements. The following archetypes (Table 2.9) illustrate differentiated pathways without ranking countries or assigning a single model to individual Member States.

Table 2.9. Illustrative Stockpiling Pathways by ASEAN Country Archetype

Country archetype	Typical characteristics	Indicative hybrid pathway	Priority design considerations
Large importing economy with significant refining and storage	High demand and import exposure; substantial domestic infrastructure	Core national reserve plus joint/producer-owned crude, selected tickets, product contingency stocks, and regional hosting where feasible	Refinery compatibility, port and pipeline throughput, domestic allocation, and fiscal optimisation
Regional refining, trading, and storage hub	Strong terminals, ports, trading, and operator capability; high commercial-stock turnover	Verified commercial layer, ticket and storage services, joint/producer-owned stocks, and logistics support; national reserve as determined domestically	Avoid double counting; protect commercial functioning; define priority, confidentiality, and release authority
Domestic producer or net-exporting/less import-dependent economy	Domestic production may reduce import risk but infrastructure and product imbalances remain	Production contingency, targeted product reserves, shared storage, reciprocal access, and contribution as host or supplier	Production disruption, refinery outages, product import dependence, and export commitments
Smaller import-dependent economy with limited refinery/storage capacity	High external exposure and limited ability to finance standalone facilities	Ticketing, host-user access, regional product stocks, pooled procurement, and modest national critical-sector stocks	Contract enforceability, delivery route, receiving capacity, foreign exchange, and last-mile distribution
Archipelagic, remote, landlocked, or geographically dispersed market	High internal logistics risk and potential isolation of sub-markets	Distributed product stocks, multiple entry points, mobile or modular storage, regional tickets, and prearranged maritime/land transport	Weather and disaster resilience, route redundancy, local depots, throughput, and delivery time

ASEAN = Association of Southeast Asian Nations.

Source: ERIA, based on comments from the ASEAN Council on Petroleum, the ASEAN Centre for Energy, the ASEAN Secretariat, and ASEAN Member States in 2026.

Country-specific optimisation should therefore determine the appropriate reserve level and composition. The ASEAN-wide 30-plus-60-day structure remains useful for regional planning and bargaining, while national implementation may use different effective-stock contributions, additional reserve days, stock types, and delivery arrangements.

8.4. Remaining limitations

The sensitivity and country-archetype analyses improve the transparency of the screening, but country-, facility-, contract-, and disruption-specific modelling remains necessary. The following limitations therefore apply.

The 'cost' calculations rely on common ASEAN-wide benchmark assumptions for oil acquisition prices, storage infrastructure and operating costs, and financing conditions. These assumptions are applied uniformly for comparability, not because costs are expected to be identical across Member States. Changes in the parameters would affect the absolute cost of each scenario. Higher oil prices and financing costs would be particularly consequential for models requiring large nationally owned inventories, while ticketing and joint stockpiling could retain a relative cost advantage. The central unit costs also do not model minimum efficient tank size, terminal throughput, land constraints, or diseconomies associated with a small pilot. Project-specific studies should therefore test minimum viable reserve volume, facility scale, utilisation, and logistics throughput before applying the regional unit costs to a single facility.

The 'benefit' is based on avoided macroeconomic losses and assumes that strategic reserves mitigate 50% of the annual GDP impact of a major supply disruption. The result is conditional rather than probability-weighted, and realised benefits would depend on the scale and duration of the disruption, release timing, logistics and distribution capacity, refinery compatibility, product availability, and regional co-ordination. Accordingly, the US$8.6 billion figure is best understood as an estimated annual avoided economic loss under the reference disruption scenario, not as a guaranteed saving in every typical year.

Annualising costs and benefits provides a consistent basis for comparing the scenarios, but it abstracts from the timing of expenditures and benefits, changing oil-price paths, inventory rotation, construction sequencing, and the possibility of prolonged or repeated disruptions. These dynamics would need to be examined in greater detail before specific investments are approved. The regional results also aggregate significant differences amongst ASEAN Member States in demand, import dependence, existing stock levels, infrastructure, and fiscal capacity. The common 90-day analytical benchmark and 60-day additional reserve requirement are used to support scenario comparability, not as uniform national mandates. For example, Thailand's estimated effective coverage of about 67 days suggests that its incremental requirement could be smaller than the common assumption, and its actual cost could therefore be lower.

Finally, the analysis does not model operational, legal, commercial, and institutional feasibility in detail. Country- and site-specific due diligence will be required on reserve composition and refinery compatibility, storage and port capacity, distribution links, access rights, customs and tax treatment, governance, financing, emergency release protocols, and replenishment arrangements. Facilities with multiple commercial owners, lenders, operators, or pre-existing customer commitments may require sequential technical due diligence, legal review, valuation, contract negotiation, regulatory approval, and end-to-end release testing. No fixed pilot completion timeline is assumed in this chapter; implementation schedules should be indicative, 'stage-gated', and conditional on the completion of each approval and commercial milestone. The priority areas for this further research are summarised in Annex 2.1.

9. Conclusions

The results of this chapter have indicated a strong economic rationale for further development of ASEAN hybrid oil stockpiling co-operation. Annualised life-cycle costs range from US$2.19 billion to US$2.80 billion, while the estimated annual avoided economic loss under the severe reference disruption scenario is US$8.60 billion. The resulting net annual benefits are US$5.80 billion–US$6.41 billion, with scenario-based benefit–cost ratios of 3.07–3.93. These figures are conditional on the reference assumptions and are not forecasts of a disruption occurring annually.

Reserve composition drives the cost difference across scenarios, while actual emergency value also depends on accessibility, deliverability, and quality compatibility. Each scenario maintains the same effective 90-day benchmark to isolate the cost effect of changing the reserve mix. Scenario 3 reduces annualised stockholding cost by about 22% and increases the net economic value by about 11% relative to scenario 1. This comparative result remains valid where lower-cost ticketed or jointly held stocks provide reliable and timely emergency access.

The results do not prescribe a uniform reserve mix or a uniform additional reserve requirement for every Member State. They support a voluntary and differentiated approach across all 11 ASEAN Member States, combining national responsibility, verified existing stocks, ticketing, and joint arrangements according to country archetype and national circumstances. Options may include using underutilised host-country tanks for exporter-owned oil while participating countries secure clearly defined and tested emergency access rights.

Collective negotiation can provide an additional strategic benefit. By pooling prospective demand and presenting a co-ordinated package of storage capacity and emergency-access requirements, participating AMS could negotiate more favourable and durable arrangements with oil-exporting partners than through fragmented bilateral approaches. This advantage depends on credible infrastructure, transparent governance, commercially workable terms, confidentiality safeguards, and enforceable rules.

Possible next steps for consideration by interested AMS include voluntary pilot preparation and targeted feasibility work covering verified stocks, cost ranges, legal access, stock type, compatibility, location, financing, pricing, release, delivery, replenishment, and dispute settlement. Any pilot should be ‘stage-gated’, subject to national approval and relevant ASEAN processes, and designed to measure accessible volume, authorisation-to-delivery time, throughput, delivery performance, and replenishment.

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Annex 2.1. Areas for Future Research and Implementation Support

While this study establishes the strategic rationale and economic justification for oil stockpiling co-operation in the Association of Southeast Asian Nations (ASEAN), several technical, institutional, and operational issues require further investigation before regional arrangements can be implemented. Priority areas include:

A. Refinery compatibility and reserve composition assessment

Future studies should undertake a detailed assessment of crude oil grade compatibility and refinery requirements across ASEAN Member States. While the current study evaluates stockpiling requirements from a regional energy security perspective, the effectiveness of strategic reserves ultimately depends on whether stored crude oil or petroleum products can be utilised by national refining systems during emergencies. Different ASEAN refineries are designed to process different crude slates, so emergency reserves must consider refinery configurations, product demand profiles, and supply chain requirements. Future technical studies should identify suitable crude grades, assess refinery compatibility, and determine the optimal balance between crude oil and refined petroleum product reserves for each participating country.

B. Country-specific stockholding optimisation

The analysis uses a standard 90-day effective reserve benchmark as an analytical reference point and distinguishes differentiated pathways for major ASEAN Member State archetypes. Future research should translate these archetypes into country-specific optimisation based on import dependence, domestic production and refining, verified commercial inventories, storage and port infrastructure, geography, fiscal capacity, product demand, and supply chain vulnerabilities. Such work could evaluate alternative effective coverage levels, including 30-, 60-, and 90-day cases, and identify the most suitable national, ticket, joint, commercial, crude, and product mix for each participating country.

C. Pilot joint stockpiling design and governance framework

One of the most important next steps will be the development of a detailed feasibility study for a pilot ASEAN joint stockpiling arrangement. While the current study proposes a voluntary ASEAN oil stockpiling approach as a practical pathway for implementation, the detailed design of such a mechanism remains beyond the present scope. Future work should evaluate alternative models, including jointly owned reserves, host-country storage arrangements, ticketing systems, contractual access rights, and hybrid structures. The study should further clarify governance

arrangements, ownership structures, stock release procedures, cost-sharing mechanisms, replenishment obligations, taxation and insurance requirements, pricing principles, quality standards, legal liabilities, and dispute resolution mechanisms. Particular attention should be given to ensuring that any pilot mechanism complements existing ASEAN frameworks, including the ASEAN Petroleum Security Agreement (APSA) and the Coordinated Emergency Response Measures (CERM), rather than creating parallel institutional arrangements.

D. Infrastructure ecosystem and emergency distribution assessment

Strategic reserves provide energy security benefits only if they can be released and delivered rapidly and reliably during supply disruptions. Future research should therefore move beyond storage capacity assessments and examine the broader infrastructure ecosystem required to support emergency response. This includes detailed mapping of storage terminals, ports, pipelines, refineries, transport corridors, and distribution networks. Future research should also evaluate the operational capability of different locations to support rapid stock release and delivery under emergency conditions. Such assessments would assist ASEAN in identifying priority infrastructure investments and determining the most suitable locations for future regional stockpiling arrangements.

E. Comprehensive Risk and Scenario Analysis

The main chapter examines external and regional maritime chokepoints, refinery and terminal outages, natural disasters, infrastructure and cyber failures, product distribution disruptions, gross domestic product (GDP) impact, mitigation, oil price and cost parameters, financing, and delivered volume. Future research should quantify disruption duration, release delay, route-specific delivery performance, infrastructure interdependencies, and probability-severity relationships using country- and project-specific data. This would offer an additional decision-making perspective alongside the central conditional annualised avoided-loss analysis used for the severe reference scenario.

F. Financing and investment mobilisation framework

Although this study evaluates the economic costs and benefits of different stockpiling approaches, additional work is required to develop a comprehensive financing framework for implementation. Future studies should assess potential financing mechanisms, including public funding, public–private partnerships, blended finance, strategic infrastructure funds, multilateral development financing, and private sector participation. Particular attention should be given to identifying bankable projects, assessing investment risks, and establishing financing arrangements that can support both pilot projects and long-term infrastructure expansion. The implementation roadmap should also consider the evolution of financing mechanisms over time, beginning with public sector–supported pilot initiatives and gradually transitioning towards commercially sustainable models.

G. Institutional and legal readiness assessment

Finally, future research should examine the legal, regulatory, and institutional frameworks necessary to support regional stockpiling co-operation. Such analysis should assess domestic legislation, emergency powers, stock release authorities, cross-border transfer procedures, liability provisions, and contractual arrangements amongst participating countries. Given the diversity of legal systems and policy frameworks across ASEAN, institutional readiness assessments will be essential for identifying practical implementation pathways while fully respecting national sovereignty and domestic approval processes.

Together, these studies would provide the technical, institutional, financial, and operational basis for voluntary and practical ASEAN stockpiling co-operation.

Annex 2.2. Cost Escalation Methodology and Unit Cost Derivation for Strategic Oil Stockpiling Mechanisms

A2.2.1. Method of the cost escalation: purpose and scope

The purpose of this annex is to provide a detailed explanation of the methodology used to derive the annualised life-cycle costs of strategic oil stockpiling under the three stockholding mechanisms evaluated in this study: national stockpiling, ticket stockpiling, and joint stockpiling.

The original stockholding cost estimates were developed through a previous study by the Economic Research Institute for ASEAN and East Asia (ERIA) on oil stockpiling and emergency response co-operation in the Association of Southeast Asian Nations (ASEAN) and East Asia (ERIA, 2022). Those studies provided an important analytical foundation for evaluating strategic reserve development in the region. However, since the completion of those studies, global energy markets have undergone substantial changes. Crude oil prices have increased, construction costs have risen significantly, operating expenditures have escalated, and global financing conditions have tightened due to higher interest rates and inflationary pressures.

Consequently, applying the original cost assumptions without adjustment would underestimate the actual cost of implementing strategic oil stockpiling under current market conditions. This annex updates the original ERIA cost structure using contemporary market assumptions and derives revised annualised unit costs suitable for the ASEAN-wide cost–benefit analysis presented in this study.

The methodology follows a life-cycle costing approach. Rather than focusing solely on the initial investment cost, life-cycle costing incorporates all major expenditures associated with establishing, operating, maintaining, financing, and managing strategic reserves throughout their economic life. This approach provides a more realistic estimate of the long-term cost of maintaining emergency oil stocks and allows direct comparison amongst alternative stockpiling mechanisms.

A2.2.2. Decomposition of the ERIA cost structure

The starting point of the analysis is the original ERIA stockholding model, which decomposed the annualised cost of maintaining strategic oil reserves into three main categories (Table A2.2.1).

Table A2.2.1. Share of Total Life-Cycle Cost

Cost component	Share of total cost
Oil acquisition and inventory ownership	46
Storage infrastructure and facilities	19
Operation and maintenance	35
Total	100

Source: ERIA based on ERIA (2022).

The oil acquisition component represents the largest share of life-cycle costs. This category includes expenditures associated with purchasing crude oil or petroleum products, inventory carrying costs, stock replacement requirements, and the opportunity cost of capital tied up in inventory ownership.

The storage infrastructure component includes expenditures associated with storage tanks, terminal facilities, pipelines, jetties, loading facilities, land development, environmental protection systems, safety systems, and supporting infrastructure required to maintain reserve operations. The operation and maintenance (O&M) component includes labour costs, insurance, utilities, maintenance activities, stock quality management, inventory rotation, security services, administration, and other recurring expenditures necessary to ensure reserve readiness.

The cost shares shown in Table A2.2.1 provide the basis for updating the original ERIA cost estimates (ERIA, 2022) to reflect current market conditions.

A2.2.3. Updating market assumptions

The original ERIA stockholding model was developed using market assumptions that reflected prevailing conditions at the time of the study. Since then, several factors have contributed to higher reserve development costs. First, international crude oil and petroleum product prices have increased significantly. Higher oil prices directly increase the cost of acquiring strategic reserves and raise inventory carrying costs. Second, infrastructure development costs have increased due to higher prices for steel, cement, engineering services, labour, marine construction, and logistics. Third, operating expenditure has risen because of higher insurance premiums, maintenance costs, utility expenses, and workforce costs. Fourth, financing costs have increased substantially as a result of higher global interest rates and tighter financial conditions.

To capture these changes, the original assumptions are updated as shown in Table A2.2.2.

Table A2.2.2. Updated Cost Assumptions

Parameter	Original Assumption	Updated Assumption
Crude oil price	US$72/bbl	US$95/bbl
Petroleum product price	US$79/bbl	US$105/bbl
Infrastructure cost	Baseline	+25%
Operating expenditure	Baseline	+25%
Financing cost	3%	6%

bbl = barrel.

Source: ERIA.

The updated assumptions are intended to represent current market conditions rather than a specific future forecast. They provide a reasonable basis for evaluating the economic viability of strategic oil stockpiling under contemporary cost structures.

A2.2.3.1. Rationale for infrastructure and O&M cost escalation assumptions

The 25% adjustment applied to infrastructure capital expenditure (CAPEX) and O&M costs is intended to reflect the cumulative increase in energy infrastructure development and operating costs observed since the assumptions used in earlier ERIA stockpiling studies. International construction cost data show that global construction costs increased sharply after 2020, driven by higher material prices, labour shortages, supply chain disruptions, transport costs, energy prices, and financing pressures. Turner & Townsend reported that global construction inflation increased by 9.5% in 2022 and estimated a further 5.8% increase in 2023, while its 2025 Global Construction Market Intelligence reported global construction cost inflation of 4.15% in 2024 and projected 3.9% in 2025 (Turner & Townsend, 2023, 2025). Compounded over 2022–2025, these annual increases are broadly consistent with a cumulative escalation of around 25%.

Energy sector evidence also supports the use of an escalation adjustment. The International Energy Agency (IEA) noted that persistent cost and interest-rate pressures continue to affect the energy investment landscape, particularly as the era of cheap borrowing has ended (IEA, 2024b). The IEA also reported that supply chain pressures remain visible in grid materials and the oil and gas sector, with grid material costs nearly doubling over 5 years and upstream oil and gas costs expected to rise further in 2025 (IEA, 2025c, 2025e). These cost pressures are relevant to strategic oil stockpiling because storage tanks, terminals, pipelines, jetties, loading facilities, safety systems, utilities, and supporting infrastructure all rely on construction materials, engineering services, skilled labour, and long-lead equipment.

O&M costs have also been affected by higher labour, maintenance, utilities, insurance, and security costs. The Organisation for Economic Co-operation and Development (OECD) reported that insurers faced higher cost pressures in 2023, reflecting inflation in claims costs and the hardening of reinsurance markets, which contributed to increases in non-life insurance premium rates (OECD, 2024). This is relevant because insurance, maintenance, security, and operational readiness are recurring cost components of strategic reserve facilities.

Therefore, this study applies a 25% escalation factor to both infrastructure CAPEX and O&M as a conservative proxy for post-2020 cost inflation. The assumption should not be interpreted as a detailed engineering estimate for any specific storage tank, terminal, pipeline, jetty, or reserve facility. Rather, it provides a reasonable adjustment for ASEAN-wide strategic screening analysis, ensuring that the updated life-cycle cost estimates better reflect current cost conditions while avoiding the need for a full bottom-up engineering reassessment.

A2.2.4. Derivation of cost escalation factors

A2.2.4.1. Oil acquisition escalation

The first adjustment relates to crude oil acquisition costs. The percentage increase in crude oil prices is calculated as:

Percentage increase in crude oil price = (updated oil price – original oil price) ÷ original oil price = (95 – 72) ÷ 72 = 23 ÷ 72 = 0.319 = 31.9%

Because oil acquisition and inventory ownership account for 46% of total life-cycle costs, the contribution of higher oil prices to overall stockholding costs is calculated as:

Oil acquisition escalation contribution = 31.9% × 46% = 14.7%

Therefore, the oil acquisition component contributes an additional 14.7% to the total life-cycle cost.

A2.2.4.2. Infrastructure escalation

Infrastructure costs are assumed to increase by 25% relative to the original ERIA baseline. Because infrastructure accounts for 19% of life-cycle costs:

Infrastructure escalation contribution = 25% × 19% = 4.75%

This represents the additional life-cycle cost attributable to higher construction and infrastructure development expenses.

A2.2.4.3. Operating expenditure escalation

O&M expenditures are also assumed to increase by 25%. Because O&M accounts for 35% of life-cycle costs:

O&M escalation contribution = 25% × 35% = 8.75%

This reflects higher costs associated with labour, insurance, maintenance, utilities, and reserve management.

A2.2.4.4. Financing escalation

Strategic oil stockpiling is capital intensive because both inventory acquisition and infrastructure development require substantial upfront investment. The original ERIA stockpiling studies assumed a financing cost of 3%, whereas the updated analysis adopts a financing cost of 6% to reflect current borrowing conditions, higher interest rates, and the increased cost of capital associated with strategic oil stockholding investments.

The increase in financing cost can be expressed as:

Percentage increase in financing cost = (6% – 3%) ÷ 3% = 100%

However, financing costs do not apply uniformly across all components of the stockholding cost structure. Financing exposure primarily affects oil inventory acquisition, storage infrastructure development, and related capital investments, whereas a significant portion of O&M expenditures is incurred on a recurring operational basis and is not directly financed through long-term capital borrowing. Consequently, the analysis applies the financing escalation only to the financing-sensitive portion of life-cycle costs.

Table A2.2.3. Financing-Sensitive Components of Strategic Oil Stockpiling Life-Cycle Costs

Cost component	Share of total cost (%)	Subject to financing cost
Oil acquisition and inventory ownership	46	Yes
Storage infrastructure and facilities	19	Yes
Operation and maintenance	35	No
Total financing-sensitive cost share	65	—

Source: ERIA based on ERIA stockholding cost structure.

Therefore: Financing-sensitive cost share = 46% + 19% = 65%

To avoid overstating the impact of higher interest rates, the analysis assumes that financing costs account for about 6% of the financing-sensitive cost components. The effective financing escalation is therefore calculated as:

Effective financing escalation = financing-sensitive cost share × increase in financing rate × financing cost share = 65% × 100% × 6% = 3.9% ≈ 4.0%

Therefore: Financing escalation contribution = 4.0%

The 4.0% financing escalation contribution should be interpreted as a conservative approximation designed to reflect the partial exposure of life-cycle costs to higher financing conditions rather than a direct one-for-one pass-through of the increase in financing rates. The adjustment captures the broad effect of tighter financing conditions on strategic reserve development while avoiding potential overstatement of financing impacts through double counting within other life-cycle cost components.

A2.2.4.5. Total escalation for a fully national stockpiling model

National stockpiling requires governments to bear the full cost of inventory ownership, infrastructure development, operation, maintenance, and financing. Therefore, all escalation factors apply.

Total life-cycle cost escalation = oil acquisition escalation contribution + infrastructure escalation contribution + O&M escalation contribution + financing escalation contribution

= 14.7% + 4.75% + 8.75% + 4.0% = 32.2%

Accordingly, the updated life-cycle cost of a fully national stockpiling model is assumed to be 32.2% higher than the original ERIA estimate.

A2.2.5. Derivation of national stockpiling cost

National stockpiling requires governments to purchase and own strategic oil inventories, construct storage infrastructure, operate reserve facilities, and finance all associated investments. Because all life-cycle cost components apply, the full escalation factor is incorporated.

Updated national stockpiling cost = original national cost × (1 + total escalation) = 8.0 × (1 + 32.2%) = 8.0 × 1.322 = 10.576 ≈ US$10.6/barrel/year

The resulting estimate indicates that national stockpiling remains the most expensive reserve mechanism due to the requirement for direct inventory ownership and dedicated infrastructure investment.

A2.2.6. Derivation of ticket stockpiling cost

Ticket stockpiling allows countries to secure emergency access rights to oil reserves held by another entity through contractual arrangements. The ticket buyer does not normally purchase the underlying inventory or construct dedicated storage facilities. Nevertheless, the ticket fee may reflect the seller's inventory carrying cost and therefore respond to fluctuations in oil prices. For the central screening estimate, the 14.7% component is treated as inventory-price exposure embedded in the ticket fee, not as direct oil acquisition by the participating country. Infrastructure escalation is excluded because the ticket buyer does not build dedicated storage under the assumed arrangement.

Applicable escalation components

- Inventory-price exposure embedded in ticket fee = 14.7%
- O&M escalation = 8.75%
- Financing escalation = 4.0%

Total applicable escalation = 14.7% + 8.75% + 4.0% = 27.45%

Updated ticket stockpiling cost = original ticket cost × (1 + applicable escalation) = 5.9 × (1 + 27.45%) = 5.9 × 1.2745 = 7.519 ≈ US$7.5/barrel/year

This result reflects the lower infrastructure requirements associated with ticketing arrangements.

A2.2.7. Derivation of joint stockpiling cost

Joint stockpiling assumes shared infrastructure and reserve-management systems. In the central case, the oil inventory remains owned by an exporting country or commercial partner, while participating ASEAN users secure emergency access rights and contribute to storage, operation, governance, or financing of their allocated share. Under that producer- or partner-owned structure, participating users are not required to finance the full oil inventory upfront. If a pilot instead adopts joint ownership by participating ASEAN Member States, the relevant oil-acquisition and carrying-cost component must be added to the unit cost and upfront investment exposure.

Consequently, oil-acquisition escalation is excluded only from the central producer- or partner-owned joint-stockpiling case.

Applicable escalation components

- Infrastructure escalation = 4.75%
- O&M escalation = 8.75%
- Financing escalation = 4.0%

Total applicable escalation = 4.75% + 8.75% + 4.0% = 17.5%

Updated joint stockpiling cost = original joint cost × (1 + applicable escalation)
= 3.8 × 1.175 = 4.465 ≈ US$4.5/barrel/year

The lower cost reflects infrastructure sharing, economies of scale, and reduced inventory ownership requirements.

Annex 2.3. Methodology for Cost-Reduction Analysis

A2.3.1. Objective

The purpose of the cost-reduction analysis is to compare the economic performance of alternative Association of Southeast Asian Nations (ASEAN) oil stockpiling configurations on a standardised basis. While the main cost–benefit analysis evaluates aggregate annualised costs and benefits, this annex expresses the results in United States dollars per barrel per year (US$/bbl/year) to facilitate comparison across stockpiling scenarios. All scenarios achieve the same additional 60-day reserve target; therefore, differences arise from reserve composition rather than reserve volume.

A2.3.2. Step 1: Estimation of annualised stockholding cost per barrel

The annualised stockholding cost per bbl is calculated using a weighted average life-cycle cost approach:

Average stockholding cost (US$/bbl/year) = [(national stockholding days × national unit cost) + (ticket stockholding days × ticket unit cost) + (joint stockholding days × joint unit cost)] ÷ 60
Where:

National unit cost = US$10.6/bbl/year
Ticket unit cost = US$7.5/bbl/year
Joint unit cost = US$4.5/bbl/year
60 = additional strategic reserve requirement (days)

Scenario 1: National-led approach
Average cost = [(45 × 10.6) + (5 × 7.5) + (10 × 4.5)] ÷ 60 = (477.0 + 37.5 + 45.0) ÷ 60 = 559.5 ÷ 60 = US$9.33/bbl/year
Scenario 2: Balanced approach
Average cost = [(35 × 10.6) + (5 × 7.5) + (20 × 4.5)] ÷ 60 = (371.0 + 37.5 + 90.0) ÷ 60 = 498.5 ÷ 60 = US$8.31/bbl/year
Scenario 3: Co-operative approach
Average cost = [(25 × 10.6) + (5 × 7.5) + (30 × 4.5)] ÷ 60 = (265.0 + 37.5 + 135.0) ÷ 60 = 437.5 ÷ 60 = US$7.29/bbl/year

A2.3.3. Step 2: Calculation of annualised economic benefit per barrel under the reference disruption scenario

The annual economic benefit is calculated using the avoided gross domestic product (GDP) loss approach. Because the reference macroeconomic impact is an annual growth downgrade, the benefit is annualised for comparison with the annualised stockholding cost. The calculation is conditional on the reference disruption occurring and is not probability weighted.

Annualised economic benefit = ASEAN GDP × annual GDP impact × mitigation rate = US$4.3 trillion × 0.4% × 50% = US$4.3 trillion × 0.2% = US$8.6 billion/year under the reference disruption scenario

The additional strategic reserve requirement is equivalent to about 300 million barrels.

Therefore:
Annualised benefit per barrel = US$8.6 billion ÷ 300 million barrels = US$28.67/bbl/year
Since all scenarios use the same 90-day effective reserve benchmark, the annualised benefit remains identical across the three scenarios so that the cost effect of reserve composition can be compared consistently.

Therefore:
Scenario 1 annualised benefit = US$28.67/bbl/year
Scenario 2 annualised benefit = US$28.67/bbl/year
Scenario 3 annualised benefit = US$28.67/bbl/year

A2.3.4. Step 3: Net economic value per barrel

Net economic value per barrel = annualised benefit per barrel – annualised cost per barrel
Scenario 1: National-led approach = 28.67 – 9.33 = US$19.34/bbl/year
Scenario 2: Balanced approach = 28.67 – 8.31 = US$20.36/bbl/year
Scenario 3: Co-operative approach = 28.67 – 7.29 = US$21.38/bbl/year

Relative to scenario 1, scenario 3 reduces the annualised stockholding cost by 21.9% [(9.33 – 7.29) ÷ 9.33] and increases the net economic value by 10.55%, about 11%, [(21.38 – 19.34) ÷ 19.34]. These are conditional annualised screening results; probability-weighted expected value is complementary.

Chapter 3

ASEAN Oil Infrastructure Ecosystem Assessment for Stockpiling Strategy

1. Introduction

The purpose of this chapter is to map the physical and institutional foundations for oil stockpiling co-operation in the Association of Southeast Asian Nations (ASEAN) to provide the oil infrastructure ecosystem assessment – encompassing the state of infrastructure development, current trade flow patterns, operator structures of relevant terminals, and each country's regulatory framework for oil reserves.

The analytical philosophy underlying this chapter is not to identify 'where to store' but rather to clarify 'what conditions qualify a location as a potential stockpiling site' from the perspective of existing infrastructure and related factors. This framework on an oil infrastructure ecosystem provides evaluation criteria that governments and industry stakeholders can apply when assessing and discussing specific candidate sites.

The findings presented in this chapter represent a first-pass assessment applying this eligibility framework to currently available data and should not be construed as prejudging the establishment of stockpiling facilities at any specific location.

1.1. Approach and methodology

The analysis in this chapter primarily focuses on stockpiling co-operation in crude oil for the following reasons. First, of ASEAN's crude oil imports in 2025, 54% (1.9 million barrels per day (MMbbl/day)) transit the Strait of Hormuz, compared with 12% (0.5 MMbbl/day) of refined product imports.[1] Crude oil is markedly more exposed to Hormuz dependence than refined products. The risk of a disruption therefore transmits more directly through crude oil procurement than through the procurement of refined products. Second, when considering multilateral accommodation arrangements, refined products are more prone to compatibility constraints arising from differing specifications such as gasoline octane ratings and sulphur content regulations. On the other hand, crude oil is comparatively fungible despite the broad sweet/sour classification, making it easier to secure flexibility in stockpiling and accommodation. Third, refined products degrade relatively quickly and require periodic stock rotation, adding to cost, whereas crude oil undergoes limited quality degradation under long-term storage, making it well suited to large-scale, long-term stockpiling.

At the same time, several ASEAN Member States (AMS) have limited domestic refining capacity and rely on imports for most of their refined product needs. For these countries, direct access to refined products matters more than access to crude oil. This assessment therefore incorporates not only crude oil infrastructure but also the elements relevant to supplying refined products – such as refinery access, which enables the conversion of stored crude into finished products, and the distribution path of oil products.

Building on this focus, the analysis in this chapter is organised around the following three elements.

[1] ERIA's calculations based on Kpler data (Kpler, n.d.).

Existing infrastructure assessment (Section 2)

Using satellite data and publicly available information, this section maps the actual state of three 'physical necessary conditions' – refinery access, crude oil storage capacity, and port access – across ASEAN.

- **Refinery access**: Ensuring access to a refinery is important for converting stored crude oil into products. Circumstances such as security or land constraints may lead to crude oil–dedicated storage sites being located away from refineries. However, being able to rotate inventory on a commercial basis alongside a refinery during normal times offers a greater business advantage because it avoids the stock becoming an idle asset.
- **Crude oil storage**: Reflecting the primary focus of this chapter on crude oil, the existing storage capacity is the most direct and self-evident condition.
- **Port access**: This pertains to the efficiency of both replenishing crude oil and releasing it or oil products in an emergency. Ports that cannot accommodate large tankers not only constrain procurement efficiency in normal times but can also become a bottleneck for drawdown operations during a crisis.

Beyond these conditions, factors such as spare capacity, loading and backloading capabilities, logistics connectivity, feasibility of land acquisition, potential for expansion, the composition of reserves by product type, and the geopolitical risk of a given location could also serve as evaluation criteria. Given the availability and comparability of data across countries, this chapter focuses on confirming the presence of existing infrastructure as an initial assessment, rather than validating emergency deliverability. These additional factors should be corroborated with each country and operator, including through the feasibility studies proposed in Chapter 4, as more specific discussions proceed.

Special considerations, including the potential reuse of existing tanks, are factored in to identify locations with infrastructure potential. The following additional assessments are then applied to these identified locations to reveal the strategic roles each country or facility could have in the context of ASEAN stockpiling co-operation.

Trade flow assessment (Section 3)

This section provides a descriptive analysis of established commercial trade flows (import origins and export destinations), based on empirical data, to clarify the logistics characteristics of each site. This analysis is necessary because physical eligibility alone (Section 2) does not reveal how vulnerable a given facility is to a shock, nor what logistics function it performs under normal conditions. The composition of import origins serves as an indicator of the scale of a facility's vulnerability under a scenario involving a Hormuz-type disruption. The composition of export destinations shows whether a facility has the logistics capacity to distribute products effectively within and beyond the region, as evidenced by empirical performance rather than solely theoretical potential.

Institutional landscape (Section 4)

In addition to the physical and flow analysis above, this section provides an overview of operator structures and each country's regulatory framework for oil stockpiling. This provides evaluation criteria for the 'soft factors' relevant to strengthening stockpiling. The structure of the operating entity can be a factor shaping the negotiating pathway for a stockpiling scheme. For each country's institutional framework, this section examines whether a legal obligation, administrative directive, or government target for stockpiling exists in the first place. This provides fundamental information regarding whether a participating country would need to develop its legal framework from scratch or could build on an existing one.

1.2. Data sources and limitations

The physical infrastructure and flow analysis (Sections 2 and 3) primarily uses the Kpler (n.d.) commodity trade intelligence platform. Kpler integrates automatic identification system (AIS) vessel position tracking with satellite imagery analysis to estimate in real time the trade flows of physical commodities such as crude oil and liquefied natural gas (LNG), as well as land tank inventory levels. It is widely used by oil companies, traders, government agencies, and research institutions. Vessel tracking data, port-call data, and storage observation data from Kpler serve as primary data sources, supplemented by desktop research using publicly available government and corporate information.

The findings presented in this chapter represent a first-pass assessment based on data that were observable and obtainable from external sources at the time of writing. Underlying operational data and actual conditions should be scrutinised further as more specific discussions proceed.

2. Existing Infrastructure Assessment

2.1. Refinery

The state of refinery development in ASEAN varies markedly across countries. The total refining capacity of operating crude refineries identified in this study is 5,374 thousand barrels per day (kbd) across ASEAN (Table 3.1).

Table 3.1. Existing Crude Refinery Capacity by Country

Country	Refining Capacity (kbd)	No. of Operating Refineries	Share (%)
Brunei	160	1	3.0
Cambodia	0	0	0.0
Indonesia	1,258	8	23.4
Lao PDR	20	1	0.4
Malaysia	1,025	6	19.1
Myanmar	25	1	0.5
Philippines	180	1	3.3
Singapore	1,119	3	20.8
Thailand	1,239	5	23.1
Timor-Leste	0	0	0.0
Viet Nam	348	2	6.5
ASEAN Total	**5,374**	**28**	**100.0**

ASEAN = Association of Southeast Asian Nations, kbd = thousand barrels per day.

Note: Percentages may not sum precisely due to rounding.

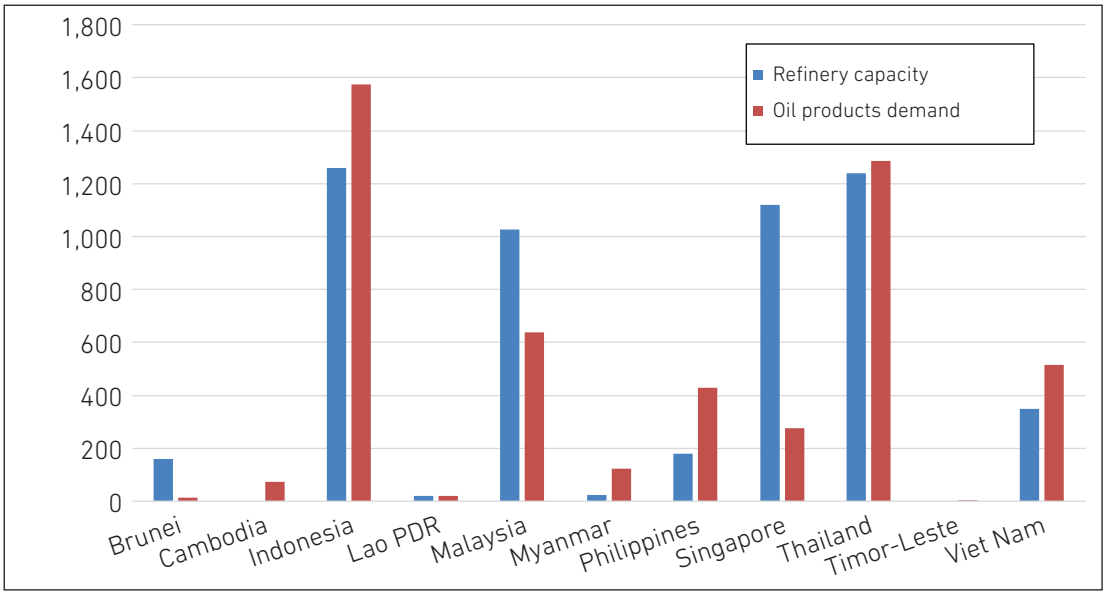
Source: ERIA's compilation based on desktop research.

The top four countries (Indonesia, Thailand, Singapore, and Malaysia) account for about 86% of regional refining capacity, while refinery infrastructure in the remaining AMS is limited.

This concentration reflects two structurally distinct patterns (Figure 3.1). First, Singapore functions as a regional refining hub, as its refining capacity (1,119 kbd as of 2026) significantly exceeds the level of domestic consumption (276 kbd in 2023),[2] making it a net exporter of refined products to both intra- and extra-ASEAN markets. Malaysia similarly has surplus export capacity. Second, Myanmar and the Lao People's Democratic Republic (Lao PDR) have limited refining capacity (25 kbd and 20 kbd, respectively), making them heavily reliant on product imports. Cambodia and Timor-Leste have no domestic refineries and are entirely import-dependent. The Philippines also relies on substantial product imports, as its sole operating refinery (Petron Bataan, 180 kbd) cannot meet domestic demand.

[2] ERIA's calculations based on IEA (n.d.).

Figure 3.1. Refinery Capacity vs. Domestic Oil Products Demand by Country
(kbd)



ASEAN = Association of Southeast Asian Nations, kbd = thousand barrels per day, IEA = International Energy Agency.

Notes:

1. Oil product demand is defined as the sum of (i) total final consumption, comprising both energy use and non-energy use; and (ii) oil products consumed in transformation processes, including oil-fired electricity generation. Crude oil inputs to refineries are excluded.
2. Values were converted from kilotonnes of oil equivalent (ktoe)/year to kbd using product-specific net calorific values (tonne of oil equivalent (toe)/ton) and barrel-to-tonne ratios (bbl/ton) from IEA World Conversion Factors (IEA, n.d.-b), with ASEAN-average or IEA default values applied where country-specific data are unavailable.

Sources: Refinery capacity – ERIA's compilation based on desktop research; oil product demand – data for 2023; ERIA's calculation based on IEA World Energy Balances (IEA, n.d.-a) for all countries except Timor-Leste, and the United States Energy Information Administration International Energy Statistics for Timor-Leste (U.S. Energy Information Administration (n.d.).

In addition to this structural concentration, several expansion projects are underway, and the future distribution of refining capacity may shift further.

Aster Chemicals and Energy expansion (Singapore)

Aster Chemicals and Energy acquired full ownership of the Bukom Condensate Splitter Facility from PCS Pte Ltd in June 2025 and announced plans to revitalise the 70 kbd unit, with operations expected to resume in 2026 and raise total refining capacity from 237 kbd to about 307 kbd (PCS Pte. Ltd., 2025; Hydrocarbon Engineering, 2025; Baird Maritime, 2026).

Balikpapan refinery expansion (Indonesia)

Pertamina's Refinery Development Master Plan project, with a total investment of US$7.4 billion (about Rp124 trillion), was completed and inaugurated by President Prabowo on 12 January 2026. Processing capacity expanded from 260 kbd to 360 kbd, making it Indonesia's largest refinery. Fuel quality was simultaneously upgraded from Euro II to Euro V standards, achieving both increased fuel output and reduced sulphur content (Business Indonesia, 2026).

Pulau Muara Besar refinery expansion (Brunei Darussalam)

Hengyi Industries in Brunei Muara Besar officially announced in January 2026 the start of a Phase 2 expansion project. The plan is to increase processing capacity from the current 160 kbd to 400 kbd (about 20 million tonnes per year), targeting completion in 2028 (Hydrocarbon Processing, 2026).

Other planned refineries

In Indonesia, several refineries at the planning stage have been identified. The largest project is the Pertamina-Rosneft joint venture Tuban Grass Root Refinery (planned capacity of 300 kbd), but the final investment decision originally scheduled for December 2025 has been postponed and no new target date has been set. Pertamina nonetheless opened a US$24 billion engineering, procurement, construction, and commissioning tender for the project in May 2026 (ANTARA, 2025; *Indonesia Business Post*, 2026).

In Malaysia, refinery development plans at Sipitang Oil & Gas Industrial Park (SOGIP, launched in February 2025) (World Oil, 2025) and at Lawas are at the planning stage, but no concrete progress on crude processing facilities is available from public sources.

2.2. Crude oil storage

The crude oil storage capacity figures in this section cover only onshore external floating roof tanks (EFRTs) identified through Kpler satellite data, and exclude several tank types such as internal floating roof tanks and fixed roof tanks. While EFRTs are widely used for crude oil storage, the figures in Table 3.2 may only partially reflect actual conditions. Moreover, the figures represent installed tank (nameplate) capacity, which does not necessarily correspond to the deliverable capacity during emergencies. A more detailed assessment, including validation of technically and commercially available capacity with facility operators, would be needed before these figures are used for site-specific planning.

Subject to the above constraints, the distribution of crude oil storage capacity confirmed from satellite data is as shown in Table 3.2.

Table 3.2. Installed Crude Oil Storage Capacity by Country (Estimated Based on Satellite Data)

Country	Storage Capacity (MMbbl)	No. of Sites	Share (%)
Brunei	9	2	5.5
Cambodia	0	0	0.0
Indonesia	30	9	18.0
Lao PDR	0	0	0.0
Malaysia	28	9	16.6
Myanmar	8	1	4.5
Philippines	8	3	4.8

Country	Storage Capacity (MMbbl)	No. of Sites	Share (%)
Singapore	39	4	23.0
Thailand	37	5	21.7
Timor-Leste	0	0	0.0
Viet Nam	10	2	5.9
ASEAN Total	**169**	**35**	**100.0**

ASEAN = Association of Southeast Asian Nations, MMbbl = million barrels.

Source: ERIA's compilation based on Kpler (n.d).

As with refining capacity in the previous section, the top four countries (Singapore, Thailand, Indonesia, and Malaysia) account for about 79% of the total, showing marked geographical concentration (subject to the satellite data limitations noted above).

The majority of observed storage facilities are co-located within the same complex as a refinery or connected to an adjacent refinery via pipeline, confirming that crude oil tanks and refinery equipment are developed as integrated complexes. A strong positive correlation is observed between refining capacity and crude oil storage capacity: higher-capacity refineries tend to have correspondingly larger storage.

Storage facilities that are not connected to a refinery function as crude oil aggregation terminals for export from offshore oil fields (e.g. Malaysia's Bintulu, Sabah, Labuan, and Terengganu terminals; and Indonesia's Santan and Senoro terminals). Notably, Myanmar's Made Island Oil Terminal serves as the origin of the China National Petroleum Corporation-operated Sino-Myanmar Oil Pipeline (771 kilometres), functioning as a transit terminal that ships crude oil to PetroChina refineries in Yunnan Province, China.

There is currently no dedicated crude oil storage facility for stockpiling purposes in ASEAN. In April 2026, Prime Minister Pham Minh Chinh of Viet Nam issued an urgent directive for the construction of a national crude oil stockpile facility in the Nghi Son Economic Zone (Báo Chính Phù, 2026) as part of the stockpiling infrastructure development plan under Decision 861/QD-TTg 2023, while also directing further study of additional storage locations at Dung Quat and Long Son.[3]

2.3. Port access

This section analyses the maximum vessel type calling at each facility in ASEAN based on Kpler port-call data (January–June 2026).

A total of 320 ASEAN sites recorded port-call activity during the observation period. The distribution of maximum vessel type calling at each site is shown in Table 3.3.

[3] Prime Minister's Decision No. 861/QD-TTg dated 18 July 2023 Approving the National Master Plan on Infrastructure for Petroleum Reserves and Supply for the 2021–2030 Period, With a Vision to 2050.

Table 3.3. Distribution of Maximum Vessel Type Calling at Each Site

Max Vessel Type Calling	No. of Sites	Share (%)
ULCC	9	2.8
VLCC	8	2.5
Suezmax	14	4.4
Aframax	54	16.9
Panamax	8	2.5
Product Tanker	160	50.0
Small Tanker	67	20.9
Total	**320**	**100.0**

ULCC = ultra large crude carrier, VLCC = very large crude carrier.

Source: ERIA's compilation based on Kpler Port Call data (January–June 2026) (Kpler, n.d.).

Port calls by very large crude carriers (VLCCs) or larger vessels were confirmed at only 5.3% (17 sites) of all sites. The vast majority of ASEAN facilities are designed for small and medium-sized vessels, confirming that physical infrastructure for large-scale crude oil transport is extremely limited in its distribution.

Aggregating average annual crude import volumes by maximum vessel type (for facilities with observed import activity only), the data reveal a clear staircase pattern in which procurement scale expands step by step with the maximum vessel size that can call (Table 3.4).

Particularly notable is the leap from Suezmax to VLCC (12.9 to 51.6 MMbbl, about fourfold). A strong association is observed between VLCC access and crude procurement scale, reflecting the transport efficiency of VLCCs (around 2 MMbbl per vessel) and the economies of scale in long-distance Middle East–Asia transportation. Facilities capable of receiving VLCCs or ultra large crude carriers (ULCCs) are best positioned for high-volume, low-cost procurement of Gulf crude, while sub-Suezmax facilities face structural constraints in both procurement volume and source diversity. For stockpiling replenishment operations premised on large-scale extra-regional procurement, VLCC access constitutes a physical advantage.

Table 3.4. Average Annual Crude Import by Maximum Vessel Type

Max Vessel Type Calling	No. of Importing Facilities	Average Annual Crude Import (MMbbl)
Small Tanker / Product Tanker	18	0.9
Panamax	2	4.2
Aframax	11	7.4
Suezmax	12	12.9
VLCC	7	51.6
ULCC	9	88.2

MMbbl = million barrels, ULCC = ultra large crude carrier, VLCC = very large crude carrier.

Source: ERIA's compilation based on Kpler data (June 2025–June 2026) (Kpler, n.d.).

Based on port-call data for Southeast Asia in the first half of 2026, VLCCs and ULCCs account for only 24.7% of the crude import call count yet carry 48.8% of the import volume (Table 3.5). The average volume per call is about 2.6 times that of Aframax vessels (VLCC: 990 kbbl vs Aframax: 385 kbbl). Aframax vessels make the most calls by count (41.1%), confirming that facilities without VLCC access face structural constraints in scale and procurement efficiency.

VLCCs and ULCCs are entirely absent from refined product exports, where small tankers and product tankers account for over 96% of the call count and over 69% of volume. The complete separation of vessel types between procurement (crude imports) and distribution (refined product exports) empirically confirms that VLCC-capable facilities possess a logistics structure that specialises in large crude oil imports.

For drawdown operations, this vessel-type separation also has important implications. A model that processes stockpiled crude oil at nearby refineries and distributes it as refined products is constrained by refinery throughput, with product transport handled by small and medium-sized vessels (small tankers and product tankers). For intra-ASEAN crude transfers, Aframax/Suezmax vessels are realistic options given intra-ASEAN sailing distances.

Table 3.5. Vessel Type Distribution by Trade Direction in Southeast Asia

Maximum size of vessel type	Crude Oil Imports (Call Count Share / Volume Share)	Refined Product Exports (Call Count Share / Volume Share)
VLCC and ULCC	24.7% / 48.8%	0% / 0%
Suezmax and below	75.3% / 51.2%	100% / 100%

ULCC = ultra large crude carrier, VLCC = very large crude carrier.

Source: ERIA's compilation based on Kpler port-call data (January–June 2026) (Kpler, n.d.).

Facilities with confirmed VLCC/ULCC port-call records are shown in Table 3.6. Geographically, Thailand (3 sites), Malaysia (4 sites), and Singapore (3 sites) are the three most concentrated countries, followed by Indonesia (2), Viet Nam (2), Brunei (1), the Philippines (1), and Myanmar (1).

It should be noted that Aster Chemicals and Energy (Singapore, Pulau Bukom) shows no VLCC port call activity in the data for the observation period due to Single Buoy Mooring repair and improvement works underway since early 2023. The company is investing in improvements to the Single Buoy Mooring and pipeline infrastructure off Pulau Bukom, with completion and resumption of direct VLCC calls expected in late 2026.

Table 3.6. Facilities with Confirmed VLCC/ULCC Port Call Records

Country	Facility	Maximum size of vessel type	Crude Storage	Refinery	Note
Brunei	Pulau Muara Besar Refinery	VLCC	√	√	
Indonesia	Balikpapan Refinery	VLCC	√	√	
	Cilacap Refinery	VLCC	√	√	
Malaysia	ATB Oil Terminal	VLCC	—	—	VTTI-operated independent multi-product terminal. Primarily refined products (diesel, fuel oil, etc.). No crude EFRT; no refinery connection.
	Pengerang Deepwater Terminals	VLCC	√	(Pipeline-connected to RAPID Refinery)	No refinery on site. Pipeline-connected to adjacent RAPID Refinery.
	Melaka Refinery	VLCC	√	√	
	RAPID	ULCC	√	√	
Myanmar	Made Island Oil Terminal	ULCC	√	—	No refinery. Origin of Sino-Myanmar Oil Pipeline; transit storage terminal for crude to Yunnan Province, China.
Philippines	Bataan Refinery	ULCC	√	√	
Singapore	ExxonMobil Singapore Refinery	ULCC	√	√	
	Jurong Port Universal Terminal	VLCC	√	—	Independent commercial storage hub.
	Singapore Refining Company (SRC) Refinery	ULCC	√	√	
Thailand	Map Ta Phut	ULCC	√	√	
	Rayong IRPC Refinery	ULCC	√	√	
	Sriracha	ULCC	√	√	
Viet Nam	FPSO Su Tu Den	VLCC	—	—	FPSO vessel moored at offshore oil field. Not connected to onshore infrastructure.
	Nghi Son Refinery	ULCC	√	√	

EFRT = external floating roof tank; FPSO = floating production, storage, and offloading; RAPID = Refinery and Petrochemical Integrated Development; ULCC = ultra large crude carrier; VLCC = very large crude carrier.

Source: ERIA's compilation based on Kpler (n.d.).

2.4. Infrastructure potential assessment results

Additional considerations: reuse of existing tanks

Although they do not meet all three conditions examined in Sections 2.1-2.3 (refinery access, crude oil storage, and VLCC/ULCC access), facilities in Dumai and Balongan in Indonesia have been identified as having potential for the reuse of existing tanks for stockpiling purposes.

Pertamina Hulu Rokan tank farm (Dumai)

The Pertamina Hulu Rokan tank farm in Dumai is a crude oil tank farm located near the Pertamina Refining Unit II Dumai. The farm comprises 16 tanks with a total capacity of 5.1 MMbbl, of which the three tanks listed in Table 3.7 are under consideration as candidates for stockpiling reuse.

Table 3.7. Potentially Available Tanks in Dumai

Tank ID	Design Capacity (bbl)	Operational Capacity (bbl)	Condition
DMT 302	673,780	651,769	Good
DMT 303	674,698	651,209	Minor Deterioration
DMT 304	674,028	650,847	Minor Deterioration

bbl = barrel.

Source: ERIA's compilation based on discussions with stakeholders.

The combined operational capacity of the three tanks is about 1.95 MMbbl. The facility has a four-berth jetty, but faces two current constraints:

- Tank ageing: Repairs are needed, and renovation investment would be a prerequisite for stockpiling use.
- Lack of backloading equipment: The absence of reverse-flow pumping equipment to transfer crude oil from tankers to onshore tanks means the facility currently cannot support discharge operations from vessels.

Pertamina EP Balongan

Balongan is a facility adjacent to the Balongan Refinery. Tank No. 4 (capacity of 300,000 bbl), managed by Pertamina EP, has been identified as a stockpiling reuse candidate, but is in a condition of minor deterioration and would require repair before use.

Summary of locations with infrastructure potential

Based on the infrastructure conditions examined above, 18 locations with infrastructure potential – comprising the 16 facilities meeting all three conditions (refinery access, crude oil storage, and VLCC/ULCC access), together with the two tank-reuse candidates noted above (Dumai and Balongan) – are shown in Table 3.8, offering a reference point for deepening ASEAN's stockpiling co-operation. These locations reflect the infrastructure and other information currently available, and do not prejudge or recommend the establishment of a stockpiling facility at any specific location.

Table 3.8. Summary of Locations with Infrastructure Potential

Country	Area	Installation name
Brunei	Pulau Muara Besar	Pulau Muara Besar Refinery
Indonesia	Balikpapan	Balikpapan Refinery
	Cilacap	Cilacap Refinery
	Dumai	Dumai Refinery
	Balongan	Balongan Refinery
Malaysia	Melaka	Melaka Refinery
	Pengerang	Pengerang Deepwater Terminals
		RAPID Refinery
Philippines	Bataan	Bataan Refinery
Singapore	Pulau Bukom	Pulau Bukom Refinery
	Jurong	ExxonMobil Singapore Refinery
		SRC Refinery
Thailand	Sriracha	Bangchak Sriracha Refinery
		Thai Oil Refinery
	Map Ta Phut	SPRC Refinery
		PTTGC Refinery
	Rayong	IRPC Rayong Refinery
Viet Nam	Nghi Son	Nghi Son Refinery

PTTGC = PTT Global Chemical; RAPID = Refinery and Petrochemical Integrated Development; SPRC = Star Petroleum Refining Company; SRC = Singapore Refining Company.

Note: Installation names are shown solely for identification and do not indicate participation in or endorsement of the initiative.

Source: ERIA's compilation.

3. Trade Flow Assessment

This section provides a descriptive analysis of the structure of current trade flows (import origins and export destinations) for the 18 facilities identified in Section 2.4, based on satellite tracking data.

By mapping the actual trade flows established on a commercial basis, this section clarifies the logistics characteristics (crude procurement composition and geographical distribution of refined product destinations) of each candidate site from actual data. The goal is to provide an objective depiction of the functional role each site could play in the context of stockpiling.

It should be noted that this analysis does not indicate the comparative suitability of specific facilities as stockpiling sites, nor does it guarantee drawdown distribution patterns in the event of an emergency.

3.1. Import origin analysis

This section uses Kpler trade flow data (June 2025–June 2026, 12 months) to analyse the source-country composition of crude oil imports at each facility (Table 3.9).

Table 3.9. Crude Import Volume and Source Composition by Facility

Country	Facility	Import Volume (MMbbl/yr)	Gulf Dependency (%)	Top 3 Source Countries
Brunei	Pulau Muara Besar Refinery	39.6	9.0	Russia (39%) Brunei domestic (29%) Viet Nam (6%)
Indonesia	Balikpapan Refinery	65.1	1.5	Indonesia domestic (28%) Nigeria (28%) Angola (11%)
	Cilacap Refinery	83.0	29.1	Saudi Arabia (29%) Indonesia domestic (28%) Nigeria (16%)
	Balongan Refinery	23.5	0.0	Indonesia domestic (56%) Angola (32%) Gabon (8%)
	Dumai Refinery	7.2	0.0	Indonesia domestic (100%)
Malaysia	Melaka Refinery	90.7	27.3	Malaysia domestic (68%) Saudi Arabia (13%) Saudi-Kuwait NZ (6%)
	Pengerang Deepwater Terminals	12.2	39.7	United States (44%) Saudi Arabia (21%) UAE (14%)
	RAPID Refinery	54.2	54.7	Oman (45%) UAE (26%) Saudi Arabia (22%)
Philippines	Bataan Refinery	47.1	77.7	Saudi Arabia (42%) UAE (22%) Iraq (11%)
Singapore	Pulau Bukom Refinery	56.5	65.7	UAE (28%) Iraq (19%) Qatar (18%)
	ExxonMobil Singapore Refinery	137.1	77.0	UAE (39%) Qatar (17%) Oman (16%)
	SRC Refinery	80.2	85.9	UAE (46%) Saudi Arabia (20%) Qatar (11%)
Thailand	Sriracha (Bangchak + Thai Oil)	133.6	60.6	UAE (42%) Saudi Arabia (13%) United States (9%)
	Map Ta Phut (Star Petroleum Refining + PTT Global Chemical)	90.3	45.1	UAE (40%) United States (16%) Thailand domestic (10%)
	IRPC Rayong Refinery	64.6	67.5	Saudi Arabia (38%) United States (26%) UAE (17%)
Viet Nam	Nghi Son Refinery	77.3	90.2	Kuwait (83%) Oman (5%) UAE (5%)

MMbbl/yr = million barrels per year, NZ = neutral zone, PTTGC = PTT Global Chemical; RAPID = Refinery and Petrochemical Integrated Development, SPRC = Star Petroleum Refining Company; SRC = Singapore Refining Company, UAE = United Arab Emirates.

Note: Gulf dependency comprises the sum of shares from Saudi Arabia, the UAE, Kuwait, Iraq, Qatar, Bahrain, and the Saudi-Kuwaiti Neutral Zone.

Source: ERIA's compilation based on Kpler data (June 2025–June 2026) (Kpler, n.d.). Data for Thailand's Sriracha zone (Bangchak Sriracha + Thai Oil) and Map Ta Phut zone (Star Petroleum Refining Company + PTT Global Chemical) are aggregated at the zone level due to data availability.

Three distinctly different supply composition patterns are observed across the facilities under study.

(1) High Gulf dependency (Gulf share > 70%)

Nghi Son Refinery (90%), Singapore Refining Company (SRC) Refinery (86%), Bataan Refinery (78%), and ExxonMobil Singapore Refinery (77%) fall into this category. All of these facilities are highly exposed to Gulf-origin crude oil passing through the Strait of Hormuz, and face significant supply disruption risk under a Hormuz closure scenario.

Nghi Son Refinery is particularly notable: Kuwaiti crude oil alone accounts for 83% of total crude imports, representing the highest single-source concentration amongst all facilities analysed. This extreme supplier concentration makes securing alternative procurement sources an especially urgent priority in the event of disruption.

(2) Mid-range Gulf dependency (Gulf share 30%–70%)

IRPC Rayong (68%), Pulau Bukom (66%), Sriracha (61%), Refinery and Petrochemical Integrated Development (RAPID) Refinery (55%), Map Ta Phut area (45%), and Pengerang Deepwater Terminals (40%) fall into this category. While Gulf-origin crude oil remains significant, these facilities source a meaningful share from non-Gulf suppliers. They are not immune to Hormuz disruption risks, but their diversified procurement base provides greater flexibility to shift towards alternative supply sources than the high-dependency group.

(3) Low Gulf dependency / diversified (Gulf share < 30%)

Balikpapan (2%), Balongan (0%), Pertamina Dumai (0%), and Cilacap (29%) in Indonesia; Melaka (27%) in Malaysia; and Hengyi (9%) in Brunei exhibit relatively high resilience against Gulf supply disruptions.

Balikpapan draws primarily on domestic Indonesian crude (28%) and Atlantic Basin supplies including Nigeria (28%), Angola (11%), and Brazil (11%), resulting in minimal Gulf exposure. Balongan and Dumai source the majority of their crude oil domestically and demonstrate comparatively strong resilience to near-term Gulf supply shocks.

Melaka Refinery also maintains a low Gulf share of 27%, with domestic Malaysian crude comprising the majority (68%) of its supply mix. However, this low dependency reflects structural reliance on upstream production within the PETRONAS integrated system rather than active supply diversification, which distinguishes it from the Indonesian facilities.

Brunei's Hengyi Refinery adopts a blend centred on Russian crude (39%) and domestic Bruneian supply (29%), supplemented by neighbouring Southeast Asian origins (Viet Nam 6%), resulting in low Gulf exposure amongst all facilities analysed. It should be noted, however, that energy supply risk from Russia differs in nature from Gulf disruption risk – it is driven by geopolitical developments and supplier-country policy dynamics and warrants separate consideration.

3.2. Export destination analysis

This section uses Kpler trade flow data (June 2025–June 2026, 12 months) to analyse the destination-country composition of petroleum product exports (all product categories) from each facility, including domestic (same-country) deliveries.

Table 3.10. Export Volume and Destination Composition by Facility

Country	Facility	Export Vol. (MMbbl/yr)	Domestic (%)	Intra-ASEAN (%)	Extra-ASEAN (%)	Top 2 Destinations
Brunei	Pulau Muara Besar Refinery	40.8	0.0	43.4	56.6	Australia (51%) Singapore (29%)
Indonesia	Balikpapan Refinery	54.3	83.1	16.8	0.1	Indonesia (83%) Singapore (9%)
	Cilacap Refinery	43.4	96.3	3.7	0.0	Indonesia (96%) Singapore (3%)
	Balongan Refinery	4.6	57.6	42.4	0.0	Indonesia (58%) Malaysia (33%)
	Dumai Refinery	15.7	97.0	2.7	0.3	Indonesia (97%) Singapore (1%)
Malaysia	Melaka Refinery	43.3	61.6	12.0	26.4	Malaysia (62%) Australia (21%)
	Pengerang Deepwater Terminals	108.0	14.5	51.0	34.5	Indonesia (32%) Malaysia (15%)
	RAPID Refinery	34.3	49.2	34.3	16.5	Malaysia (49%) Singapore (29%)
Philippines	Bataan Refinery	10.1	97.7	2.3	0.0	Philippines (98%) Malaysia (2%)
Singapore	Pulau Bukom Refinery	41.7	30.9	40.4	28.6	Singapore (31%) Viet Nam (16%)
	ExxonMobil Singapore Refinery	87.7	34.5	24.8	40.6	Singapore (35%) Australia (15%)
	SRC Refinery	58.2	42.4	41.4	16.2	Singapore (42%) Malaysia (15%)
Thailand	Bangchak Sriracha Refinery	8.5	46.6	47.9	5.5	Thailand (47%) Malaysia (28%)
	Thai Oil	11.3	11.7	81.4	6.8	Singapore (57%) Malaysia (17%)
	Map Ta Phut (Star Petroleum Refining + PTT Global Chemical)	22.9	28.4	63.0	8.6	Singapore (35%) Thailand (28%)
	IRPC Rayong Refinery	18.4	57.5	27.9	14.6	Thailand (58%) Viet Nam (10%)
Viet Nam	Nghi Son Refinery	38.4	93.6	6.0	0.4	Viet Nam (94%) Malaysia (4%)

ASEAN = Association of Southeast Asian Nations, MMbbl/yr = million barrels per year, PTTGC = PTT Global Chemical; RAPID = Refinery and Petrochemical Integrated Development, SPRC = Star Petroleum Refining Company; SRC = Singapore Refining Company.

Notes: Domestic = deliveries to own country. Intra-ASEAN = ASEAN Member States other than own country. Extra-ASEAN = outside ASEAN. Export data include some scheduled cargoes, treated here as realised within the analysis period.

Source: ERIA's compilation based on Kpler data (June 2025–June 2026) (Kpler, n.d.).

Based on the geographical distribution of export destinations in Table 3.10, facilities are organised into three types.

(1) Domestic dominant (domestic share > 50%)

Eight facilities – Cilacap (96%), Pertamina Dumai (97%), Bataan (98%), Nghi Son (94%), Balikpapan (83%), Balongan (58%), IRPC Rayong (58%), and Melaka (62%) – supply the large majority of their refined output to their respective domestic markets. These facilities function as critical infrastructure for national energy security, and their capacity to redirect product flows to neighbouring countries within the region is limited under normal operating conditions.

(2) Intra-regional hub (domestic share ≤ 50%, intra-ASEAN share > extra-regional share)

Seven facilities fall into this category: Thai Oil (intra-ASEAN share 81%), Map Ta Phut area (63%), Sriracha (48%), Pengerang Deepwater Terminals (51%), SRC (41%), Pulau Bukom (40%), and RAPID (34%). These facilities maintain established product flows to multiple AMS and play a meaningful role in the regional distribution of refined products. Their existing logistics track record provides a reference point for assessing the feasibility of intra-regional reallocation in emergency scenarios.

Thai Oil is particularly notable, with 57% of exports directed to Singapore and 17% to Malaysia, effectively functioning as a refined product supply hub for the ASEAN region. Pengerang Deepwater Terminals records the largest export volume amongst all facilities, estimated at 108 MMbbl/year, with a broad distribution footprint spanning Indonesia (32%), Malaysia (15%), Australia (14%), Japan (9%), Viet Nam (5%), and the Philippines (5%).

(3) Extra-regional hub (domestic share ≤ 50%, intra-ASEAN share < extra-regional share)

ExxonMobil Singapore Refinery (extra-regional share 41%) and Hengyi Refinery (57%) are characterised by a relatively high proportion of exports destined outside ASEAN. ExxonMobil Singapore Refinery maintains a well-established supply chain across Oceania – including Australia, New Zealand, Fiji, Papua New Guinea, and Solomon Islands – and functions primarily as a long-haul export hub for refined products. Hengyi Refinery ships virtually no product to its home market (Brunei) and operates as a pure export refinery, with Australia (51%) and Singapore (29%) as its principal destination markets.

4. Institutional Landscape

This section maps the 'soft factors' influencing the feasibility of stockpiling co-operation, complementing the physical infrastructure and trade flow characteristics analysed in Sections 2 and 3. Specifically, it covers the operator structures of each facility (Section 4.1) and an overview of each country's regulatory framework for oil stockpiling (Section 4.2).

4.1. Operating structure

Understanding who operates and controls each facility matters because it shapes the likely negotiation pathway, suitable business model, and governance structure for a stockpiling scheme. The operators and ownership structures of the 18 facilities identified in Section 2.4 are shown in Table 3.11. Based on this analysis, three distinct patterns are observed as follows.

(1) Government affiliated (national oil companies and state affiliated)

This category includes Pertamina's directly operated facilities in Indonesia (Balikpapan, Cilacap, Dumai, and Balongan); PETRONAS's directly operated facilities in Malaysia (Melaka and RAPID); PTT-affiliated listed companies in Thailand (Thai Oil, PTT Global Chemical, and IRPC); and the Bangchak Corporation-affiliated facility (Sriracha). Government policy priorities are reflected in facility operations either directly or indirectly, making government-to-government negotiations the primary channel for stockpiling participation.

The three PTT-affiliated companies are listed entities in which PTT holds effective controlling interests, while Bangchak Corporation qualifies as a broadly defined government-affiliated enterprise, with government-linked shareholders – including the Vayupak Fund, the Social Security Office, and the Ministry of Finance – amongst its principal investors. All facilities in this category share a common characteristic: government policy has a meaningful influence over major strategic decisions.

(2) Private led

ExxonMobil Singapore (100%), SRC (Chevron/PetroChina), Pulau Bukom (Chandra Asri/Glencore), Bataan (Petron/San Miguel), and Pengerang Deepwater Terminals (Dialog/Vopak) are facilities led by entities that make decisions on a commercial basis. Participation in stockpiling schemes will require the design of a financially viable framework, such as fee-based storage contracts or ticket stockpiling arrangements. Pengerang Deepwater Terminals is an independent commercial tank terminal whose core business is the provision of storage services.

(3) Mixed

Nghi Son (Kuwait Petroleum International, Petrovietnam, Idemitsu Kosan, and Mitsui); Star Petroleum Refining (Chevron and Thai investors); and Hengyi PMB (Hengyi Group and Brunei government-affiliated interests) are facilities in which different types of shareholders – national and international oil companies and private entities – co-invest. Decision-making requires consensus amongst multiple shareholders, making the negotiating structure comparatively complex.

Table 3.11. Operator and Ownership Structure by Facility

Country	Facility	Operating Company	Ownership Structure	Operator Type
Brunei	Pulau Muara Besar Refinery	Hengyi Industries Sdn Bhd	Zhejiang Hengyi Group 70% Damai Holdings (Brunei govt-affiliated) 30%	Mixed

Country	Facility	Operating Company	Ownership Structure	Operator Type
Indonesia	Balikpapan Refinery	PT Kilang Pertamina Balikpapan	Pertamina 100%	Government affiliated (NOC)
	Cilacap Refinery	PT Kilang Pertamina Internasional	Pertamina 100%	Government affiliated (NOC)
	Dumai Refinery	PT Kilang Pertamina Internasional	Pertamina 100%	Government affiliated (NOC)
	Balongan Refinery	PT Kilang Pertamina Internasional	Pertamina 100%	Government affiliated (NOC)
Malaysia	Melaka Refinery	Malaysian Refining Company Sdn Bhd	PETRONAS 100%	Government affiliated (NOC)
	Pengerang Deepwater Terminals	Pengerang Independent Terminals Sdn Bhd (Phase 1); Pengerang Terminals (Two) Sdn Bhd (Phase 2/3A)	Phase 1: Dialog Group 46%, Royal Vopak 44%; Phase 2/3A: PETRONAS 40%, Dialog Group 25%, Royal Vopak 25%	Private-led (independent commercial terminal)
	RAPID Refinery	PRefChem	PETRONAS 100% (Saudi Aramco fully divested its 50% stake in 2026)	Government affiliated (NOC)
Philippines	Bataan Refinery	Petron Corporation	San Miguel Corporation 68.26%	Private led
Singapore	Pulau Bukom Refinery	Aster Chemicals and Energy Pte Ltd	Chandra Asri (Indonesia) 80% / Glencore 20%	Private led
	ExxonMobil Singapore Refinery	ExxonMobil Asia Pacific Pte Ltd	ExxonMobil 100%	Private led
	SRC Refinery	Singapore Refining Company Pte Ltd	Chevron Singapore 50% PetroChina 50% (Chevron stake agreed to be sold to ENEOS; announced in May 2026, close expected in 2027)	Private led
Thailand	Bangchak Sriracha Refinery	Bangchak Sriracha Public Company Limited (BSRC; delisted December 2025)	Bangchak Corporation 99.72%	Government affiliated
	Thai Oil Refinery	Thai Oil Public Company Limited	PTT Public Company Limited 45.03%	Government affiliated
	SPRC Refinery	Star Petroleum Refining Public Company Limited	Chevron 61%	Mixed
	PTTGC Refinery	PTT Global Chemical Public Company Limited	PTT Public Company Limited 48.18%	Government affiliated
	IRPC Rayong Refinery	IRPC Public Company Limited	PTT Public Company Limited 45.05%	Government affiliated
Viet Nam	Nghi Son Refinery	Nghi Son Refinery and Petrochemical LLC	Idemitsu Kosan 35.1% Kuwait Petroleum International 35.1% Petrovietnam 25.1% Mitsui Chemicals 4.7%	Mixed

NOC = national oil company, PRefChem = Pengerang Refining and Petrochemical, PTTGC = PTT Global Chemical; RAPID = Refinery and Petrochemical Integrated Development, SPRC = Star Petroleum Refining Company; SRC = Singapore Refining Company.

Source: ERIA's compilation based on publicly available corporate information and desktop research.

4.2. Regulatory framework

Oil stockpiling regimes in ASEAN (Table 3.12) vary across countries in the stage of legal development and level of obligation. Brunei, Thailand, the Philippines, and Viet Nam each have statutory reserve or inventory obligations, several reinforced by recent emergency measures or quantified expansion targets. Indonesia has operationalised its National Energy Reserve framework through a 2024 presidential regulation, though physical infrastructure remains at an early stage.[4] Malaysia and Singapore currently have no statutory strategic reserve obligation and rely on commercial inventory.

No AMS currently operates a dedicated government-owned crude oil strategic reserve facility. Existing frameworks instead fall into either minimum inventory obligations held within private industry's own facilities, or legislated national reserve targets whose underlying infrastructure remains under construction or consideration. No country currently has a statutory strategic reserve system meeting International Energy Agency (IEA) criteria (90 days), and none has completed institutional development towards that level. This reality implies that each participating country would need to enact or amend domestic legislation as a prerequisite for stockpiling participation, while also indicating that scope remains for designing a flexible intra-regional framework unconstrained by existing domestic regimes – a graduated approach aligned with each country's institutional readiness may be the most realistic path forward.

The state of legal and institutional development is a component of the ecosystem assessment on a par with infrastructure and trade flow analysis, and this mapping of each country's institutional readiness should inform the design of the framework.

Table 3.12. Overview of Stockpiling Regimes in Major ASEAN Member States

Country	Regime / Legal Basis	Description
Brunei	Yes. Ministry of Energy Directive 1 of 2020	The Ministry of Energy issued Directive No. 1 of 2020 on the Strategic Petroleum Reserve, requiring all crude oil producers and importers/local buyers to maintain a strategic reserve equivalent to a minimum of 50% of their existing storage capacity, held within their own facilities. This reserve may be drawn down as operational stock at any time, provided it is replenished promptly thereafter. Given the limited scale of domestic consumption (Brunei is an oil exporter), the primary focus of the strategic reserve is on domestic supply stability rather than export control. Updated fuel management measures (including restrictions on refuelling foreign vehicles) came into effect in April 2026.
Indonesia	Yes. Oil and Gas Law No. 22/2001 Art. 46; PP 79/2014 (revised as PP 40/2025); Perpres 96/2024	Article 46(3) of the Oil and Gas Law No. 22 of 2001 provides the statutory basis for a national fuel reserve, and PP 79/2014 (revised as PP 40/2025) establishes the National Energy Reserve (Cadangan Energi Nasional) framework, comprising strategic reserves, energy buffer reserves, and operational reserves. Presidential Regulation No. 96/2024 operationalises the Energy Buffer Reserve (Cadangan Penyangga Energi) component with quantified targets for gasoline, LPG, and crude oil through 2035, managed by the National Energy Council (DEN) and the Ministry of Energy and Mineral Resources. Construction of crude oil storage tanks under this framework, including at the Balongan facility, remains under consideration as of July 2026. In the interim, the country continues to rely substantially on Pertamina's commercial operating inventory (about 20 days).

[4] Presidential Regulation No. 96 of 2024 dated 1 September 2024 Regarding Energy Buffer Reserves.

Country	Regime / Legal Basis	Description
Malaysia	None	Under the Petroleum Development Act, 1974, PETRONAS holds comprehensive rights over Malaysia's petroleum resources, but no legislation establishes a mandatory strategic reserve or minimum stockholding obligation for industry. Refining and petrochemicals are overseen by the Ministry of Investment, Trade and Industry, while distribution and anti-leakage enforcement fall under the Ministry of Domestic Trade and Cost of Living (KPDN, formerly MDTCA) under the Control of Supplies Act, 1961. Following the National Energy Council meeting chaired by the Prime Minister in 2026, the Ministry of Economy has begun studying the feasibility, fiscal implications, and governance models for a national strategic petroleum reserve.
Philippines	Yes. RA 8479 (1998); EO 134 (2002); DC 2003-01-001	Executive Order No. 134 (2002), issued under the Downstream Oil Industry Deregulation Act of 1998 (RA 8479), and its implementing Department Circular No. 2003-01-001 establish minimum inventory requirements by the industry segment – 30 days for refiners, 15 days for bulk suppliers, and 7 days for LPG dealers – which function, de facto, as emergency reserves. While a state-owned strategic petroleum reserve is not yet operational, the government has reinforced inventory management following the declaration of a national energy emergency under Executive Order No. 110 in early 2026. Under this order, the Department of Energy has mandated strict and regular reporting on storage capacity and utilisation, driving actual commercial inventories well above statutory minimums. Concurrently, the Department of Energy is progressing plans for a state-backed strategic reserve framework, supported by pending congressional legislation to formally establish a national strategic petroleum reserve.
Singapore	None	Singapore functions as an international refining and trading hub, with refining capacity well in excess of domestic consumption, giving it substantial commercial inventories and refining capacity. However, the bulk of this is oriented towards exports and transit trade and is therefore distinct in character from a national strategic petroleum reserve. Singapore has no statutory strategic reserve obligation and does not disclose official reserve levels. Separately, the Energy Market Authority requires power generation companies to maintain licensed fuel (diesel) reserves as a backstop against gas supply disruption, supplemented by a standby LNG facility that the Energy Market Authority can direct generators to draw upon – though this sector-specific mechanism is narrower in scope than an economy-wide strategic petroleum reserve.
Thailand	Yes. Fuel Trade Act, 2000 Section 7	A ministerial regulation under Section 7 of the Fuel Trade Act, 2000, administered by the Department of Energy Business, imposes a statutory minimum inventory obligation of 1% of petroleum product sales volume (about 25 days) on refiners, importers, and related parties – one of the more clearly institutionalised industry obligations in ASEAN. In response to the escalating Hormuz situation in 2026, the government implemented emergency measures raising the statutory obligation level – applicable to refined petroleum products including gasoline, high-speed diesel, Jet A-1, and LPG – to 1.5% (about 27 days) on 31 March 2026, and to 3% (about 32 days) on 30 April 2026.
Viet Nam	Yes. Decree 95/2021/ ND-CP; Decision No. 861/QD-TTg 2023	Decree 95/2021 provides the statutory basis for minimum inventory obligations on petroleum products, requiring wholesalers and producers with organised distribution systems to maintain a minimum 20-day reserve, and distributors a minimum 5-day reserve, based on the prior year's average daily domestic consumption. Decision No. 861/QD-TTg (2023) established a national plan for oil and gas stockpiling infrastructure development (2021–2030). The plan targets 15–20 days of national crude oil reserve capacity by 2030 (75–80 days' stock in total) and envisages expansion to 25–30 days by 2050 (90 days stock in total). Development of national crude oil stockpiling facilities in the Nghi Son Economic Zone has been designated a priority, leveraging geographical proximity to Nghi Son Refinery.

ASEAN = Association of Southeast Asian Nations, DC = Department Circular, DEN = Dewan Energi Nasional (National Energy Council), EO = executive order, KPDN = Kementerian Perdagangan Dalam Negeri dan Kos Sara Hidup (Ministry of Domestic Trade and Cost of Living), LPG = liquefied petroleum gas, MDTCA = Ministry of Domestic Trade and Consumer Affairs, Perpres = Presidential Regulation, PP = Peraturan Pemerintah (Government Regulation), RA = Republic Act.

Source: ERIA's compilation based on publicly available government information.

5. Conclusion

This chapter has examined the core elements for stockpiling co-operation in ASEAN across three dimensions: the distribution of existing physical infrastructure (Section 2), current trade flow patterns (Section 3), and the institutional landscape (Section 4).The potential positioning of each country in ASEAN regional stockpiling co-operation can be broadly organised into the five types: high Gulf dependence, domestically oriented supply; high Gulf dependence, distribution hub; low Gulf dependence, domestically oriented supply; low Gulf dependence, distribution hub; and limited refining infrastructure. This typology is intended as an illustrative starting point for identifying where co-operation could generate mutual benefit, rather than a fixed assignment of roles – how any individual country ultimately participates would depend on further engagement, negotiation, and its own policy choices.

High Gulf dependence, domestically oriented supply: early stock access needs

Refining capacity in these countries is limited relative to domestic demand for petroleum products, with distribution concentrated on the domestic market. In addition, high Gulf dependence for crude oil means high vulnerability to shocks, giving these countries a high priority both for strengthening national reserves and for securing early access rights to stockpiles. In the context of regional stockpiling co-operation, these countries would have the greatest need for early participation in shared stockpile arrangements.

- Philippines: Bataan Refinery, the country's sole domestic refinery, carries a Gulf crude dependency of 78%, with nearly all crude requirements met through imports. A Hormuz closure would directly threaten both refinery operations and domestic petroleum product supply. Strengthening national strategic reserves, alongside a phased expansion of stockpiling capacity through ticketing schemes and joint stockpiling arrangements with producing countries, represents an important priority.
- Viet Nam: Nghi Son Refinery mainly processes Kuwaiti crude oil, which accounts for 83% of the total crude input. The large majority of refined output is directed to the domestic market, and a Hormuz closure would threaten both refinery operations and domestic petroleum product supply. Domestic crude oil production has also been on a declining trend, reinforcing the urgency of strengthening energy security through stockpile build-up. A national petroleum reserve infrastructure development plan for the Nghi Son area is underway under Decision 861 (2023), and progress on the institutional side has been relatively positive. Leveraging existing equity relationships with producing-country investors to secure joint stockpile arrangements, and establishing early access through ticketing schemes, are amongst the viable options available.

High Gulf dependence, distribution hub: regional hub/host potential

These countries hold relatively large refining capacity compared with domestic demand for petroleum products, and possess a number of facilities that function as hubs supplying not only the domestic market but also destinations both within and beyond ASEAN. At the same time, their dependence on Gulf crude is also high, and the spillover impact on other countries in the event of a shock would be significant. Strengthening stockpiling in these countries would therefore benefit not only their own security but also that of the region as a whole. These countries could be capable of taking on a host/hub function by leveraging their existing infrastructure.

- Malaysia: The country's profile varies considerably by facility. The Pengerang complex (RAPID and Pengerang Deepwater Terminals) exhibits considerable Gulf dependency and a track record of broad product distribution within and beyond ASEAN, placing it in a similar position to Singapore. Melaka, by contrast, is primarily oriented towards domestic supply from national crude oil production. No formal institutional framework for strategic stockpiling exists, but PETRONAS plays a central operational role across most of the country's refining facilities, and there is considerable scope for government involvement in scheme design. Malaysia is positioned to play a range of roles in regional stockpiling co-operation, including as a potential host or hub country.
- Singapore: Singapore operates the largest refining cluster in ASEAN across three facilities – ExxonMobil Singapore, SRC, and Pulau Bukom – and maintains broad distribution capabilities both within and beyond the ASEAN region. However, all three facilities are heavily dependent on Gulf-origin crude, meaning that a Hormuz closure would generate significant disruption effects across the region. Moreover, all facilities are operated by international oil companies or commercial joint ventures, and stockpiling remains on a purely commercial basis. Singapore has the potential to serve as a central hub in ASEAN stockpiling co-operation, but realising this role will require designing commercially viable schemes in close co-ordination with the private sector.
- Thailand: Thailand maintains a moderate level of Gulf dependency, while a large share of its refined product exports flows to ASEAN destinations, giving it an established track record as a regional distribution supplier. State-affiliated enterprises led by the PTT Group are the principal operators, and an institutional framework for industry-level stockpile obligations exists under a ministerial regulation pursuant to the Fuel Trade Act – making Thailand one of the more institutionally prepared countries in ASEAN for government-led stockpiling enhancement. Thailand also holds strategic significance as a potential land bridge hub for the Mekong region, with overland supply routes serving Cambodia, Lao PDR, and Myanmar.

Low Gulf dependence, domestically oriented supply: selective hosting potential

- Indonesia: Pertamina's refining facilities all exhibit low Gulf crude dependency, giving the country relative resilience on the crude procurement side under a Hormuz disruption scenario. However, the large majority of refined output is directed to the domestic market, and Indonesia also relies on product imports from Singapore and Malaysia, meaning that its vulnerability is more likely to materialise as a product import disruption risk than as a crude supply shortage. A legal framework for strategic reserves exists but has not been implemented, and current inventory levels remain low at about 20 days. Building up domestic product stockpiles and establishing complementary emergency procurement arrangements are therefore important priorities. At the same time, there may be scope for Indonesia to play a supplementary host or hub role in regional stockpiling co-operation, for example, by leveraging available tank capacity at facilities such as Dumai.

Low Gulf dependence, distribution hub: supply backstop potential

- Brunei Darussalam: Pulau Muara Besar Refinery has low Gulf crude dependency amongst large-scale refining facilities in ASEAN, at 9%, and maintains an established track record of broad-based exports to Australia and across the ASEAN region. However, the facility's joint venture operating structure (Hengyi Industries) and the high share of extra-regional product flows introduce complexity into any emergency reallocation or sharing arrangement, though its high shock resilience and distribution track record mean it could potentially function as a supply backstop for the region.

Limited refining infrastructure: early product access needs

- Cambodia, Lao PDR, Myanmar, and Timor-Leste: These countries have limited or no domestic refining capacity and are significantly dependent on imports of refined products. The immediate priority is not crude stockpiling but rather securing emergency access to refined products through procurement arrangements – with ticketing schemes representing an important option to explore.

As shown above, the location and degree of vulnerability differ asymmetrically across AMS. Were each country to build up its reserve levels independently without accounting for this asymmetry, the region as a whole could end up with more duplicated investment than necessary. Optimising stockpiling through regional co-operation offers the scope to achieve an equal or higher level of security at a lower cost than what each country could achieve independently.

However, it should be also noted that the analysis presented in this chapter constitutes an initial assessment based on data that are externally observable and accessible at the current time. Further work will be required on operational realities, stakeholder engagement with national governments and facility operators, financing structures, and the design of enabling institutional frameworks.

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Chapter 4

Main Messages, Roadmap, and Recommendations

1. Introduction

The previous chapters discussed the strategic basis for oil stockpiling and examined the economic rationale for various policy options and the supporting infrastructure ecosystem. This chapter discusses the main findings and recommendations.

The 12 main recommendations are as follows:

Recommendation 1	Adopt an effective hybrid and voluntary approach to oil stockpiling.
Recommendation 2	Ensure co-operation is flexible, voluntary, and open to participation.
Recommendation 3	Base the technical foundation of the strategy on the oil infrastructure ecosystem assessment.
Recommendation 4	Foster pilot initiatives and scale them regionally by developing public–private partnerships.
Recommendation 5	Evaluate selection and readiness, and establish a monitoring and evaluation strategy when preparing pilot initiatives.
Recommendation 6	Strengthen institutional co-ordination and develop legal, contractual, and reserve-accounting instruments for pilot initiatives.
Recommendation 7	Assess feasibility, bankability, and risk when developing appropriate financing plans.
Recommendation 8	Support effective implementation by strengthening ties with the private sector, oil-producing countries, and dialogue partners.
Recommendation 9	Establish robust protocols for emergency release, delivery, and replenishment.
Recommendation 10	Monitor performance, evaluate results, and adapt arrangements.
Recommendation 11	Strengthen co-operation on upstream oil exploration and development.
Recommendation 12	Advance practical implementation through voluntary co-operation.

Main messages and recommendations

Recommendation 1: Adopt an effective hybrid and voluntary approach to oil stockpiling

This study (i) assesses the economic viability of various stockpiling scenarios, (ii) evaluates the region's oil infrastructure ecosystem, and (iii) proposes practical policy actions and an implementation roadmap.

The study analyses three case scenarios using a 90-day effective reserve benchmark as a regional planning reference. About 30 days of existing refinery and commercial inventories are assumed to contribute to emergency preparedness, while national-led, balanced, and co-operative approaches are assessed for the remaining 60 days. The results indicate that the co-operative approach provides the strongest economic performance and that joint oil stockpiling can be economically

beneficial. These benefits reflect avoided fuel shortages, lower emergency procurement costs and oil-price volatility, improved supply continuity, reduced inflationary pressure, and greater macroeconomic stability during supply disruptions.

A hybrid approach that combines existing refinery and commercial inventories, national stockpiling, ticket stockpiling, and joint stockpiling in a flexible manner will be central to an effective ASEAN oil stockpiling strategy.

The region shares external supply routes and integrated trade and logistics networks, while refinery and storage assets are unevenly distributed. Co-ordinated access, emergency logistics, and release arrangements can reduce competition for scarce cargoes and prevent a national disruption from cascading across the region. They can also give countries with limited domestic infrastructure access to storage and refinery capacity elsewhere in the region, thereby improving effective reserve coverage while reducing the costs of duplicating infrastructure.

Oil stockpiling should not be framed as a choice between national and joint reserves. ASEAN should instead advance a pragmatic, voluntary, and flexible hybrid co-operative approach. It should not impose a single model on all ASEAN Member States (AMS); rather, it should guide further technical work, including feasibility studies, location consultations, and the assessment of financing and cost-sharing options.

Recommendation 2: Ensure co-operation is flexible, voluntary, and open to participation

Interested and ready AMS should be able to begin with small arrangements, while maintaining an open pathway for other AMS to join later. No country should be required to adopt the same reserve composition, host stocks, or rely on stocks located abroad. Participation should respect national law, sovereignty, fiscal capacity, infrastructure readiness, commercial confidentiality, and strategic priorities. Each arrangement should proceed only when the participating governments and counterparties are satisfied with its technical, legal, financial, and operational conditions. Co-operation should be supported by location consultations.

Recommendation 3: Base the technical foundation of the strategy on the oil infrastructure ecosystem assessment

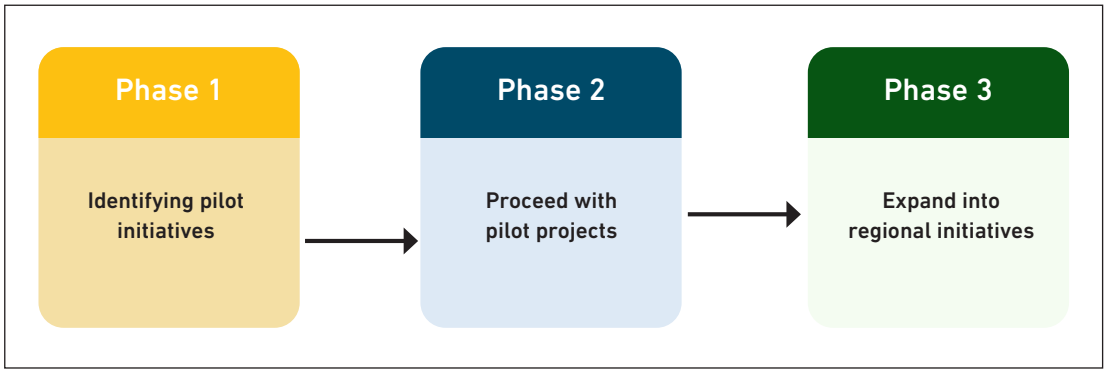
The oil infrastructure ecosystem assessment can help identify the conditions that make a location potentially suitable for stockpiling co-operation, including refinery access, crude oil storage capacity, ports capable of handling very large crude carriers (VLCCs) and ultra large crude carriers (ULCCs), terminal infrastructure, logistics connectivity, emergency dispatch capability, operator readiness, regulatory preparedness, commercial feasibility, and potential for expansion.

The results show that ASEAN's refining, storage, and large-vessel port capacity is concentrated in several major refining and logistics economies, while smaller and more import-dependent countries may have limited ability to develop large national reserves at a reasonable cost. This reinforces the need for a regional approach based on shared facilities, ticketing, joint stockpiling, and negotiated access arrangements.

Recommendation 4: Foster pilot initiatives and scale them regionally by developing public–private partnerships

Pilot preparation should begin amongst interested and ready AMS. Then, building on the experience gained, ASEAN can explore regional reserve hubs where technically, commercially, and politically feasible, taking account of the oil infrastructure ecosystem assessments of the countries involved. ASEAN co-operation on oil stockpiling could progress through several stages: identifying pilots, developing projects through discussion between the public and private sectors, assessing readiness, monitoring and evaluating projects, and incorporating the lessons into possible regional expansion (Figure 4.1).

Figure 4.1. Approach from Pilot Initiatives to Regional Expansion



Source: ERIA.

In the first phase, interested and prepared AMS could scope a limited number of practical pilot opportunities that respond to clearly defined energy-security and resilience needs (see Recommendation 5 for details).

In the second phase, participating AMS could structure an appropriate public-private partnership where private participation can improve operational capability, financing efficiency, or risk allocation. Governments should define the public objective and regulatory treatment, while commercial and operational counterparties help design feasible ownership, service, financing, and delivery arrangements. Proposed pilots should then undergo pilot-specific feasibility assessment and due diligence. The parties should confirm the stock type and quality, volume, location, ownership and custody, access rights, financing, legal and regulatory treatment, commercial terms, release and delivery pathways, replenishment, data protection, and measurable success criteria. Once readiness is confirmed and the necessary instruments are approved, each pilot should conduct an end-to-end simulation or controlled operational exercise covering the emergency request, authorisation, verification, pricing, release, terminal throughput, cross-border movement, delivery, replenishment, and deactivation. The subsequent evaluation should identify effective elements, unresolved weaknesses, corrective actions, and whether the arrangement should be discontinued, revised, repeated, continued, or expanded.

In the third phase, successful models may be adopted voluntarily by other groups of interested AMS and counterparties. Expansion could rely on demonstrated experience and adaptable model instruments. Compatible arrangements may gradually improve interoperability in stock verification, emergency communication, release procedures, logistics, and monitoring, while preserving national sovereignty and avoiding a mandatory centralised regional reserve.

Recommendation 5: Evaluate selection and readiness, and establish a monitoring and evaluation strategy when preparing pilot initiatives

Proposed pilot initiatives should have a clearly defined resilience purpose, and their documentation should identify the host and user participants, stock owner, operator, logistics provider, verifier, and other necessary counterparties. The participating parties should prepare a pilot-specific feasibility and incremental-cost assessment. A viable pilot should be a controlled arrangement capable of testing end-to-end emergency access, release, transport, and delivery. Measurable success criteria should be agreed before the pilot begins. Assessment should cover verified accessible volume, authorisation and release time, terminal throughput, customs and cross-border clearance, delivery time and delivered volume, stock-quality compliance, safety, data reliability, payment readiness, and replenishment. The participating parties should prepare a pilot-specific feasibility and incremental assessment to monitor and evaluate the pilot based on these criteria.

Recommendation 6: Strengthen institutional co-ordination and develop legal, contractual, and reserve-accounting instruments for pilot initiatives

Legal and regulatory preparation will be essential in several areas, such as rules on reserve access, ownership, custody, stock rotation, emergency release, allocation, replenishment, liability, customs and taxation, data protection, confidentiality, and dispute resolution (Table 4.1).

Interested AMS may prepare non-binding models to help governments and the private sector negotiate efficiently. These instruments should be adaptable to domestic law and transaction-specific requirements and developed with relevant government agencies, customs and tax authorities, legal experts, operators, oil companies, financiers, and insurers.

Table 4.1. Key Legal, Contractual, and Reserve-Accounting Considerations for Regional Oil Stockpiling Pilots

Instrument area	Key issues
Reserve access and authorisation	Eligible users, emergency triggers, decision authority, release sequence, allocation, and delivery obligations
Ownership and storage rights	Title to stocks, capacity reservation, custody, quality specifications, substitution, and operational responsibilities
Rotation and replenishment	Quality maintenance, replacement of aged stocks, losses, timing, volume, price, and responsibility after withdrawal
Customs, taxation, and cross-border movement	Bonded storage, duties and taxes, documentation, emergency exemptions, and transit procedures
Liability, insurance, and dispute resolution	Accidents, contamination, delay, force majeure, governing law, arbitration, mediation, and enforcement
Stock data and reserve accounting	Eligible stock categories, verification, non-duplication, ticket and joint-stock allocation, drawdown reporting, and replenishment status
Confidentiality and cybersecurity	Protection, access controls, aggregation, retention, audit, and secure information exchange

Source: ERIA.

National rules concerning emergency powers, mandatory industry stocks, government access to commercial inventories, cross-border stockholding, ownership and custody, customs and taxation, data protection, foreign participation, and replenishment are important elements that should be respected in legal instrument design. Pilot-specific legal due diligence should focus on the participating host and user countries and the proposed transaction structure.

A simple confidential reporting template should be tested during the pilot stage. It should provide sufficient assurance that stocks exist, are not double counted, and can be released and delivered, while protecting commercially sensitive and national security information. Over time, participating AMS may develop secure monitoring arrangements for reserve status, drawdowns, replenishment, and emergency co-ordination.

Recommendation 7: Assess feasibility, bankability, and risk when developing appropriate financing plans

ASEAN should mobilise a combination of public financing, public-private partnerships, shared financing amongst participating countries, ticketing fees, producer-consumer arrangements, development finance, blended finance, export credit support, commercial storage operators, and reserve service contracts. Public budgets alone are unlikely to support the full cost of regional stockpiling.

Financing and cost-sharing responsibilities should be discussed based on reserve options, site screening, and pilot design. Strategic stockpiling may require capital for inventory, construction or capacity reservation, terminals, safety and security systems, operation and maintenance, insurance, rotation, monitoring, emergency release, transport, and replenishment. Responsibilities should be allocated based on ownership, access rights, benefits, and operational control. The participating AMS and counterparties should compare feasible financing options, including public or state-owned enterprise financing, transparent ticket or reserve-service fees, public–private partnerships, shared participant financing, producer-owned stocks, guarantees and credit enhancement, development finance, export credit, and commercial lending. Bankability requires credible counterparties, predictable revenue or payment commitments, enforceable emergency access rights, clear risk allocation, and manageable currency, interest-rate, commodity-price, construction, operational, and demand risks.

Interested AMS may consider various financing and cost-sharing options, as shown in Table 4.2. Public resources may support sovereign oil stocks, strategic infrastructure, guarantees, or targeted risk reduction. Private capital may be mobilised where projects have credible revenue streams, long-term contracts, bankable risk allocation, and predictable rules. Development finance and export credit may support enabling infrastructure, logistics, safety systems, and digital monitoring, subject to the mandates and appraisal requirements of the relevant institutions.

Table 4.2. Financing and cost-sharing options

Option	Application	Key design consideration
National public or state-owned enterprise financing	National strategic stocks and infrastructure where sovereign control is prioritised	Phase commitments and establish transparent cost recovery and fiscal safeguards
Public–private partnership	Storage terminals, logistics assets, and monitoring platforms	Use competitive procurement, performance standards, and clear tariff and termination rules
Ticketing or reserve-service fees	Contractual access to stocks or capacity without full public ownership	Verify stocks and counterparties; specify release, delivery, substitution, and payment terms
Shared participant financing	Joint facilities or pilot arrangements	Allocate costs according to reserved capacity, access rights, risk, and benefits
Producer-consumer arrangement	Exporter- or supplier-owned crude or products stored near ASEAN markets	Define ownership, fees, emergency access, stock rotation, replenishment, and geopolitical risk
Development or blended finance	Enabling infrastructure, resilience systems, and early-stage risk reduction	Link support to bankability, resilience outcomes, safeguards, and additionality
Export credit or commercial lending	Equipment, tank farms, terminals, port systems, and bankable service projects	Manage interest-rate, currency, credit, construction, and demand risks

ASEAN = Association of Southeast Asian Nations.

Source: ERIA.

Cost sharing should be transparent and linked to benefits and responsibilities. Host countries or operators should be compensated for facilities, capacity, operations, security, land, and regulatory services. User countries should pay the agreed reservation or access fees and normally bear the commodity value, incremental handling, transport, customs, and replenishment costs associated with their drawdown, unless contracts provide otherwise. Financing documents should be fully aligned with emergency access, pricing, release, delivery, and replenishment instruments.

The financing plan should avoid double payment for the same service and should remain fully aligned with the pilot's access, pricing, release, delivery, replenishment, and termination provisions. Smaller or fiscally constrained AMS should be able to consider phased participation or lower-capital contractual arrangements where these provide credible and deliverable emergency access.

Recommendation 8: Support effective implementation by strengthening ties with the private sector, oil-producing countries, and dialogue partners

Much of ASEAN's storage, refining, shipping, trading, insurance, financing, stock rotation, and logistics capacity is commercially owned or operated. Early and structured engagement with national oil companies, international suppliers, terminal and refinery operators, logistics firms, banks, insurers, technology providers, and commodity traders is therefore necessary to identify realistic opportunities and test operational feasibility and bankability. Early market engagement can identify underutilised tanks, available port and terminal capacity, potential host-user partnerships, and commercially realistic pilot structures. At the regional level, participating AMS could also explore practical collaboration with dialogue partners to support technical assistance and financing such as the Partnership on Wide Energy and Resources Resilience Asia (POWERR Asia).

Governments should define the public objective, safeguards on access, regulatory treatment, and any justified risk sharing, while industry participants contribute commercial, financing, and operational expertise. Public–private partnerships should be structured transparently and competitively procured (where appropriate), with partner selection subject to safety, security, environmental, performance, transparency, and confidentiality requirements.

Recommendation 9: Establish robust protocols for emergency release, delivery, and replenishment

Participating AMS and counterparties should develop a clear and testable protocol covering the full chain from an emergency request to final delivery, replenishment, and deactivation. As participation in a pilot is voluntary, the protocol should be consistent with relevant national procedures, laws, and pilot contracts, and it should distinguish policy and release decisions from commercial and physical execution. The suggested protocol comprises the following steps:

1. **Identify a situation where assistance is required and provide a detailed request.** The participating country could assess the supply shortfall, apply relevant national demand-management measures, and submit a time-stamped request through the applicable national channels. The request could specify the petroleum type and quality, volume, destination, urgency, and delivery window.
2. **Conduct stock verification and release authorisation.** Host and user authorities, stock owners, terminal operators, and an agreed verifier should confirm that the stock is physically available, legally accessible, and compatible with the receiving market. If these conditions are met, the approval process could identify the allocation, applicable export and import requirements, and release sequence. Each arrangement should follow a predetermined sequence, although the details may vary according to the delivery time, proximity, quality, refinery compatibility, contractual priority, cost, and nature of the disruption.
3. **Confirm commercial details and arrange physical dispatch.** Contracting parties could apply pre-agreed pricing, currency, tax, fee, and payment security terms so that negotiation during an emergency does not delay delivery. Once authorisation and payment conditions are confirmed, appointed operators could choose the tank, terminal slot, carrier, loading rate, route, customs documentation, and contingency arrangements. Receiving authorities and operators could facilitate the entry, unloading, reconciliation, refinery intake or substitution, and domestic distribution.
4. **Undertake replenishment, deactivation, and review.** The pilot contract could identify who will restore the released volume, the required quality, the replenishment deadline, the applicable cost and priority rules, and the treatment of losses. Relevant ASEAN bodies and requested technical organisations could contribute to an after-action review within their respective mandates.

The pilot should also test force majeure provisions applicable to both ticketing and joint stockpiling arrangements, covering exceptional events that could prevent access to, release of, or delivery of stocks, together with requirements for notification, mitigation, alternative delivery locations or substitution arrangements, and the allocation of risks and liabilities. Importantly, the supply emergency that triggers activation of the arrangement should not constitute a force majeure event, since the purpose of both mechanisms is precisely to provide access to oil during such disruptions. Force majeure should instead address separate circumstances that make the agreed stock inaccessible or delivery impracticable and should trigger appropriate contractual remedies, including alternative delivery, substitution, or other agreed contingency measures.

Effective information sharing is essential throughout the process. Participating AMS should agree on all key information, such as stock category, owner, eligible user, location, volume, quality, custody, availability, reservation status, release decision, dispatch, delivery, and replenishment. Reporting should use controlled access, aggregation where appropriate, audit trails, retention rules, cybersecurity safeguards, and confidentiality obligations. Only information necessary for verification and co-ordination should be shared, and no stock volume should be counted twice.

The complete protocol should be tested through tabletop simulations and controlled end-to-end exercises (see Table 4B.1). Any unresolved critical failure should lead to corrective action and retesting before the pilot progresses or is proposed for voluntary replication.

Recommendation 10: Monitor performance, evaluate results, and adapt arrangements

Participating AMS should establish a proportionate monitoring and evaluation process for pilot initiatives. The process should identify reporting schedules, verification requirements, and performance indicators. Monitoring should focus on operational readiness and deliverability rather than on the number of meetings, studies, or consultations completed.

Following each simulation, operational exercise, or actual release, the participating AMS could conduct a joint evaluation with relevant operators and counterparties. The evaluation could compare actual performance with agreed readiness and success criteria; identify operational, contractual, financial, or institutional weaknesses; and determine corrective actions and retesting requirements.

Based on the evidence, participating AMS could decide whether to discontinue, revise, repeat, continue, expand, or voluntarily replicate the arrangement. Any subsequent arrangement should be approved separately and should define its own participants, stock type and volume, financing, access rights, responsibilities, performance thresholds, and review procedures.

Each arrangement should also be reviewed periodically and when material conditions change, including oil demand, trade and supply routes, infrastructure availability, market structure, financing conditions, technology, climate and disaster risks, or geopolitical exposure. The review should determine whether the arrangement remains technically feasible, economically reasonable, legally enforceable, and operationally reliable.

Recommendation 11: Strengthen co-operation on upstream oil exploration and development

Interested AMS may consider strengthening regional collaboration on upstream oil exploration and development as a complementary pillar of long-term energy security. While strategic stockpiling strengthens preparedness for short-term supply disruptions, the discovery and responsible development of additional regional oil resources could enhance indigenous supply, diversify sources, and reduce exposure to external supply shocks over the longer term.

Areas of co-operation could include joint geological and seismic studies, exchange of technical and resource data, co-ordinated exploration of prospective and cross-border petroleum basins, investment facilitation, and greater participation of AMS national oil companies and private sector partners. Where commercially and technically viable, joint or co-ordinated upstream activities could help unlock under-explored resources, share exploration risks and costs, strengthen regional technical capabilities, and improve the resilience of ASEAN's petroleum supply system.

Such co-operation should remain voluntary, commercially driven, consistent with national sovereignty and applicable laws, and aligned with ASEAN's broader energy-security and energy-transition priorities. Upstream collaboration should therefore complement, not substitute, strategic stockpiling, demand-side preparedness, supply diversification, and emergency response arrangements.

Recommendation 12: Advance practical implementation through voluntary co-operation.

Implementation of the ASEAN oil stockpiling strategy should be based on the voluntary participation of interested ASEAN Member States and proceed through practical co-ordination arrangements that avoid duplication and focus on areas of shared interest in advancing regional oil stockpiling co-operation.

The ASEAN Centre for Energy (ACE), the ASEAN Secretariat, relevant ASEAN sectoral and sub-sectoral bodies could play key roles to facilitate the translation of the results of the pilot projects into practical oil security co-operation, based on their respective mandates.

The Economic Research Institute for ASEAN and East Asia (ERIA) and the International Energy Agency (IEA) could provide analytical and technical assistance, while the ASEAN Council on Petroleum and Energy (ASCOPE) could provide operational and commercial expertise. Such support could cover analytical work, feasibility assessment, policy design, monitoring methodology, industry expertise, financing facilitation, emergency response exercises, and producer-consumer co-operation options.

Annexes

Annex 4A provides a risk assessment matrix (Table 4A.1) covering institutional, financial, legal, technical, operational, and geopolitical risks and possible mitigation measures. Annex 4B sets out the monitoring and evaluation matrix (Table 4B.1), including operational readiness indicators and means of verification. Together, the annexes provide a practical basis for managing risks, monitoring progress, and adjusting arrangements as circumstances evolve.

Annex 4A: Risk Assessment and Mitigation

Implementation risks should be addressed from the beginning and reviewed as pilot arrangements evolve. The matrix focuses on risks most likely to affect participation, bankability, deliverability, and confidence.

Table 4A.1: Risk Assessment Matrix

Risk category	Description	Potential impact	Mitigation
Political and participation risk	AMS may differ in priorities, readiness, or willingness to participate	Slow or uneven progress	Use voluntary, phased participation; define decision points; keep an open pathway for later participants
Sovereignty and access risk	Participants may hesitate to rely on stocks located or owned elsewhere	Limited co-operation or weak confidence	Preserve national decision authority; specify enforceable access, verification, delivery, and dispute resolution rights
Financing and fiscal risk	High upfront capital, price volatility, or weak revenue certainty may delay projects	Unbankable pilots or fiscal pressure	Match finance to the reserve model; phase investment; use predictable fees, risk sharing, credit enhancement, or producer-owned stocks where suitable
Legal and regulatory risk	Domestic law, customs, tax, ownership, or emergency powers may not support the arrangement	Contractual uncertainty or blocked cross-border delivery	Conduct early legal review; use adaptable templates; agree customs, tax, and emergency procedures before implementation
Data and cybersecurity risk	Governments or firms may be unable or unwilling to share sensitive stock information	Weak verification, double counting, or loss of trust	Use minimum necessary data, confidential reporting, access controls, aggregation, audit rights, and secure systems
Commercial and counterparty risk	Operators or stock providers may not perform, or contractual terms may not be bankable	Unavailable stocks or limited private participation	Apply due diligence, performance standards, verification, guarantees, or collateral where appropriate, and clear remedies
Infrastructure and deliverability risk	Storage, port, refinery, transport, or emergency-dispatch capacity may be inadequate	Stocks cannot reach affected markets in time	Use ecosystem screening and proportionate due diligence; test logistics and alternative routes through simulations
Geopolitical and replenishment risk	The same disruption may affect supply sources, shipping, or replacement cargoes	Delayed replenishment or prolonged reserve depletion	Diversify suppliers, locations, routes, and stock types; pre-agree replenishment responsibilities and priorities
Safety, environmental, and disaster risk	Storage or infrastructure may face accidents, extreme events, or public concern	Injury, damage, opposition, or project delay	Apply recognised safety, environmental, security, and disaster-resilience standards; maintain insurance and continuity plans
Co-ordination risk	Roles may be unclear or overlap across multiple agencies	Slow decisions during a crisis	Use lean governance, named authorities, escalation paths, exercises, and agreed communication protocols
Expectation-management risk	The initiative may be misunderstood as a completed regional reserve mechanism	Premature commitments or stakeholder disappointment	Emphasise consistently that it provides policy direction and a roadmap; specific arrangements require consultation, due diligence, negotiation, and pilot testing

AMS = ASEAN Member State/s, ASEAN = Association of Southeast Asian Nations.

Source: ERIA.

Annex 4B: Monitoring and Evaluation

Monitoring and evaluation should focus primarily on operational readiness rather than the number of meetings, studies, or consultations completed. ASEAN does not need to publish sensitive reserve data, but participating authorities require sufficient confidential evidence to verify that stocks are accessible, release decisions can be made rapidly, facilities can dispatch the required volume, and oil can reach the affected market within the agreed timeframe.

Table 4B.1. Operational readiness and deliverability indicators

Readiness dimension	Operational indicator	Measurement or evidence
Accessible stock	Verified volume immediately accessible under the pilot, with no double counting	Barrels and days of demand/imports; verification date; owner and eligible user
Stock quality and compatibility	Share of accessible stock meeting the agreed specification or substitution/refining pathway	Percent compliant; quality certificate; compatible refinery or receiving facility
Authorisation readiness	Elapsed time from valid emergency request to completed release authorisation and allocation	Hours; decision log; unresolved approvals
Pricing and payment readiness	Elapsed time to apply the agreed pricing formula and confirm payment or credit security	Hours; price notice; payment security confirmation
Physical release readiness	Elapsed time from authorisation to first physical movement from storage	Hours; terminal time stamp
Terminal and logistics throughput	Sustained dispatch/loading rate and volume that can be moved within the required window	Barrels per hour/day; berth/terminal utilisation; carrier availability
Cross-border clearance	Elapsed time for export, transit, customs, and import clearance under the emergency procedure	Hours; documents completed; exemptions used
Delivery performance	Elapsed time from authorisation and from dispatch to receipt at the affected market	Hours/days; route; receiving point; delivered volume
Fulfilment reliability	Delivered volume relative to the approved request and allocated volume	Percent delivered; shortfall and cause
Operational continuity and safety	Critical incidents, shutdowns, security events, environmental events, and contingency-route availability	Incident count and severity; alternate route test
Data and monitoring reliability	Accuracy, completeness, timeliness, and availability of confidential stock and movement data	Reconciliation variance; reporting delay; system uptime
Replenishment readiness	Time to restore the released volume and quality under the agreed obligation	Days; restored barrels; residual depletion
Financial readiness	Availability of committed funding, payment security, and cost allocation for release and replenishment	Funding confirmed; unpaid obligations; cost per accessible barrel
Exercise outcome	End-to-end pilot or simulation completed without unresolved critical failure	Pass/conditional pass/fail; corrective actions and closure dates

Source: ERIA.

A short progress report from each monitoring or evaluation session should distinguish exploratory scoping, ASEAN policy consultation, national approval, contractual commitment, verified stock availability, demonstrated release capability, measured throughput, delivery, replenishment, and formal deactivation. This prevents activity counts from being mistaken for operational readiness and helps senior officials identify remaining legal, technical, financial, or industry constraints.

Recent disruptions to the Strait of Hormuz have highlighted ASEAN's dependence on imported crude oil and petroleum products, as well as its vulnerability to supply disruptions and price shocks. This book develops an analytical foundation to support practical, voluntary, and implementation-oriented regional co-operation. It presents a cost–benefit case study comparing national, balanced, and co-operative approaches, together with an assessment of the region's refinery, storage, and port infrastructure and the conditions that make locations suitable for regional stockpiling co-operation. Building on these analyses, the book proposes a hybrid policy mix combining national, ticket, and joint stockpiling, and sets out recommendations and an implementation roadmap covering pilot initiatives, financing options, and institutional arrangements.

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