



CCS Business Solution by PETRONAS

A collaboration between the industries in Japan

3 September 2024

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STORAGE

GATHER

TRANSPORT

CAPTURE & PROCESSING

(JV Storage)
CO₂
Injection
Facility

(JV Terminal)
Onshore
Gathering
Terminal

(JV Transport)
Liquid CO₂
Carriers²

**Foreign
Industrial
Emitters**

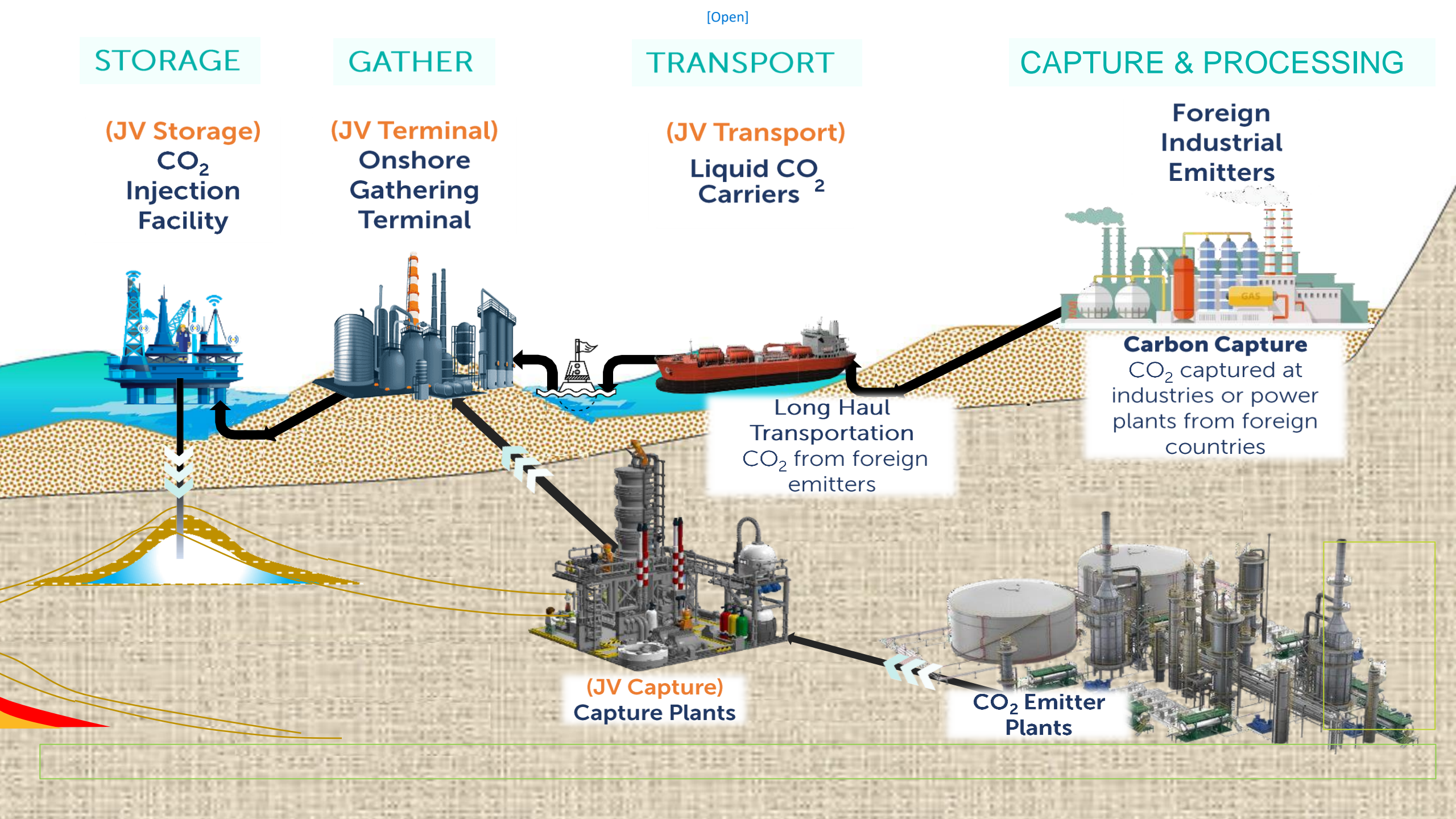


Carbon Capture
CO₂ captured at
industries or power
plants from foreign
countries

Long Haul
Transportation
CO₂ from foreign
emitters

(JV Capture)
Capture Plants

**CO₂ Emitter
Plants**



Carbon permanent storage is a proven solution that has been safe in operations for over 25 years

Sleipner CCS offshore of Norway is the world's 1st geological storage project for the purpose of carbon emission abatement. This project captures carbon dioxide from gas development for storage in an offshore sandstone reservoir.



The world's first and longest lasting commercial storage project (since 1996, 20+ Mt CO₂ stored).

Geological containment of CO₂

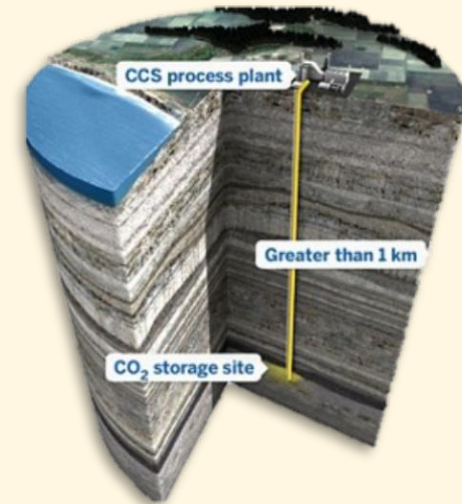
The injected CO₂ remain in Utsira sandstone for thousands of years, similar to how O&G have been trapped in deep geological formations for millions of years.



Where is CO₂ Being Stored?

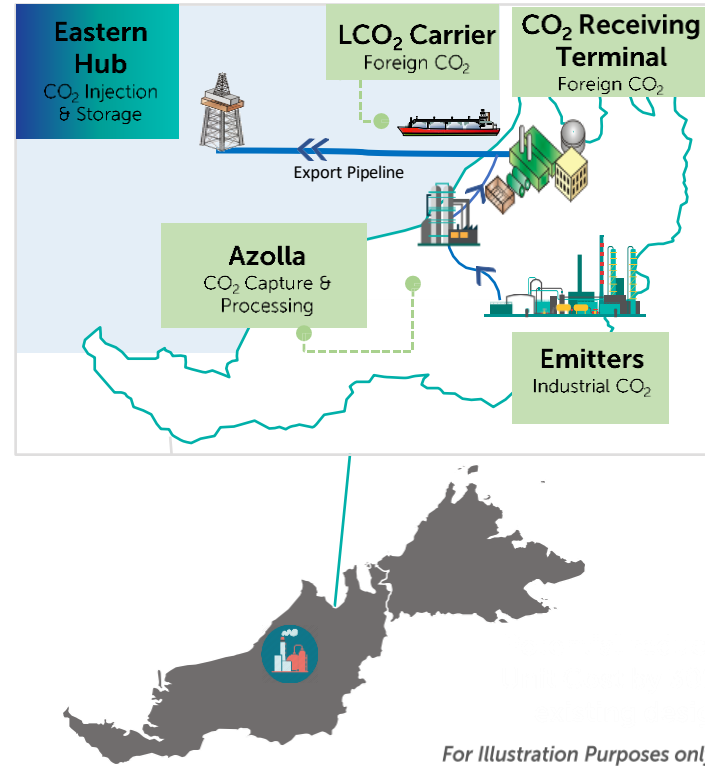
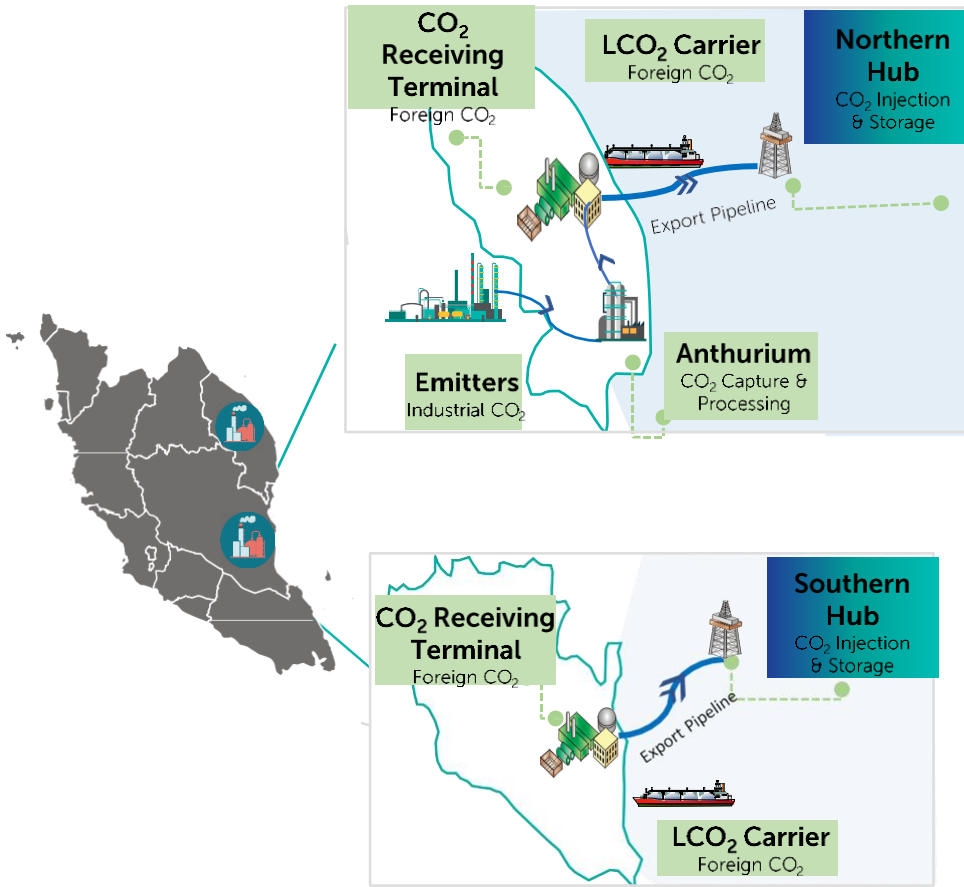
CO₂ is injected to deep geological reservoirs below impermeable rocks

- 1 **Deep Underground**
Keep CO₂ underground at least 800 meters below the seabed
- 2 **Impermeable Seal**
CO₂ is sealed in place by a thick impermeable layers of caprock
- 3 **Permanent Storage**
CO₂ transform from gas into solid minerals
- 4 **Closely Monitored**
Underground CO₂ placement and movement is undergoing structured monitoring process



It is estimated that geological sequestration is safe with overall leakage rates at <math><0.001\% \text{ yr}^{-1}</math> (Alcalde et al. 2018).
IPCC AR6 WG III, Pg 980

Collaborative studies have progressed into CCS projects to cater for PETRONAS Sustainability Agenda and regional decarbonization effort



For Illustration Purposes only

Eastern CCS Hub (Sarawak)	Execution of Key Principles Agreement effective 22 nd September 2023 and Site Storage Agreement effective 26 th February 2024.
Shipping for LCO ₂ Carrier	Term Sheet for Shareholder Agreement (SHA) signed on 22 nd September 2023. Followed by Joint Venture Agreement (JVA) signed on 10 th May 2024.

Short & Long Haul LCO₂ Carrier

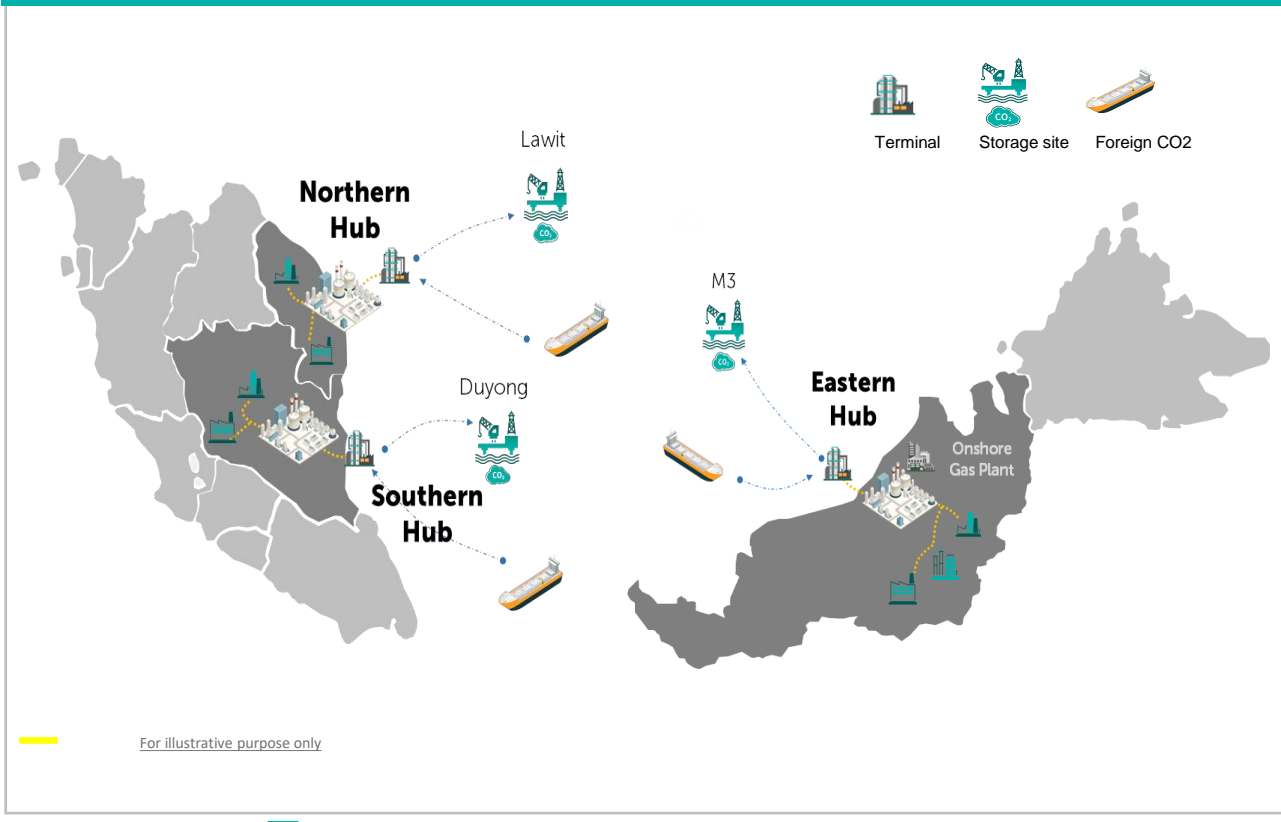
- Completed Conceptual Design for 2 LCO₂ Carriers
- Designs obtained Approval in Principle (AIP) from DNV/ ABS
- Potential reduction of Unit Cost by 30% from existing design in market

PETRONAS has taken the approach of collaborative strategy in developing the CCS hub in which the partners are from diversified industries.

Development of CCS at Southern Hub will offer new future growth to Kuantan Port










Development of 3-CCS hubs for Malaysia as a no-regret move to achieve this target and position Malaysia as key CCS Hubs for the region



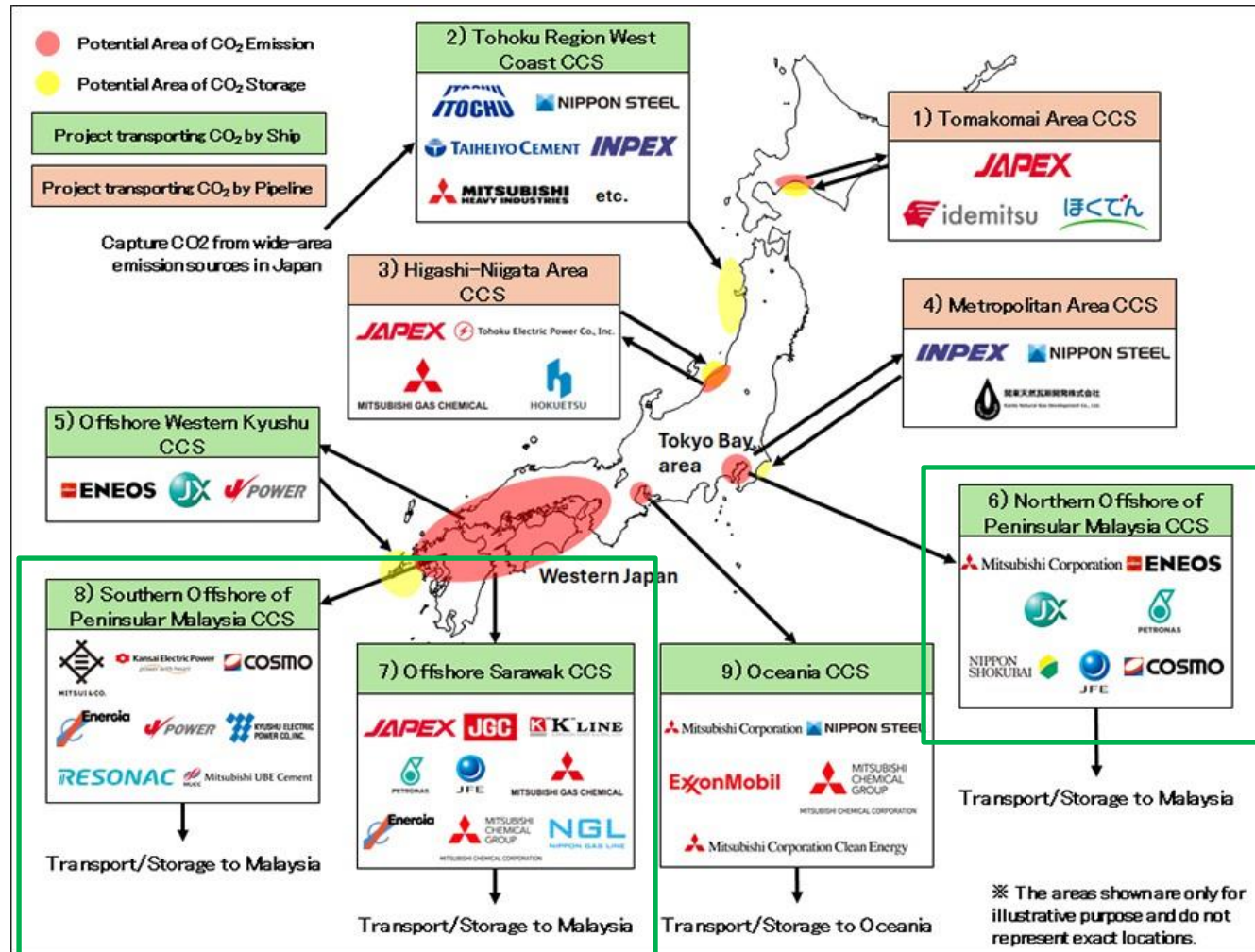
PETRONAS CCS Venture / Solutions

Terminal	Shipping	Storage	Current Partnerships	Potential partnership in discussions	Certification
		<p>Northern Cluster</p>	<p>Southern Cluster</p>	<p>Eastern Cluster</p>	<p>Penyu Cluster</p>
				<p>F Cluster</p>	

Overview of Other Ongoing Collaboration with Japanese Companies

No	Partners	Key Areas of Collaboration	Status Update
1.	 	Southern CCS Hub (Kuantan, Pahang)	Execution of CCS Development Agreement effective 16 th June 2023 for duration of 2 years.
2.	  	<p>Joint Feasibility Study for Tokyo Bay & Ise Bay Emission for Storage in Malaysia.</p> <p>Note: Kanowit depleted field to be developed as potential CCS storage site and/ or store CO₂ in existing Malaysia CCS hubs. (optional)</p>	Execution of MoU on 1 st March 2024 for duration of 1 year (with option for extension of another 1 year).
3.		Joint Feasibility Study to store CO ₂ in existing CCS hubs and to explore High Pressure/ High Temperature shipping and terminal.	Execution of Joint Preliminary Feasibility Study Agreement on 29 th March 2024 for duration of 1 year.
4.		Joint Feasibility Study for capturing and collecting biogenic CO ₂ from Southeast Asia for storage in Malaysia.	Confirmation on ability to utilize existing NDA completed. Target to sign MoU within Q3 2024.

Advanced Efforts for Commercialization of CCS – 9 projects selected as Japanese Advanced CCS Projects (24th July 2024)



- FY2024, Japan Organization for Metals and Energy Security (JOGMEC) selected 9 role model projects (5 projects are planned for domestic storage in Japan, while the remaining 4 projects target storage in Asia and Oceania, which might lead to decarbonization throughout the Asia-Pacific region.) for Japanese Advanced CCS Projects. These will significantly promote decarbonization by supporting the "CCS" technology, through "basic engineering design for CCS value chain" and "assessment on CO₂ storage potential" including exploratory drilling.
- The 9 projects cover various industries, including electric power, oil refinery, steel, chemical, paper and pulp, and cement in regions with high CO₂ emissions, such as **Hokkaido, Kanto, Chubu, Kinki, Setouchi, and Kyushu**. The project aim to store approximately **20 Mtpa of CO₂ annually**.

A total of 9 projects store about 20 million tons of CO₂ per year

Location map and proposed companies of 9 projects selected as advanced CCS projects in 2020



PETRONAS

50
YEARS