

Unveiling CCUS : Indonesia's Path to Carbon

Neutralitas

1

Indonesia's current energy is dominated by fossil fuels (coal, crude oil and natural gas) meeting around 84% of the national energy demand with coal being the largest source for CO₂ emissions accounting for 1/3rd of annual CO₂ emissions.

2

To meet this rising energy demand, the country stands at a crossroads: utilise more of its domestic coal resources, while also turning to international oil and gas markets to import energy from overseas; or pursue the huge untapped potential of renewable sources that can provide local and affordable solutions to fossil fuels.

3

Studies shows that it is cheaper to do the latter, with the share of renewable energy reaching two-thirds of the country's energy mix in 2050, up from just 14% today. Therefore, CCUS will prove to be of immense importance to facilitate this transition from fossil fuels to renewable energy, and looking at the potential of Indonesia's storage capacity it is quite possible.

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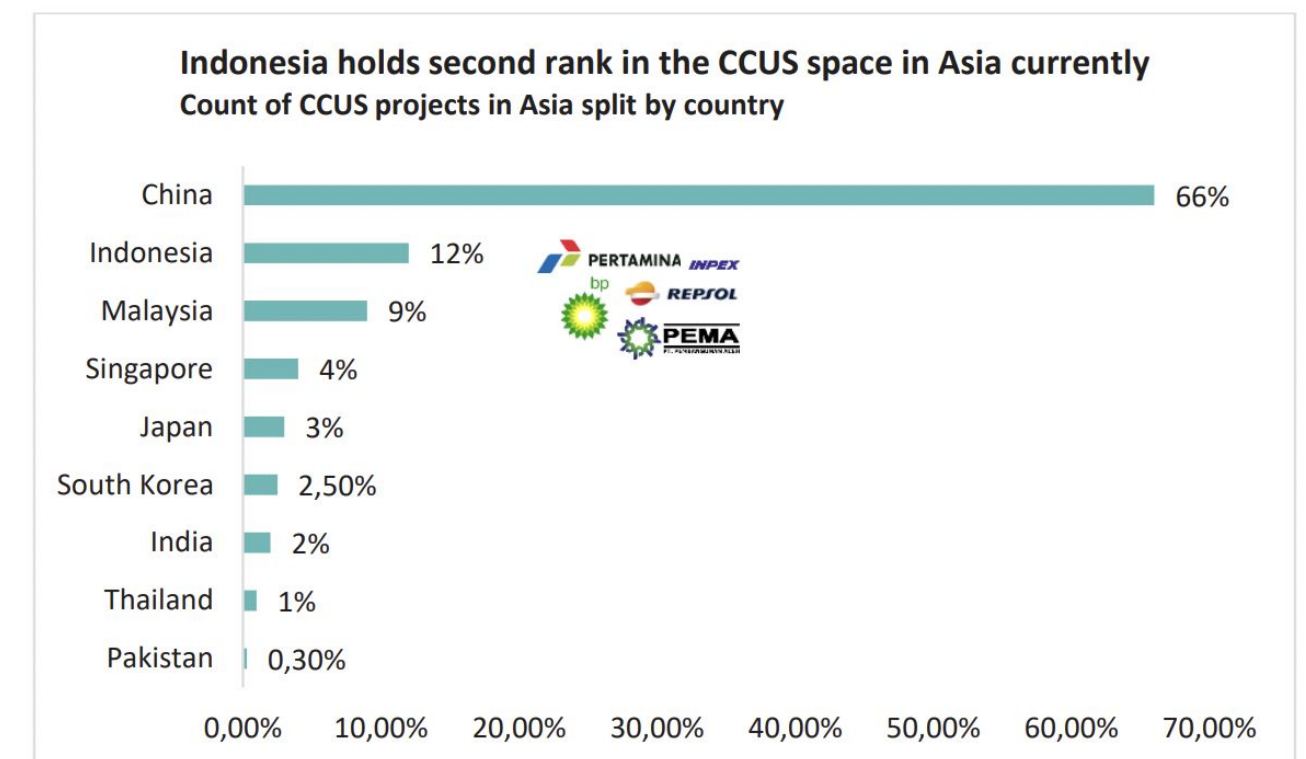
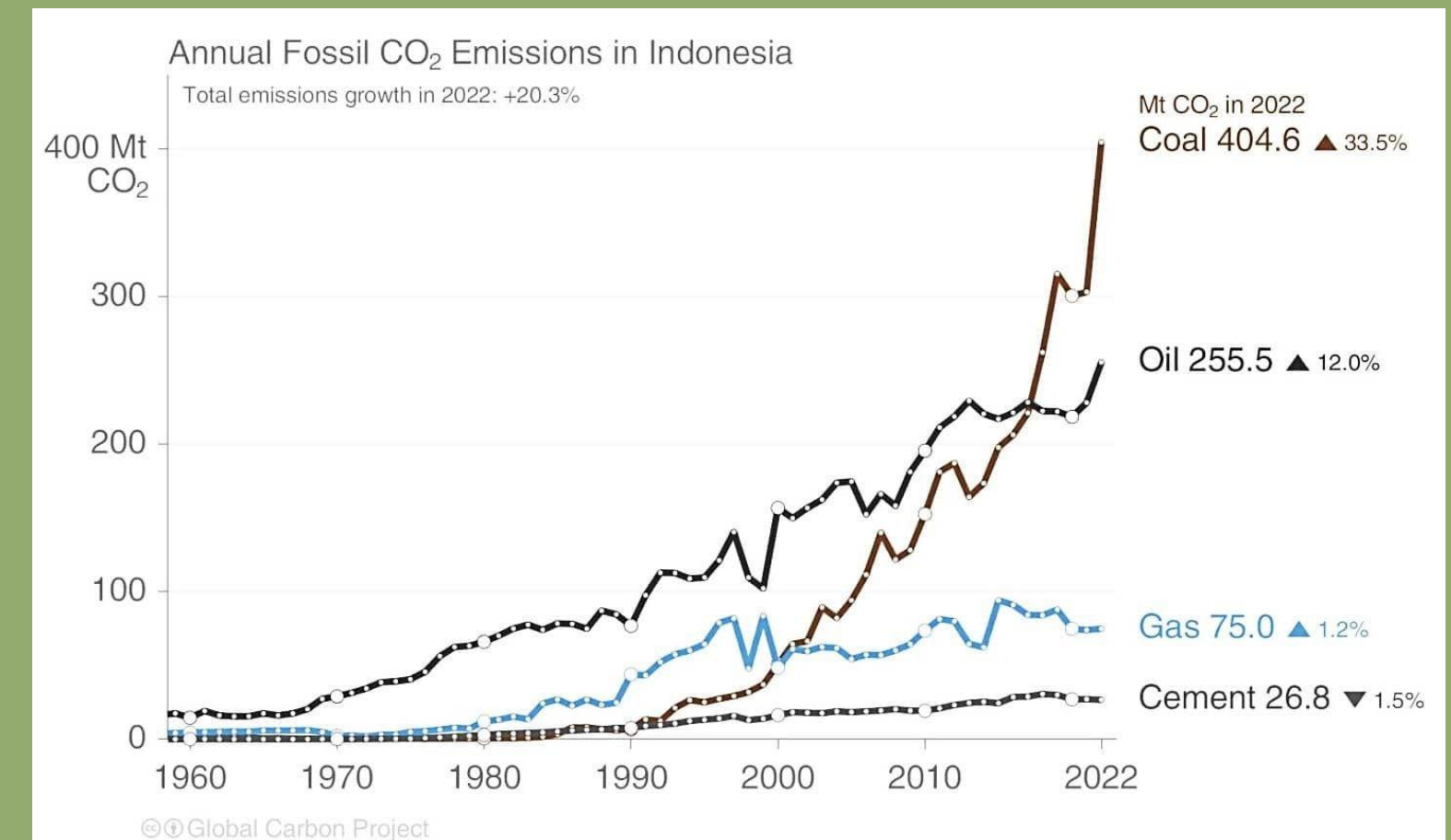
Indonesia, with a potential CO₂ storage capacity of 400 to 600 gigatons in depleted reservoirs and saline aquifers, stands at the forefront of the green industrial era. This potential allows national CO₂ emissions to be stored for 322 to 482 years, with an estimated peak emission of 1.2 gigatons of CO₂-equivalent in 2030.

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However, even if Indonesia uses only its depleted oil and gas fields it still has a staggering storage potential of 8 gigatons. Indonesia is currently in the forefront in the commercial CCUS landscape of Southeast Asia comprising of 55% of the total projects, followed by Malaysia with another 33%.

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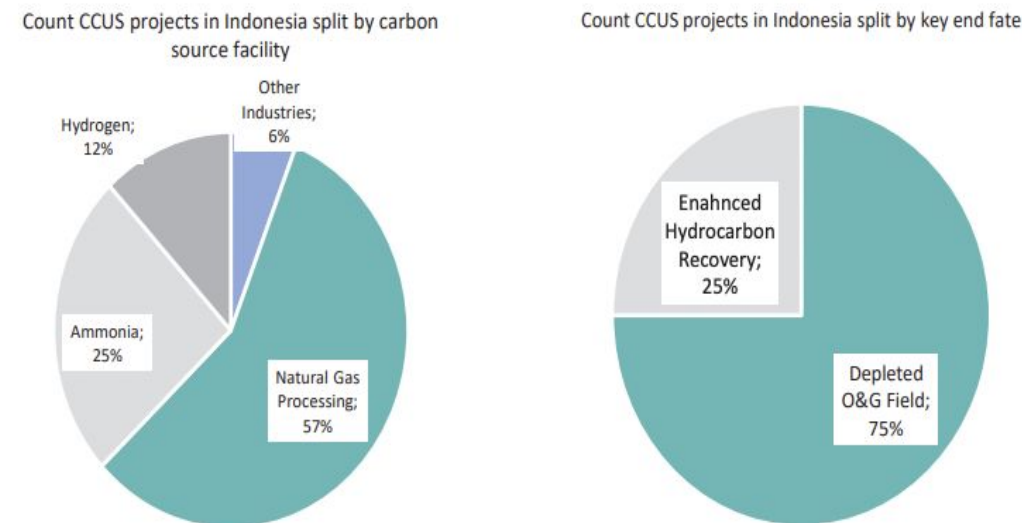
Statistically 2022 onward till date, Indonesia has registered a massive 114% growth in new CCUS project announcement compared to pre 2022 timeframe. Indonesia is expected to require only half of its storage capacity of eight gigatonnes of carbon in the depleted reservoirs, while an additional 400 gigatonnes of storage capacity is available if it utilises its saline aquifers.



Source: Rystad Energy CCUS Solutions, Rystad Energy research and analysis

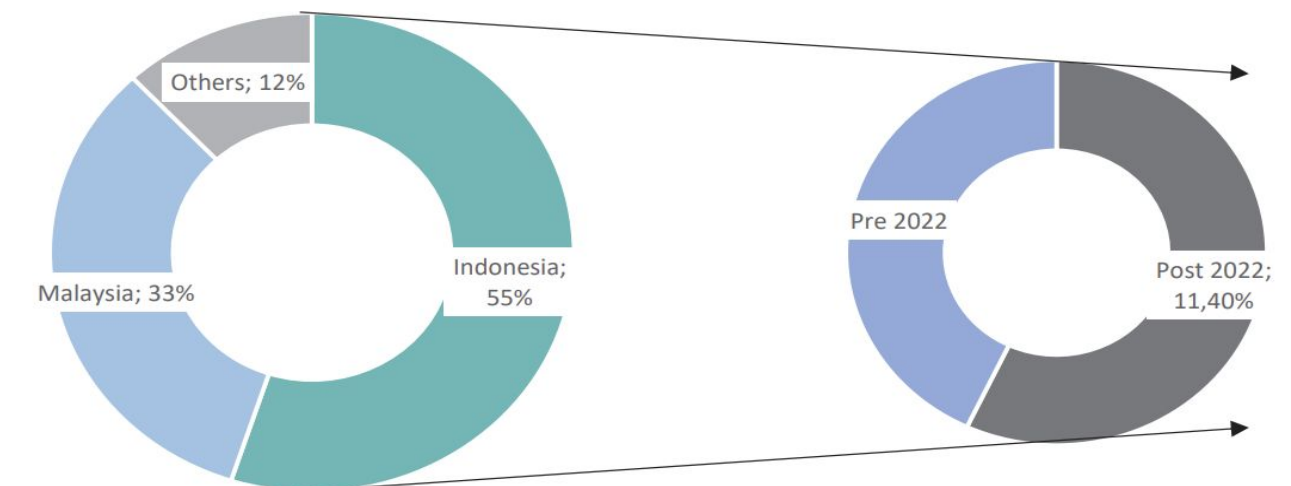
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Commercial CCUS projects in Indonesia is led by LNG facilities with key end fate in oil and gas fields



Source: Rystad Energy CCUS Solutions, Rystad Energy research and analysis

Indonesia registers 55% of the CCUS landscape in Southeast Asia with an 114% growth post 2022



Source: Rystad Energy CCUS Solutions, Rystad Energy research and analysis

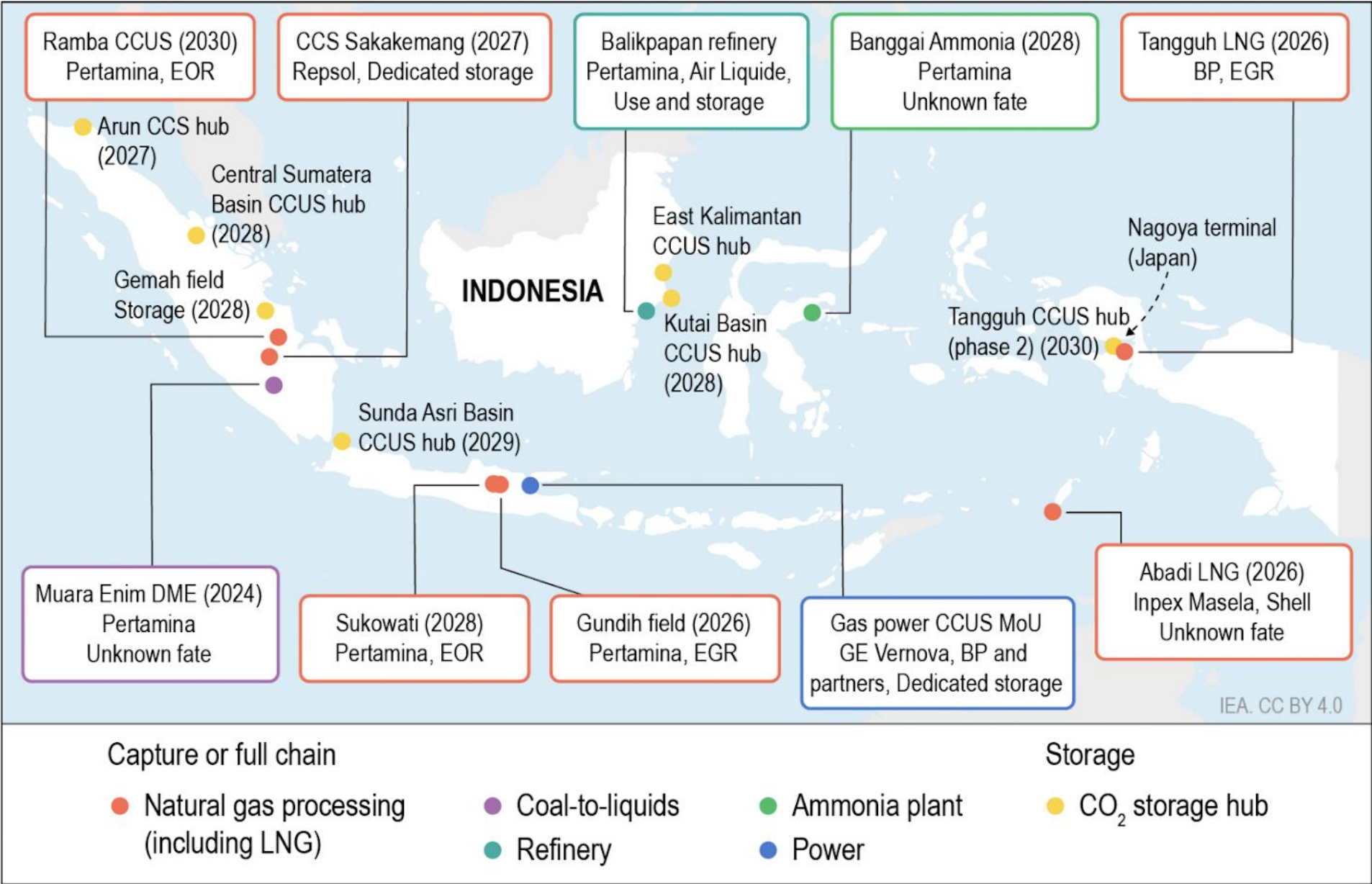
- Indonesia can leverage its vast CO₂ storage capacity to provide safe storage for CO₂ from countries like Japan, South Korea, and Singapore.
- Partnerships with companies like Pertamina indicate the potential for Indonesia to establish a carbon storage hub, creating a viable business market. This could generate revenue by offering CO₂ sequestration sites to foreign countries seeking favorable storage locations.
- Regarding this, Indonesia has issued a presidential regulation regarding carbon capture and storage (CCS), allowing CCS operators to set aside 30% of their storage capacity for imported carbon dioxide, with Indonesian government collecting royalties from storage fees charged by the CCS operators.
- To store carbon from overseas, Indonesia would only permit emitters that have invested in the country or are affiliated with companies that have done so, and the government must have a bilateral agreement with the government where the emission came from.

- Indonesia is currently in the forefront in the commercial CCUS landscape of Southeast Asia comprising of 55% of the total projects, followed by Malaysia with another 33%.
- Statistically 2022 onward till date, Indonesia has registered a massive 114% growth in new CCUS project announcement compared to pre 2022 timeframe.
- Statistically, we can expect at least a 200% growth in new projects in the upcoming years once alliances realize into full scale commercial projects. This is thereby likely to play a pivotal role to shape up the national CCUS game quite significantly.
- 40% of the total CCUS projects in the country is dominated by INOC Pertamina, followed by other companies including Repsol, BP, Inpex etc.

Pioneering Projects: The Rise of CCUS in

Indonesia

Map of CCUS projects under development in Indonesia, 2023



Energy Ministry data indicates there are 15 CCS and CCUS projects in various stages of preparation in Indonesia with a combined investment of nearly US\$8 billion, including BP's project.



Exxon Mobil plans to invest up to \$15bn to develop petrochemical project and carbon capture and storage (CCS) facilities in Indonesia



Indonesian state energy company Pertamina and Exxon also agreed to assess investments of \$2bn for the development of CCS facilities utilising two underground basins in the Java Sea.



Pertamina said that the proposed CCS hub will have potential storage capacity of at least three gigatons of carbon dioxide (CO₂).



BP expects that completion for Tangguh is targeted for 2026 or 2027 and, by that time, 4 million metric tons of carbon dioxide will be injected back into the reservoir annually, with the amount reaching a total of up to 25 million metric tons of carbon dioxide by 2035 and 33 million metric tons by 2045.



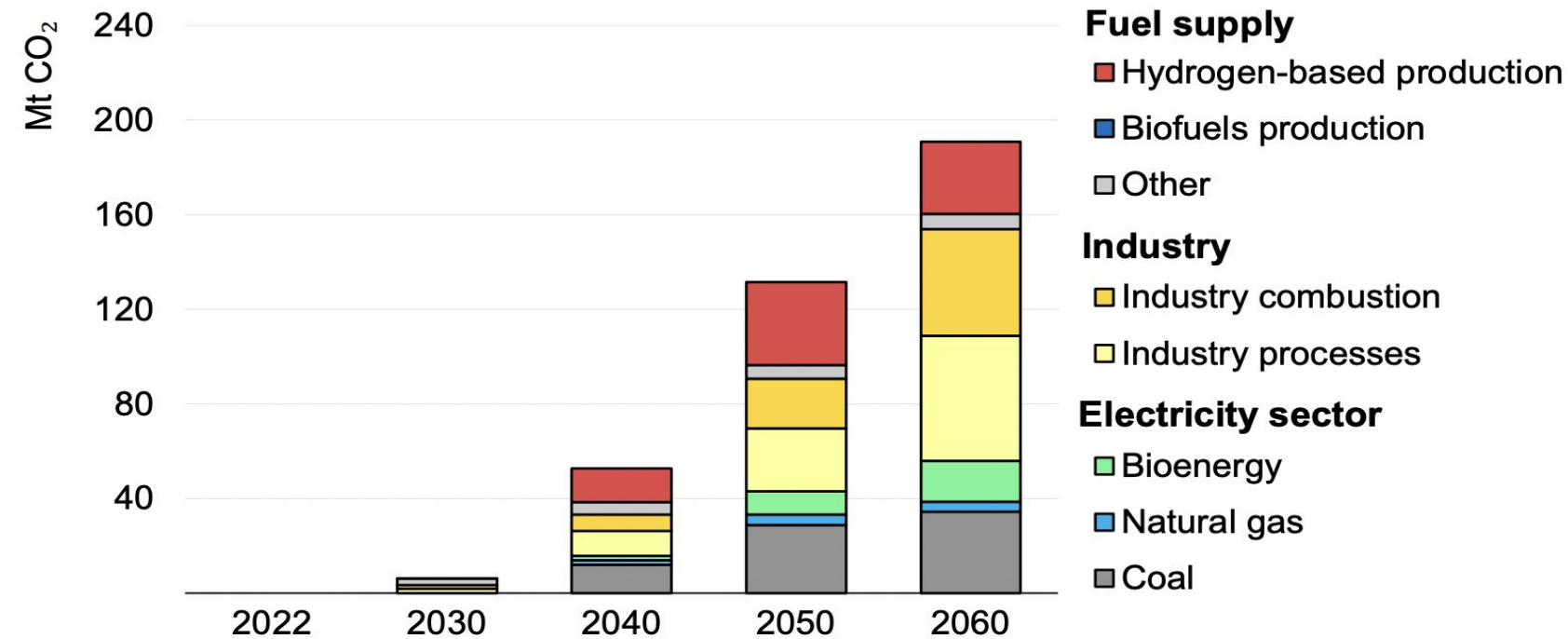
He added that through enhanced gas recovery and by sequestering the carbon dioxide, Tangguh operators will potentially gain up to 300 billion cubic feet of incremental gas in 2035 and as much as 520 billion cubic feet in 2045.



Tangguh is the largest gas producer in Indonesia, generating 1.4 billion standard cubic feet of gas per day, or up to 20% of the country's daily gas production. BP and its partners are working on increasing Tangguh's production capacity to 2.1 billion standard cubic feet of gas per day.

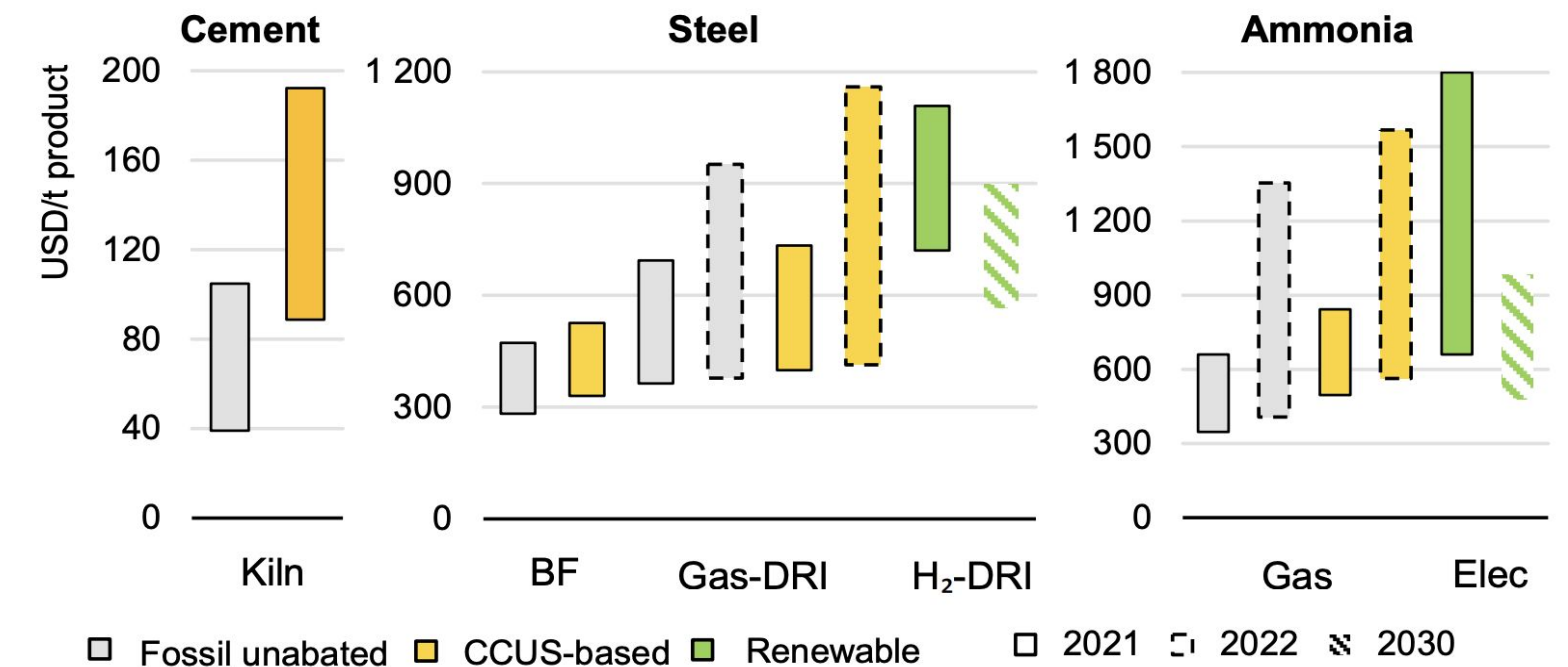
The Future of CCUS in Indonesia

CCUS deployment by sector in the IEA Announced Pledges Scenario, 2022-2060



IEA. CC BY 4.0

Indicative levelised cost of production of selected industry products for different routes, 2022



IEA. CC BY 4.0

- 57% of the carbon source associated with the projects are from natural gas processing facilities.
- This is followed by the remaining 43% across different segments of industry including ammonia production, paper production and other chemicals.
- CCUS is still lacking in one of the most emission intensive sector – power plants.
- Over a third of Indonesia's energy sector emissions come from the power sector, with 85% from coal-based generation. The average age of the coal fleet is 13 years, and new plants continue to be built.
- Supercritical and ultra-supercritical power plants, which constitute about 20% of Indonesia's coal fleet, are more efficient and suitable for CCUS retrofits. These large-scale, recently built plants could serve as anchor projects for developing CO2 storage hubs.

• Cement production

1. Largest industrial emitter in Indonesia, with two-thirds of the sector's direct emissions originating from clinker production.
2. 30 major cement plants, which emit around **45 Mt CO2 per year**.

• Iron and steel production

1. CCUS can be a cost-effective route to decarbonise.
2. 6 large-scale steel mills with annual CO2 emissions of around **30 Mt CO2**.

• Ammonia production

1. CCUS can also be a cost-effective solution for low-emissions ammonia production. Japan and Indonesia signed a Memorandum of Co-operation (MoU) in 2022 leading to a joint CCUS study on a 0.7 Mt ammonia plant in Central Sulawesi.

CCUS Framework Indonesia

MEMR 2/2023

- Indonesia has established a pioneering legal and regulatory framework for Carbon Capture, Utilization, and Storage (CCUS) with the Ministry of Energy and Mineral Resources Regulation Number 2 of 2023 (MEMR 2/2023), finalized in March 2023.
- This makes Indonesia the first country in Southeast Asia to implement such a framework. MEMR 2/2023 addresses key areas like detailed monitoring and reporting requirements essential for safe CO2 storage.
- It relies on upstream exploration and production companies to lead CCUS development and operations due to their expertise in large-scale projects and subsurface knowledge.
- MEMR 2/2023 is built on Indonesia's oil and gas regulatory framework and allows only oil and gas contractors to develop CCUS projects. This limitation stems from the regulation's scope, confined to the ministry's jurisdiction, unlike broader legislation seen in other regions.



Changes Required

To maximize CCUS's role in Indonesia's decarbonization, additional regulations are needed to expand the framework beyond the oil and gas sector. These should cover:

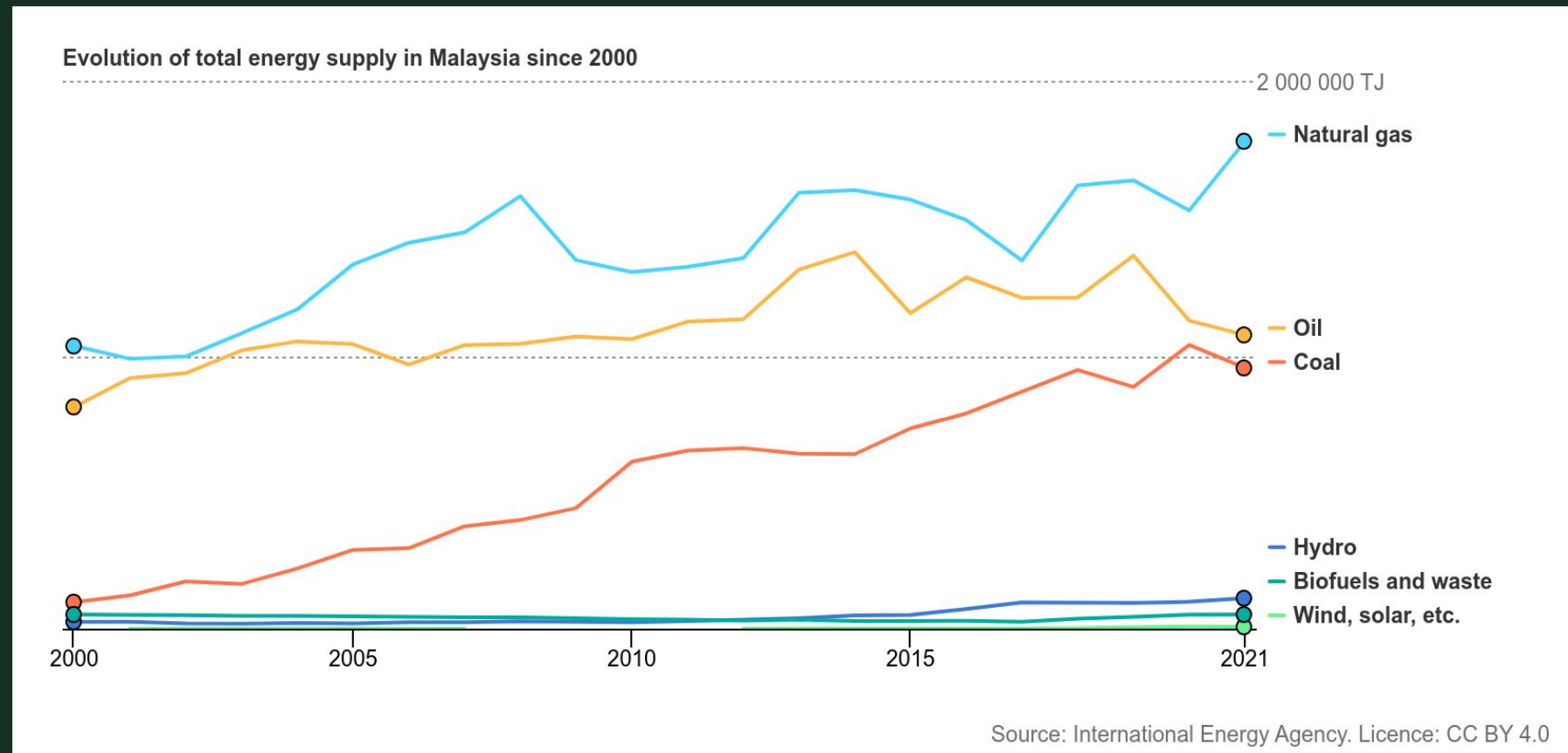
1. **CO2 Storage Development Outside Oil and Gas Areas:** Creating frameworks for defining, licensing, permitting, monitoring, and regulating CO2 storage outside oil and gas zones.
2. **Inclusion of Non-Oil and Gas Companies:** Developing regulations for non-oil and gas companies to participate in CO2 transport and storage, fostering CO2 storage hubs.
3. **International Implications:** Addressing cross-border projects and international regulations, considering Indonesia's potential to support regional and global decarbonization.



4. Monetization of Carbon Credits: Ensuring a robust methodology for generating and trading CCUS-enabled carbon credits to meet emissions reduction targets and monetize credits from CO2 captured outside the oil and gas sector.

- In summary, Indonesia's MEMR 2/2023 is a pioneering step for CCUS in Southeast Asia, establishing essential regulatory frameworks for CO2 storage.
- However, to enable broader participation and fully realize the potential of CCUS in Indonesia's decarbonization strategy, further regulations are needed to expand the scope beyond the oil and gas sector, address international collaborations, and develop robust methodologies for carbon credit monetization.
- Indonesia can follow suit of legislations in other countries like the CCS Directive in the European Union and Australia's Offshore Petroleum and Greenhouse Gas Storage Act 2006.

Malaysia's Current Energy Mix



- **Fossil fuels** continue to contribute the **largest share (~95%)** of Malaysia's energy supply and have a significant influence in shaping the country's energy landscape.
- As of 2020, four energy sources dominated the national total primary energy supply (TPES) mix.
- **Natural gas** constituted the largest portion at **42.4%**, followed by **crude oil and petroleum products** at **27.3%** and **coal** at **26.4%**.
- Renewables, comprising hydropower, solar and bioenergy, constituted just a mere 3.9%.

Malaysia's Storage potential



- Malaysia has significant potential for carbon capture, largely due to the nearing end of life for several oil and gas fields. According to data from Malaysia Petroleum Management (MPM), **the country's 16 depleted oil fields have a carbon storage capacity exceeding 240 million tonnes.**
- Coupled with local expertise and policy support, Malaysia is poised to become a transnational carbon storage hub for major markets like Australia and Japan.
- Estimates place Malaysia's **total offshore CO2 storage potential at 500 metric tonnes**, presenting the possibility for the development of more projects like Kasawari
- Eleven of these 16 potential CCS sites are at fields offshore Sarawak while the other five are located offshore Peninsular Malaysia.
- In addition to offering storage solutions for domestic projects, Malaysia will make its excess storage capacity available to third parties, thereby establishing the nation as a regional CCS hub. **Sixty% of the storage capacity will be allocated to Malaysia for Petronas and partners while the remaining 40% will be made available to other countries.**



Lang Lebah Gas Field CCUS project

The Lang Lebah gas field is in block SK410B, 90km off the coast of Miri, Sarawak, Malaysia. It is the largest gas discovery near to Malaysia by PTT Exploration and Production Public Company (PTTEP), a wholly owned subsidiary of the Petroleum Authority of Thailand (PTT).

The Lang Lebah field is expected to come on stream in 2027 and will produce up to one billion cubic feet (Bcf) of gas per day. The Lang Lebah field is estimated to hold five trillion cubic feet (Tcf) of gas in place. **This project will also involve the removal of hydrogen sulphide (H₂S) in addition to CO₂.**

Produced gas from Lang Lebah will flow via pipeline to an onshore processing plant dubbed OGP-2, and the extracted CO₂ will then be piped back offshore for injection at the depleted Golok field

The Kasawari gas field is The field is estimated to contain 3.2 trillion cubic feet (tcf) of natural gas resources. It is expected to produce 900 million standard cubic feet per day (mmscfd) of gas and 3.5 million barrels of condensate per day. It is expected to commence production in 2023.

Petronas also reached a final investment decision (FID) for the development of the Kasawari carbon capture and storage project in November 2022. The CCS project is expected to capture up to 3.3 million tons (Mt) of carbon dioxide equivalent emitted by flaring at the gas field each year.

For Petronas Carigali's Kasawari phase 2 project – the nation's maiden CCS development – the extracted and compressed carbon dioxide will flow some 135 kilometres via a pipeline to the M1 field where it will be injected into a depleted reservoir.

Malaysia's national oil company claims Kasawari will be the largest offshore CCS project in the world when it starts up, with 4 million tonnes of carbon dioxide to be captured annually. A total of 76 million tonnes of CO₂ from Kasawari will ultimately be injected at the M1 field, the company says.
Kasawari CCS (Kasawari phase 2) is targeting first injection in the fourth quarter of 2025.



Major Collaborations signed

Posco international

Malaysian state oil company Petronas has initialled a memorandum of understanding (MoU) with a pair of South Korean steel companies to explore opportunities in carbon capture and storage technologies as well as carbon dioxide storage solutions in Malaysia. According to Petronas, the MoU with Posco International Corporation and Posco Engineering & Construction will see the trio "assess opportunities to unlock CCS potential and identify suitable technology within the scope of carbon capture, transportation of CO2 and storage for potential application

Malaysian state-run oil giant Petronas has partnered with Japan Petroleum Exploration (Japex) to pursue carbon capture and storage (CCS) opportunities. The pair signed a memorandum of understanding late last week that will see the two companies carry out technical maturation activities to unlock potential CCS solutions, including suitable carbon dioxide storage locations in Malaysia.

Japan petroleum exploration

Petronas is hoping to leverage Japex's experience with the Tomakomai CCS Demonstration Project in Hokkaido, Japan. Tomakomai is Japan's first full-chain CCS project that captured roughly 100,000 tonnes of CO2 per annum from a coastal oil refinery from 2016-2019 and stored it in two nearby offshore saline aquifers for storage and monitoring.

SHELL

Anglo-Dutch supermajor Shell is teaming up with Malaysian state-run giant Petronas to explore potential carbon capture and storage (CCS) opportunities in Malaysia. Petronas confirmed on Tuesday that it had signed a joint study and collaboration agreement with Sarawak Shell to explore CCS opportunities and project collaborations.

EXXONMOBIL

Malaysian national oil company Petronas has signed an agreement with ExxonMobil to jointly explore carbon capture and storage (CCS) technologies to help decarbonise Malaysia's upstream industry and to provide carbon dioxide storage solutions for the region.



ExxonMobil

posco

JAPEX
Japan Petroleum Exploration Co., Ltd.



PETRONAS

Ccus Opportunities for Asia-Pacific

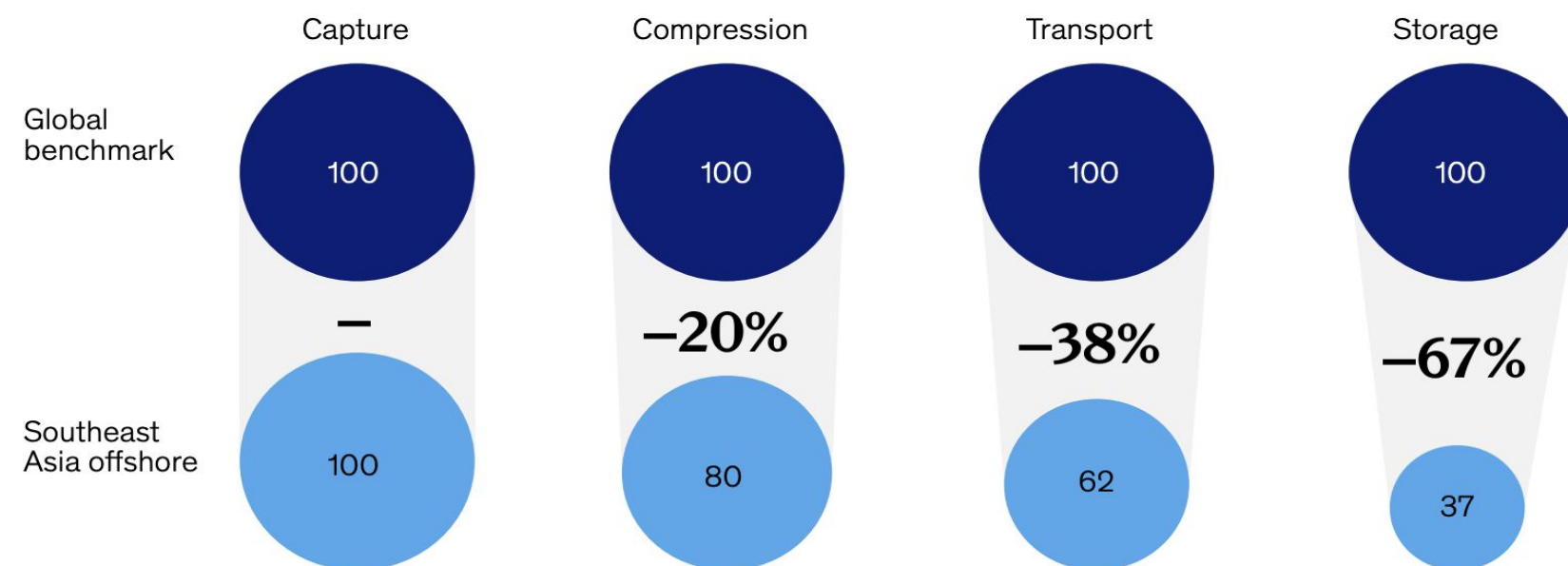
- Asia-Pacific could account for 55 percent of global carbon capture, utilization, and storage by 2050
- However, unlocking CCUS potential in Asia-Pacific is not an easy task. To realize its potential, the region needs to deliver exponential growth: at least 450 times its current operational CCUS projects. It is also characterized by inequitable access to viable domestic underground storage, and varying levels of regulatory maturity.
- The costs in Asia-Pacific are comparable to global benchmarks at the capture stage, and the rest of the CCUS value chain is even more cost-efficient. Most significantly, costs at the storage stage are estimated to be 65 percent lower than the global

The Asia-Pacific region faces significant challenges in scaling up Carbon Capture, Utilization, and Storage (CCUS):

- 1. Access to Sequestration Sites:** Major industrial emitters in Japan, Korea, Taiwan, and Singapore, with combined annual CO₂ emissions of 840 million tons, lack nearby viable sites for CO₂ storage.
- 2. Regulatory Support:** The region scores an average of 34 on the Global CCS Institute readiness index, behind Europe (41) and North America (71). More comprehensive government policies and regulations are needed for effective CCUS deployment.
- 3. Technical Expertise:** Outside the oil and gas sector, technical understanding of CCUS is low. The region lacks sufficient pilot and operational projects to demonstrate technological readiness and de-risking processes.

These challenges are why the Asia-Pacific region is not technically ready for CCUS at the same level as North America and Europe.

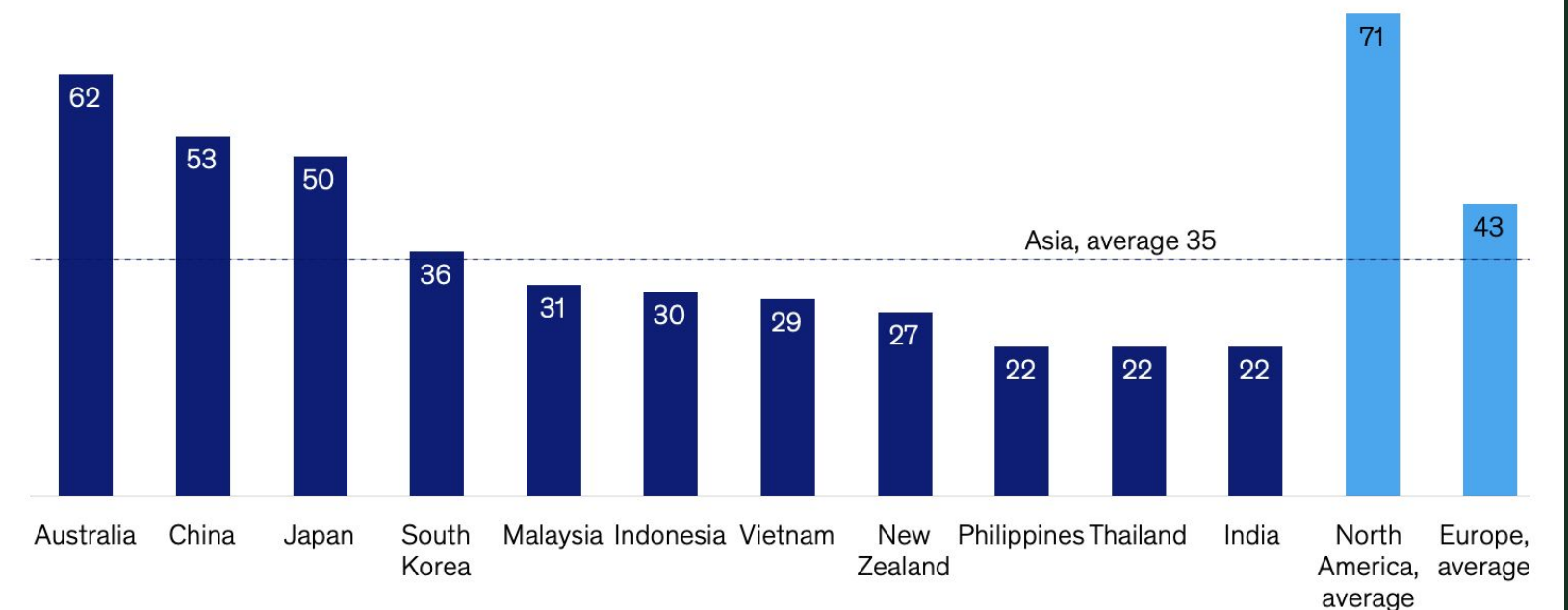
Carbon capture, utilization, and storage costs, % difference from benchmark



Source: Global CCS Institute; National Petroleum Council; Energy Insights by McKinsey; Westney Capital Analytics by McKinsey

McKinsey & Company

Carbon capture and storage readiness, by location,¹ index (100 = ready)



¹Carbon capture and storage (CCS) readiness in each location is evaluated individually across several metrics, including need of CCS, development on regulations, policies, and sink resources.
Source: Global CCS Institute

McKinsey & Company