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GLOBAL CCS INSTITUTE

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An initiative on re-utilization of abandoned offshore oil and gas platforms for CCS

Study Case :
Offshore North West Java (ONWJ) & Karawang CCS Hub

Presented by :
Amri Widyatmoko
Geoscientist at CMI

CARBON MANAGEMENT INDONESIA (CMI)

The Emil Salim Institute hosted the Indonesia Climate Change Forum (ICCF) on December 13–14, 2023, in Jakarta, which gave rise to the CMI discussion group. It has now evolved into an organization that aims to accelerate CCS implementation and create value through the conceptualization, development, and operation of commercial-scale CCS projects.

- **Dr. Winardi Sani (UTHM PhD, Malaysia – 2013)**
  Professional in Enviro and Safety, experience in energy industry, former Deputy Director GPM – US, Director of PT Smart PLN, international consultant for Petronas, Pertamina.
- **Dr. Taufiq Wisnu Priambodo BSc., MSc. (Bonn PhD, Germany – 2015)**
  Professional in Climate Change, experience in agriculture and agribusiness, former research director of Universitas Indonesia and BPPT staff, consultant for government and lecturer.
- **E. Kurniawan Padma S.Si., MT. (ITB Master, Indonesia – 2004)**
  Entrepreneur in Enviro Business, enviro activist and scientist, experience in safety industry for local government and private, CEO of PT Indonesia Environment Consultant & President of Emil Salim Institute.
- **Ahsanul Khair Husin S.Si., MSc. (UI Master, Indonesia – 2006)**
  Entrepreneur and Scientist in Energy, experience in oil and gas industry, international consultant for Pertamina. Energy Trainer and independent research scientist. Activist of Biomass and Transition Energy.
- **Amri Widyatmoko S.Si., MT. (ITB Master, Indonesia – 2013)**
  A Sustainability Geoscientist, expert in seismic analysis, reasearcher of the development of technology for monitoring and verifying CO2 sequestration efforts. Consultant for seismic and CO2 Storage study. Former Geoscientist Staff in Elnusa & Halliburton in Malaysia. Senior Staff at APG Geophysics Ltd.
- **Bobby Hendry Panggarbesi S.Si., MT. (ITB Master, Indonesia – 2013)**
  Entrepreneur in energy-mining-shipping industry, activist and scientist for energy and mining industry, experience in energy, mining, and shipping industry. former CEO of PT. PLA Shipping, Business Expansion Advisor for Sucofindo, Assistant VP Exploration PHE, GM Elnusa, Co-Scientist ESDM for BLUs, International Consultant for Aramco, NEOM Project, & Petronas.

OUTLINE

Carbon Capture, Utilisation and Storage (CCUS) is an important part of the mix to help Indonesia and the world meet our net zero emission targets

01
North West Java Basin

The Northwest Java Basin is a mature oil and gas basin that has been explored and developed for more than 50 years.

02
Offshore CCS

By storing CO_2 offshore, the risk of groundwater contamination is reduced compared to onshore CCS projects

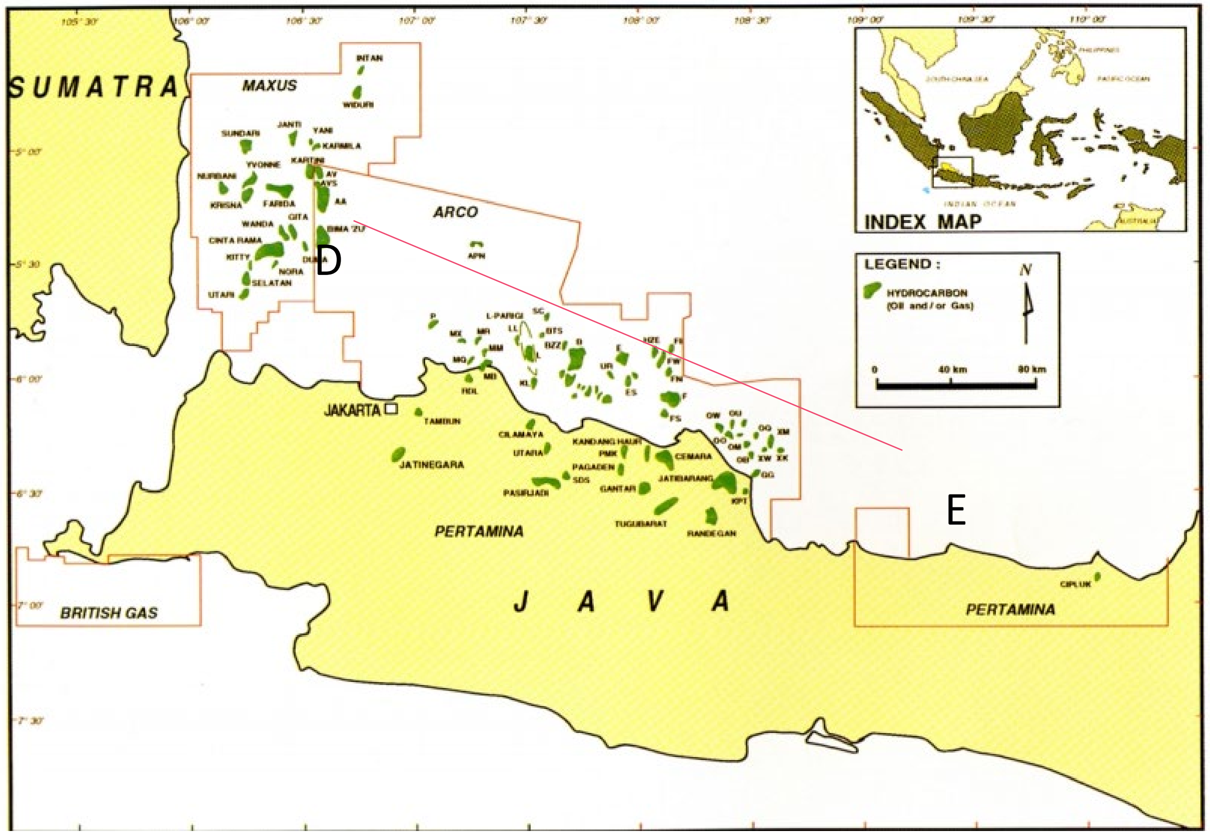
03
CCS Hubs & Clusters

CCS hubs facilitate the sharing of infrastructure which can significantly reduce the costs associated with capturing and storing CO_2

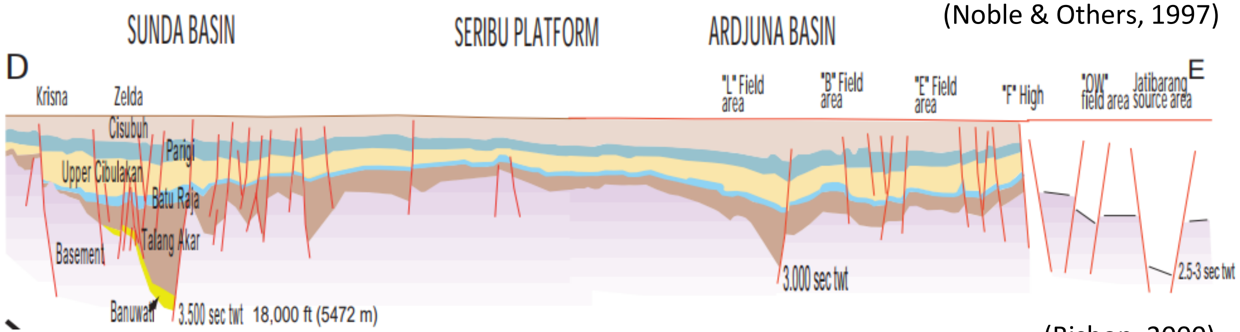
04
CCS Value Chain

Climate change is a global issue that requires international cooperation. Sharing technology and resources can be more effective.

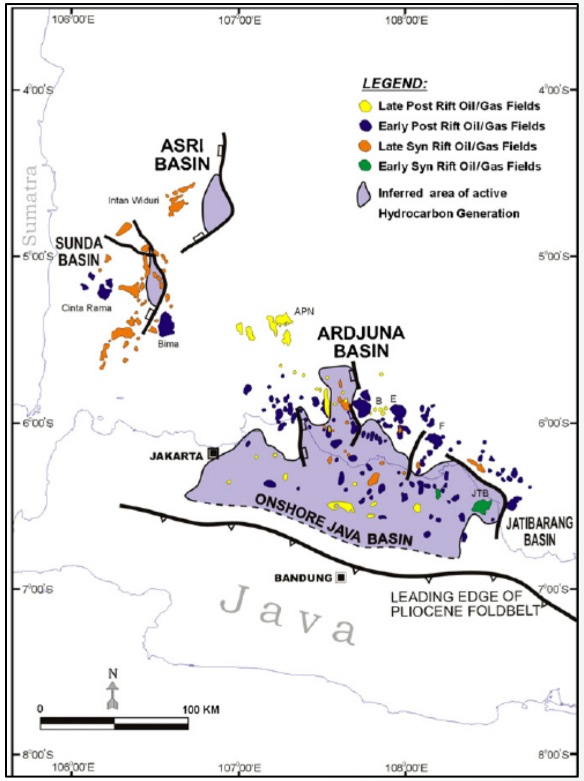
Offshore North West Java Basin



(Noble & Others, 1997)

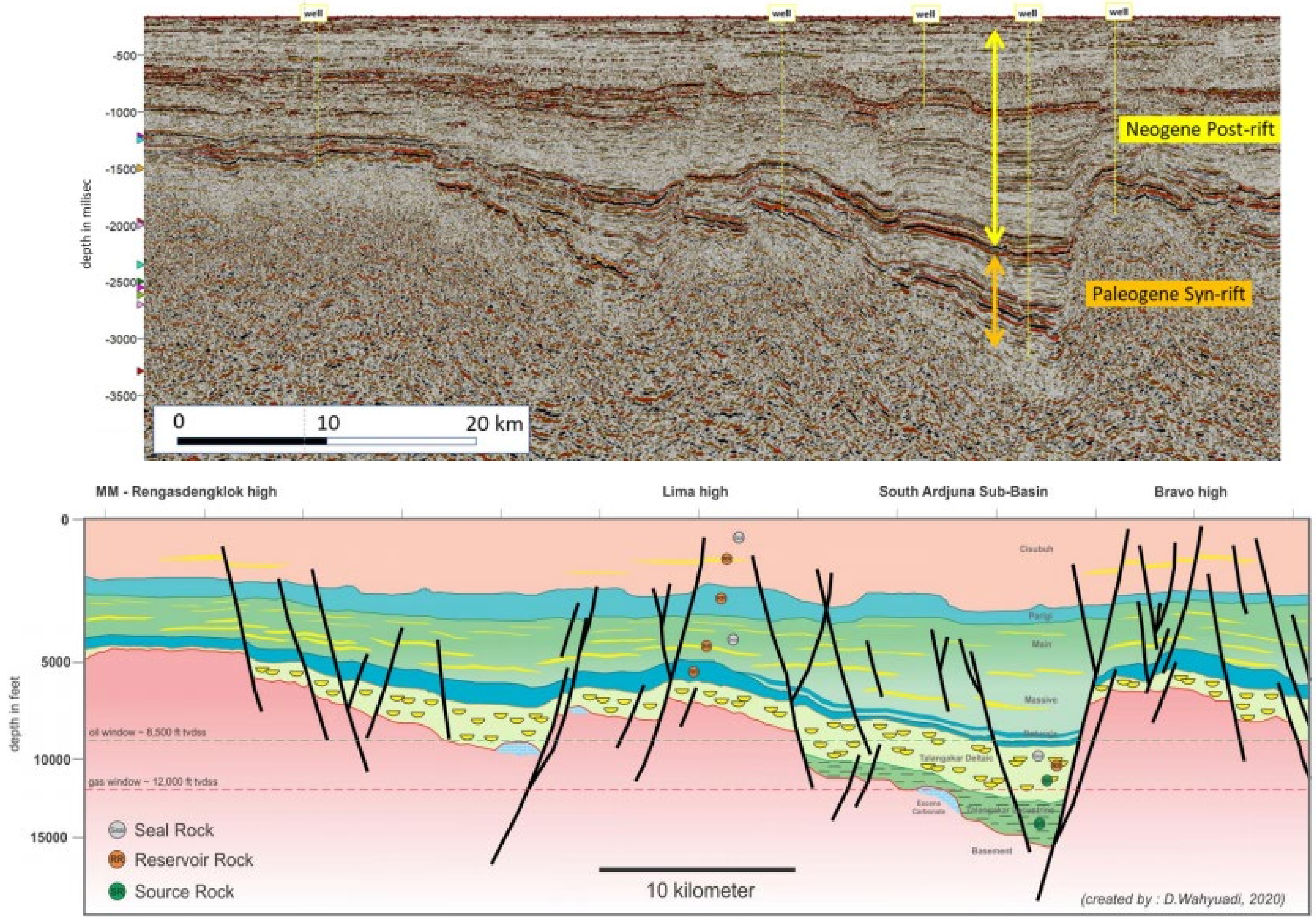


(Bishop, 2000)



- Offshore Northwest Java area consists of the OSES (Offshore Southeast Sumatra) and ONWJ (Offshore Northwest Java) blocks which are exploration and production blocks.
- Sub-basins in the Offshore Northwest Java Basin (ONWJ) these are the Asri, Sunda, Yani and North Seribu Trough, Ardjuna (south, central, and north), E-15 graben and Jatibarang Sub-basin.

South Ardjuna Sub-Basin



(Wahyuadi, 2020)

- The production formation in the Southern Ardjuna area primarily includes the Parigi and Pre-Parigi intervals, which are marine carbonate build-ups deposited during the Neogene section. These formations are significant for their contribution to the hydrocarbon production in the South Ardjuna Sub-Basin.

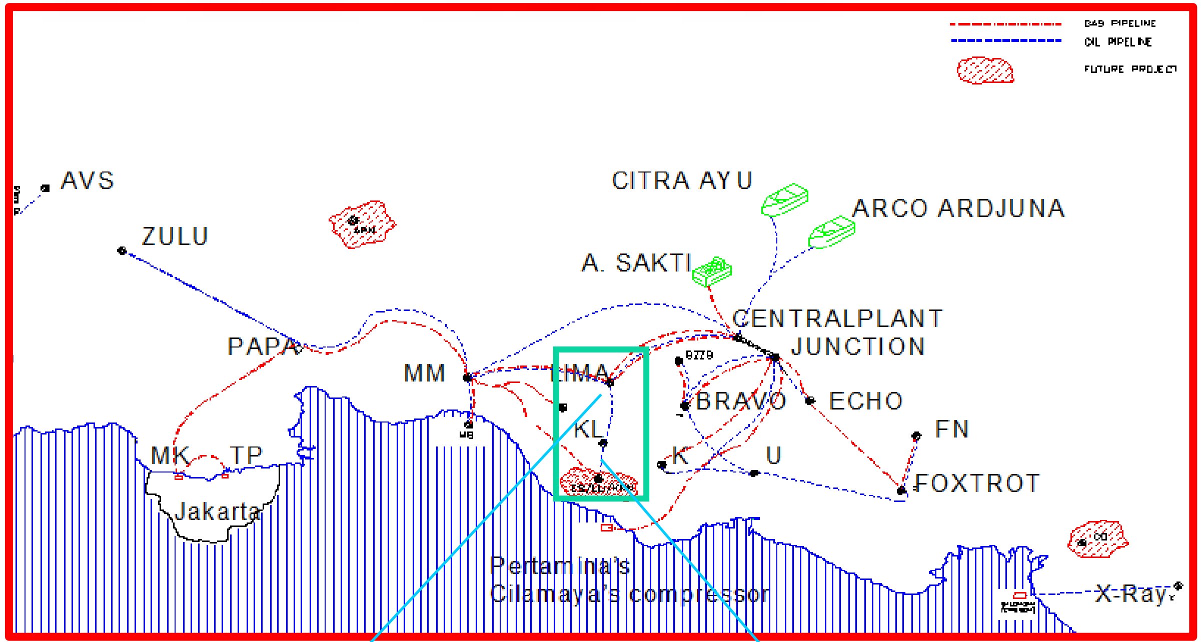
- Exploration in a mature field presents numerous challenges. Due to extensive exploration and development activities over more than 50 years, almost all conventional plays in mature fields like the Offshore Northwest Java Basin have been explored and produced.

Parigi Formation as Gas Reservoir

- The offshore Northwest Java (ONWJ) Block has oil and gas fields that have been producing since 1967. Oil production mainly comes from Main Formation and Talang Akar Formation. As for Gas production, currently comes from Parigi & Pre Parigi Carbonate.

- PHE ONWJ production installed capacity is 300 MBOPD (oil) and 300 MMSCFD (gas). Due to natural decline, the production to date is 27 MBOPD (oil) and 74 MMSCFD (gas).

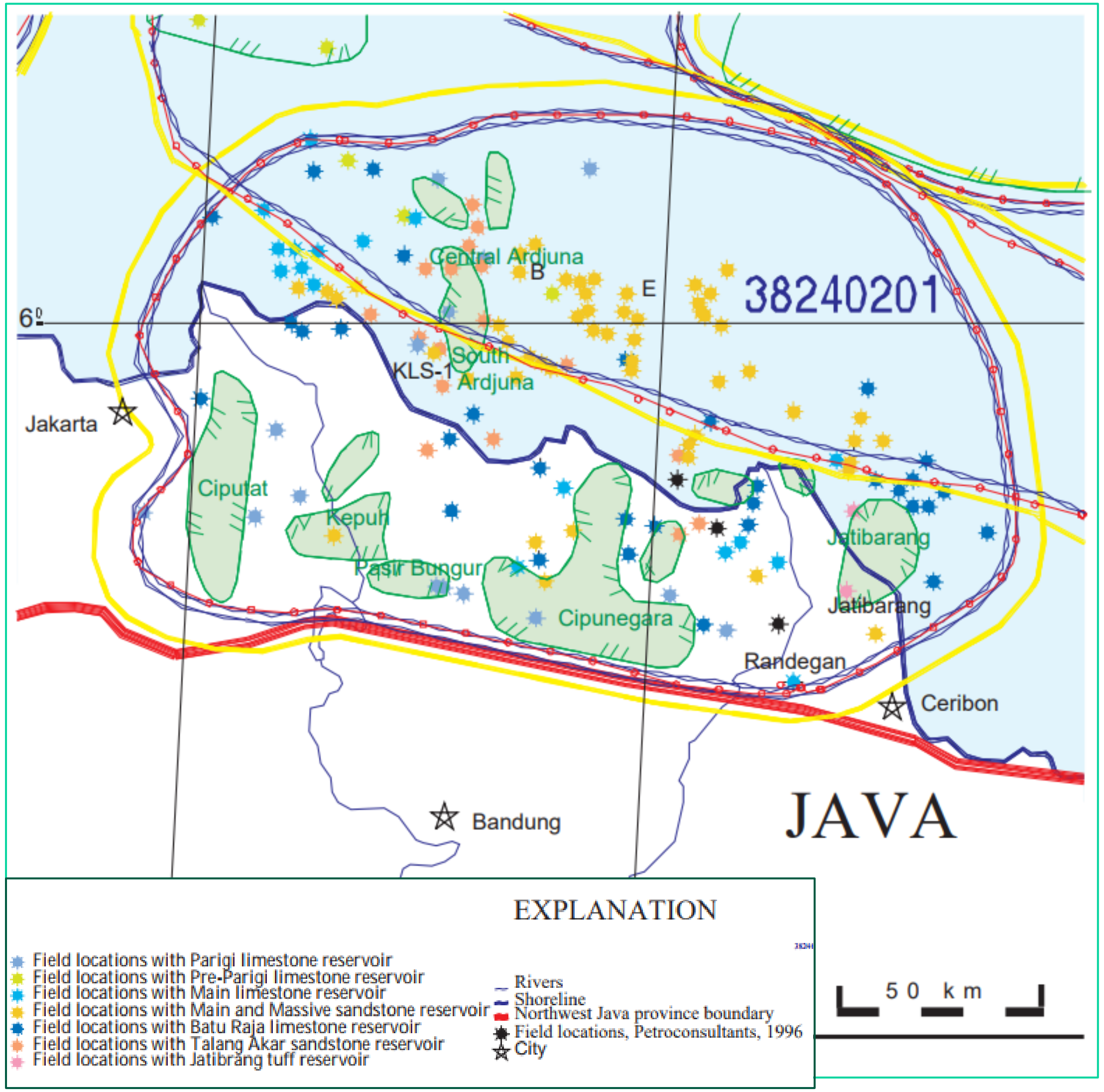
- The Weyburn Oilfield, Canada, with its commercial-scale CCS project, serves as a benchmark for evaluating the suitability of geological formations in Indonesia for CCS. Based on the geologic characteristics of the reservoir in Weyburn, a similarity with the Parigi Formation was found, specifically mentioning that Parigi has the same rock types and diagenesis process. (*Hendry & Marbun, 2011*)



Platform at Lima Field

Platform at KL Field

Parigi Formation as CO_2 Storage



(Bishop,2000)

- The Parigi Formation has favorable reservoir characteristics, including appropriate depth, high permeability, and porosity.
- The formation is capped by the Cisubuh Formation shales, which provide a tight seal, preventing the escape of CO_2 and ensuring its long-term containment. The Parigi Formation also has a lower geothermal gradient compared to other formations.
- The total “known” gas volume is 8 Tcf. Only 1.5 TCF of the 8 TCF is produced (USGS, 2000). If the proven volume gas is 1.5 TCF and potential volume 8 TCF it means (1 TCF of natural gas ≈ 54.86 Mt of CO_2), **the potential volume capacity CO_2 is 82 Mt – 438 Mt.**
- After the depleted gas and oil have run out, the deep saline aquifer, which has more depth, can be explored in the future.

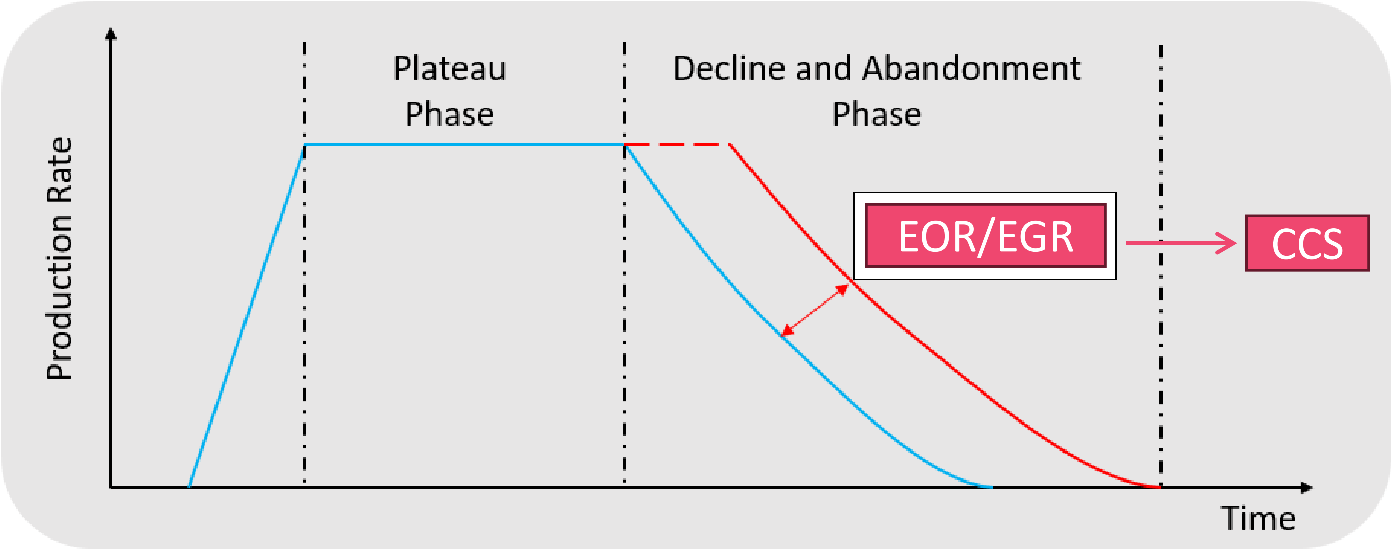
Prospect of Parigi Formation for CO_2 Storage

Parameter	Lower Cibulakan	Middle Cibulakan	Upper Cibulakan			Parigi Formation
	Talang Akar Formation	Baturaja Formation	Main and Massive Sandstone	Main Carbonate	Pre-Parigi	
Porosity	7-28%	15-36%	12-36%	16-32%	30%	20-35%
Permeability	20-3000 mD	10-1000 mD	0,2-3000 mD		< 2000 mD	50-2000 mD
Reservoir Thickness	1000ft	900ft	1000ft	340ft	700ft	1500ft

(Hendry & Marbun, 2011)

- Highlighting the Parigi Formation's suitability for CCS due to its favorable properties such as high porosity, permeability, and significant reservoir thickness

Decline & Abandonment Phase



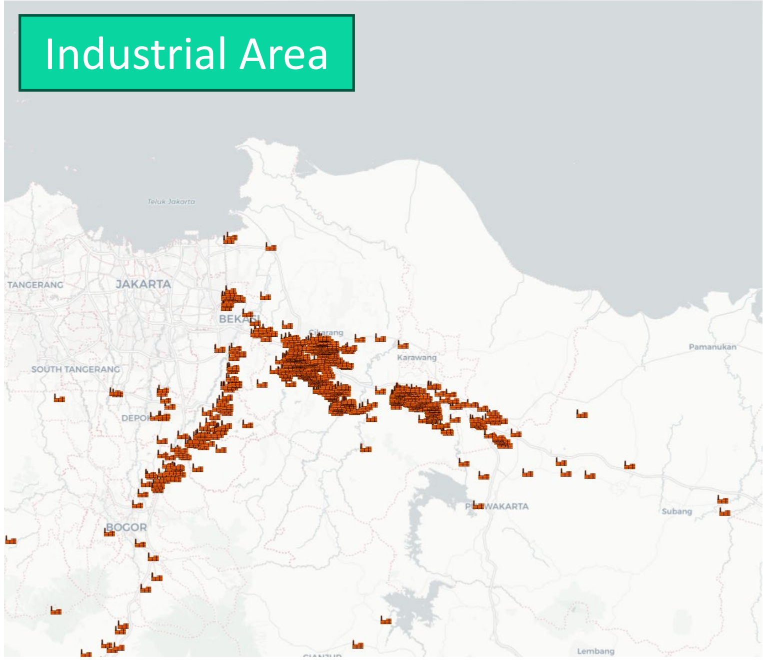
- CCUS can be used to maximize field production output by utilizing carbon dioxide for enhanced oil recovery (EOR) or enhanced gas recovery (EGR), therefore reducing overall emissions and increasing productivity.

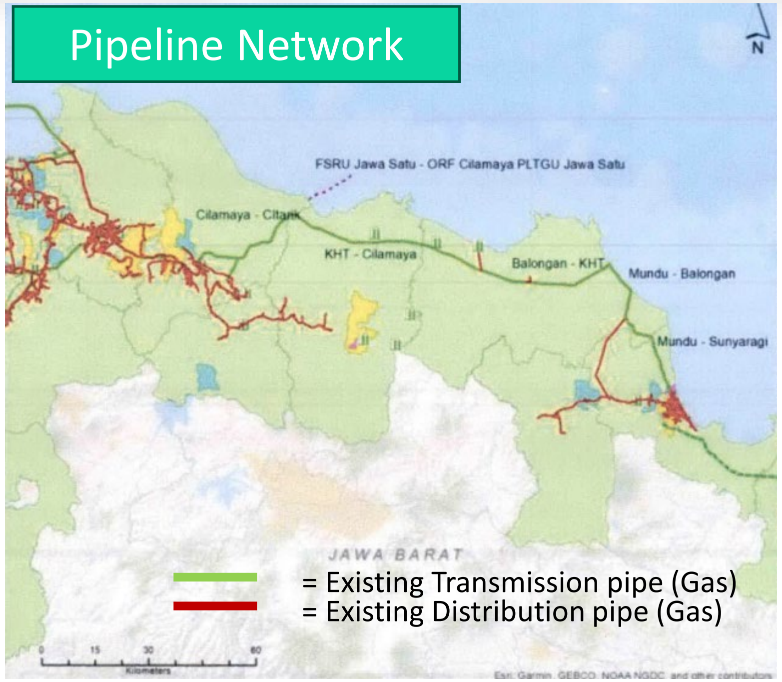
- Indonesia is a long-standing producer of crude oil, though production has been falling steadily for more than 20 years, having reached a plateau between 1977 and 1995, turning the country into a net oil importer.

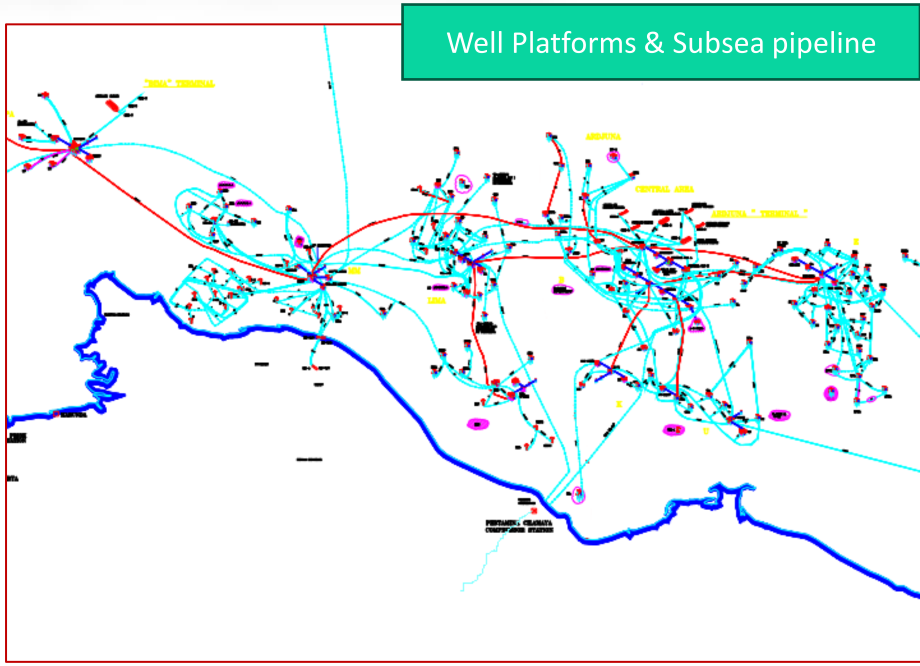
- The government is seeking to boost oil production and reduce import dependence for economic and energy security reasons. There may be extensive opportunities for Enhanced Oil Recovery (EOR), including using CO_2 , given the maturity of many of the country's oilfields.

- CO_2 -EOR is a potentially attractive win–win solution for Indonesia, by halting the decline in oil production while addressing the urgent need to curb CO_2 emissions.

Existing industrial areas, gas pipelines, and well platforms in West Java Province



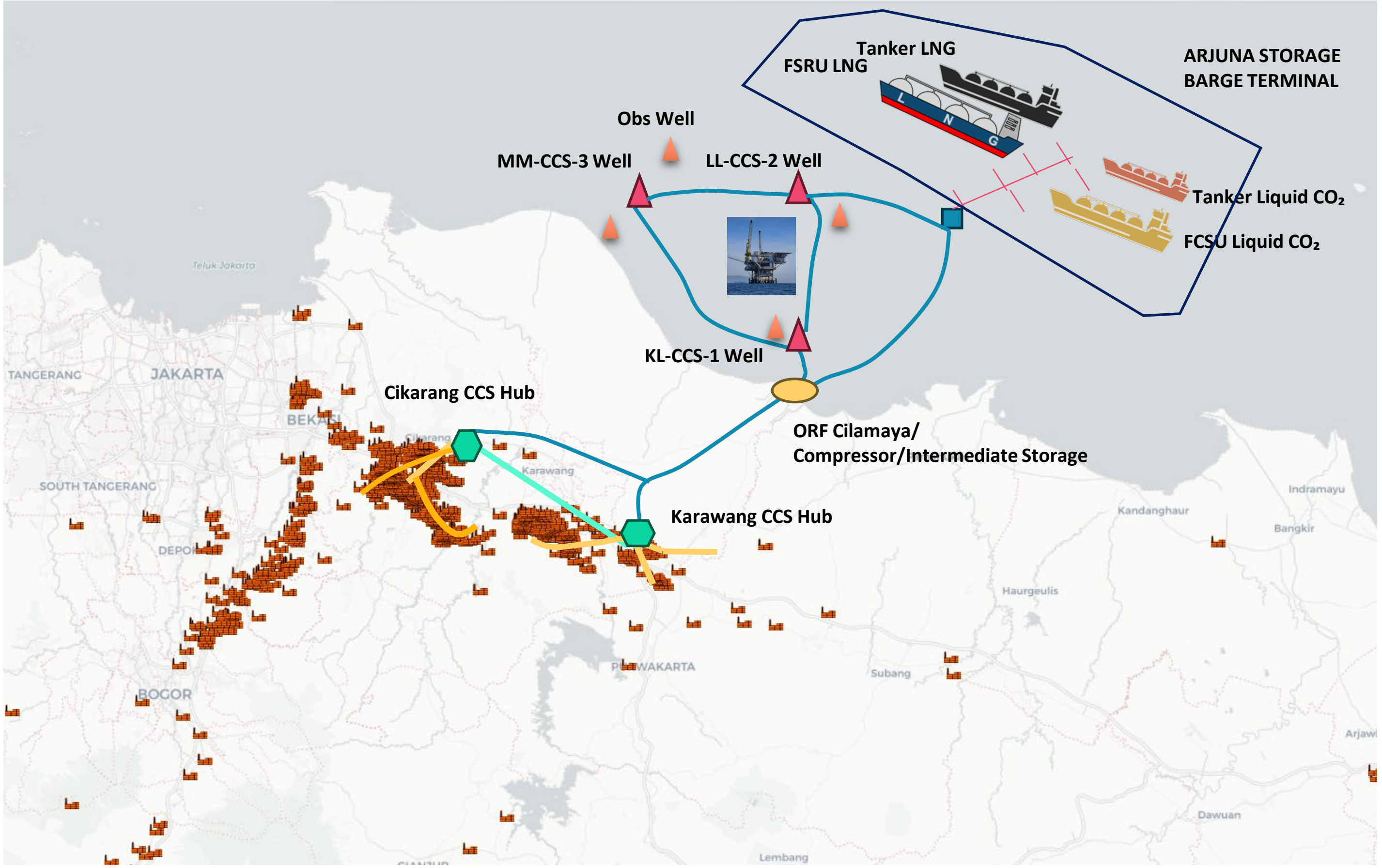




Satu Peta Jabar, 2024

- Most of industrial estates are located in north-western part of West Java, mainly in Bekasi-Cikarang and Karawang
- The most concentrated CO_2 production occurs around Jakarta and the western part of Java. The energy sector significantly contributes to emissions. The majority of emissions come from fossil fuels power generator and industrial zone in the area.
- More than 100 platforms in the Offshore North West Java (ONWJ) area are in Abandonment and Site Recovery (ASR) status due to depleted oil.

CCS Hub & Sharing Infrastructure



- Sharing infrastructure for CO_2 capture, transport, and storage can significantly reduce costs and emissions in industrial facilities.
- Cross Border CCS value chain activities must allocate at least 70 percent of their total carbon storage capacity for domestic carbon storage, while the remaining 30 percent can be designated for storing carbon from overseas.
- Shared pipelines allow for the aggregation of CO_2 from multiple sources, leading to larger pipeline capacities and reduced average transport costs.

= CO_2 pipe (Gas)

= Flue gas ducts

= Injection Well Platform

= Shared CO_2 Capture Plant

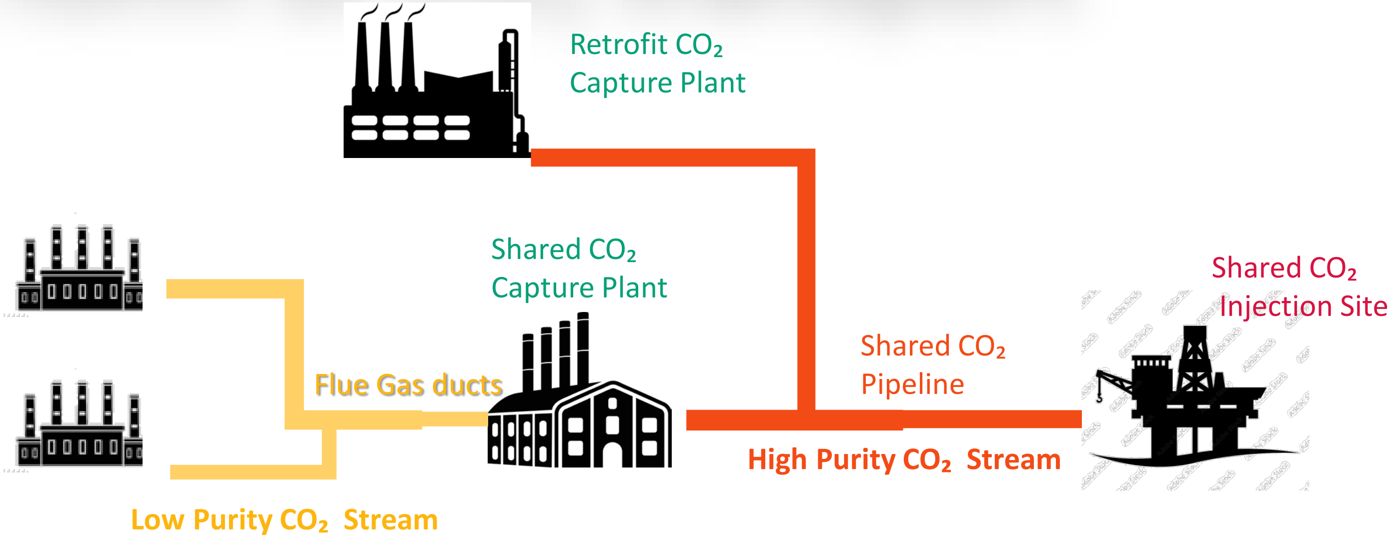
= Intermediate Storage & Compressor (Onshore)

= Observation Well Platform

= Floating CO_2 Storage Unit/compressor

= Liquid CO_2 Carrier

Use of flue gas ducts as an alternative form of CO_2 transport



- Shared capture plants benefit from economies of scale, which can reduce the average cost of CO_2 capture. For example, when shared capture facilities are introduced, average capture costs can fall by 19% to 36% depending on the scenario.

- The economic feasibility of ducting flue gases is limited by distance. For example, the maximum feasible ducting distance is estimated to be around 14 km, beyond which the costs of ducting would exceed the capture cost savings.

- High-purity CO_2 streams, such as those from ammonia production or natural gas processing, require simpler capture systems. These systems typically involve only CO_2 dehydration, compression, and cooling, without the need for cogeneration. This is because high-purity streams require very little heat supply for capture. *(Gunawan, Princeton U., 2023)*

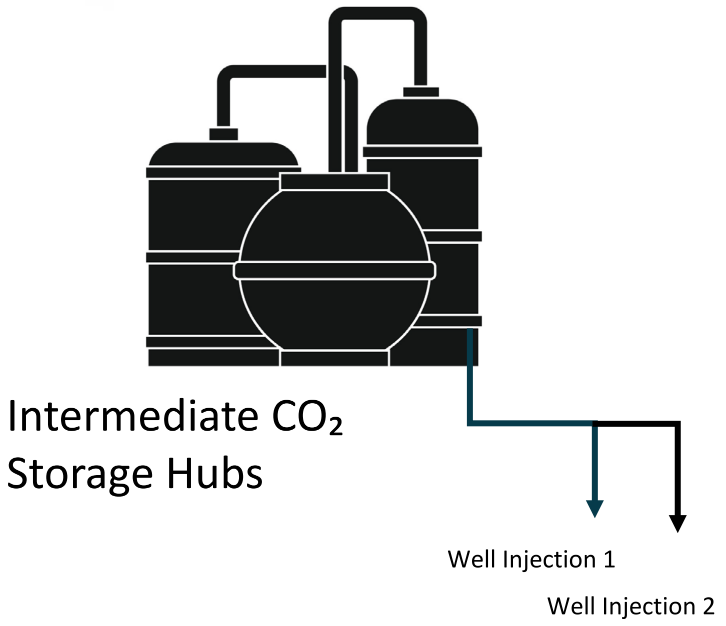
Transport & Injection Strategy

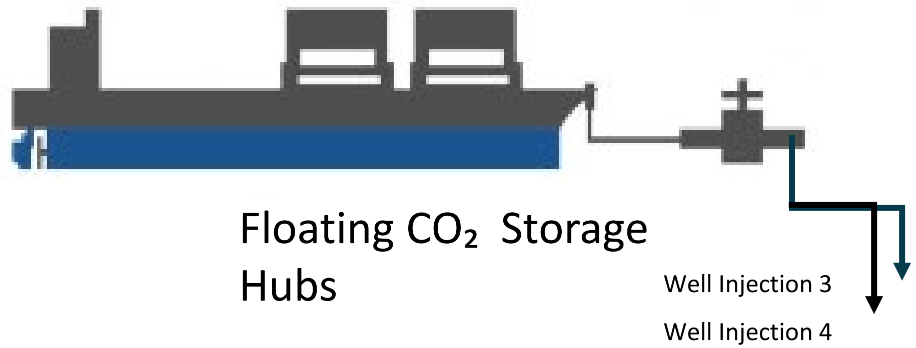
- Intermediate/Storage hub plays a crucial role in the overall CO_2 management chain by providing a flexible and efficient solution for the transportation, temporary storage, and continuous injection of CO_2 into geological reservoirs.

- Continuous Injection: Storage Hubs allows for the continuous injection of CO_2 into geological reservoirs, transitioning from a discontinuous logistics chain to a continuous process.

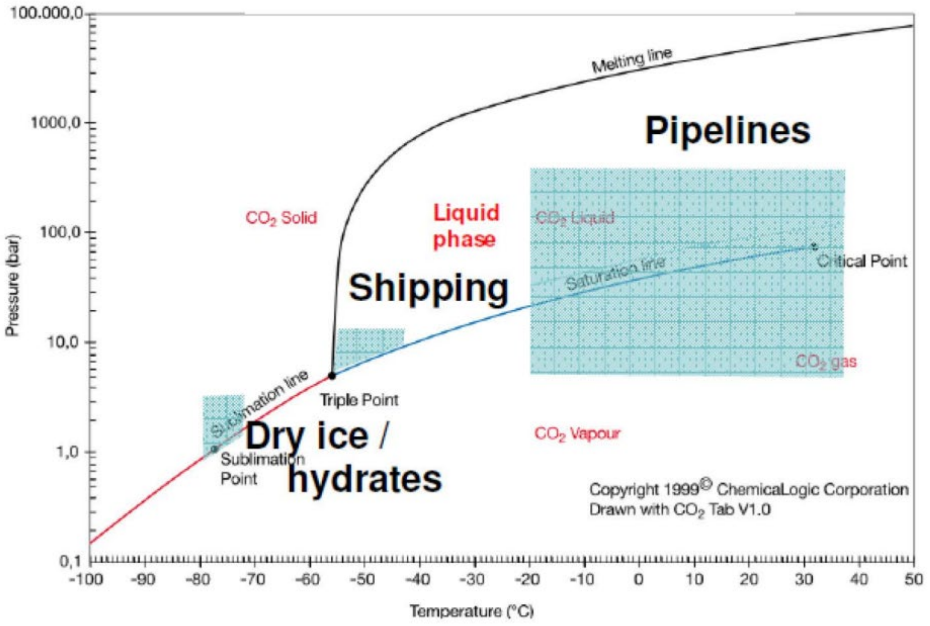
- Multi-well injection can be used as a backup to ensure continuous CO_2 injection. This approach can help distribute the injection load and mitigate risks associated with blockages or operational issues in a single well.

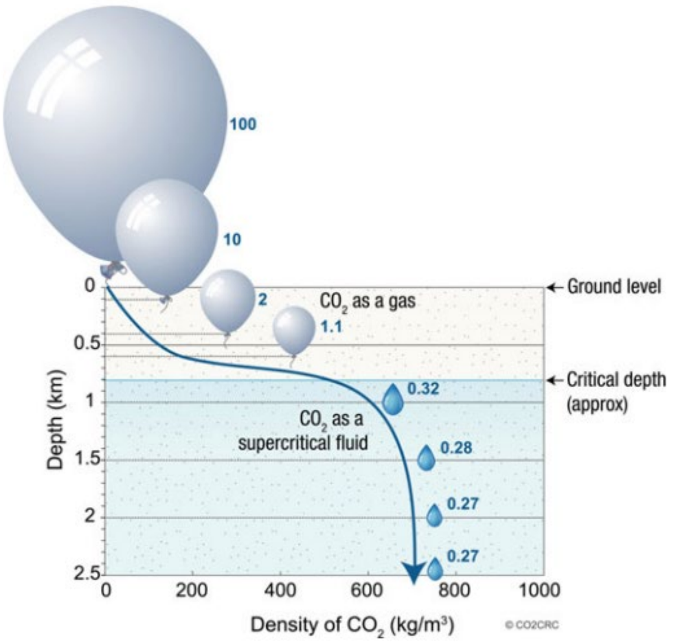
- Intermittent injection can cause blockages in the reservoir, making the injection process less smooth and potentially disrupting the overall CO_2 management chain. Continuous injection, on the other hand, ensures smoother operation and increases the availability of the injection system.





CO_2 Phase Diagram





-Liquid CO_2 Density : Approx 1.03 to 1.10 g/cm³
-LNG Density : Approx 0.45 to 0.50 g/cm³

Because liquid CO_2 has a higher density than LNG, ships designed to transport LCO_2 need to account for the greater weight per unit volume.

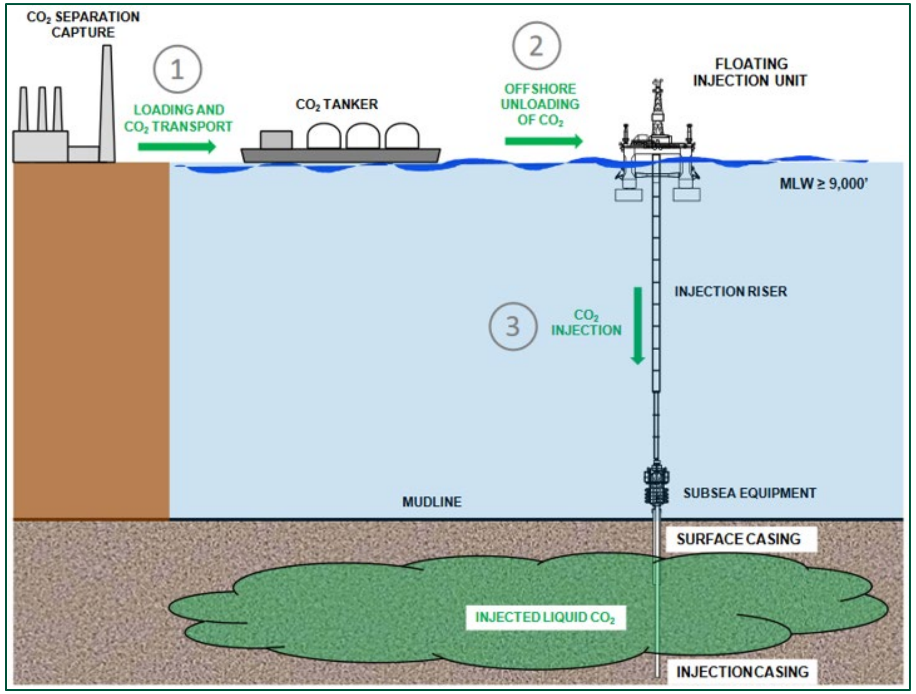
- The phase diagram is crucial for understanding the phase behavior of CO_2 under various pressure and temperature conditions, including the presence of impurities. This understanding is essential for ensuring the technical and operational viability of repurposing pipelines for CO_2 transport, as it helps in maintaining single-phase flow and avoiding issues like hydrate formation, pipeline plugging, and corrosion.

- No need cryogenic temperature like as LNG ship at -162°C. CO_2 at around -20°C, applying pressure in 25-50 bar should suffice to convert gaseous CO_2 into liquid CO_2 (reducing cost)

Offshore CCS

- Storing CO_2 offshore reduces the risk of groundwater contamination compared to onshore CCS projects. Offshore storage sites, such as depleted oil and gas reservoirs or deep saline aquifers, are typically located far from freshwater aquifers, minimizing the potential for CO_2 to migrate and contaminate groundwater resources.

- Storing CO_2 offshore can help avoid community issues on land, such as concerns about safety, land use, and environmental impact. Offshore storage sites are typically located far from populated areas, reducing the potential for public opposition and allowing for more flexible project development. Additionally, the use of existing offshore infrastructure, such as platforms and pipelines, can further enhance the feasibility and cost-effectiveness of offshore CO_2 storage



- Storing CO_2 offshore can also simplify the supply chain, particularly when dealing with overseas transportation. Offshore storage sites can be more accessible for ships transporting CO_2 from different regions, reducing logistical complexities and costs associated with overland transportation. This flexibility can enhance the overall efficiency and feasibility of CO_2 storage projects

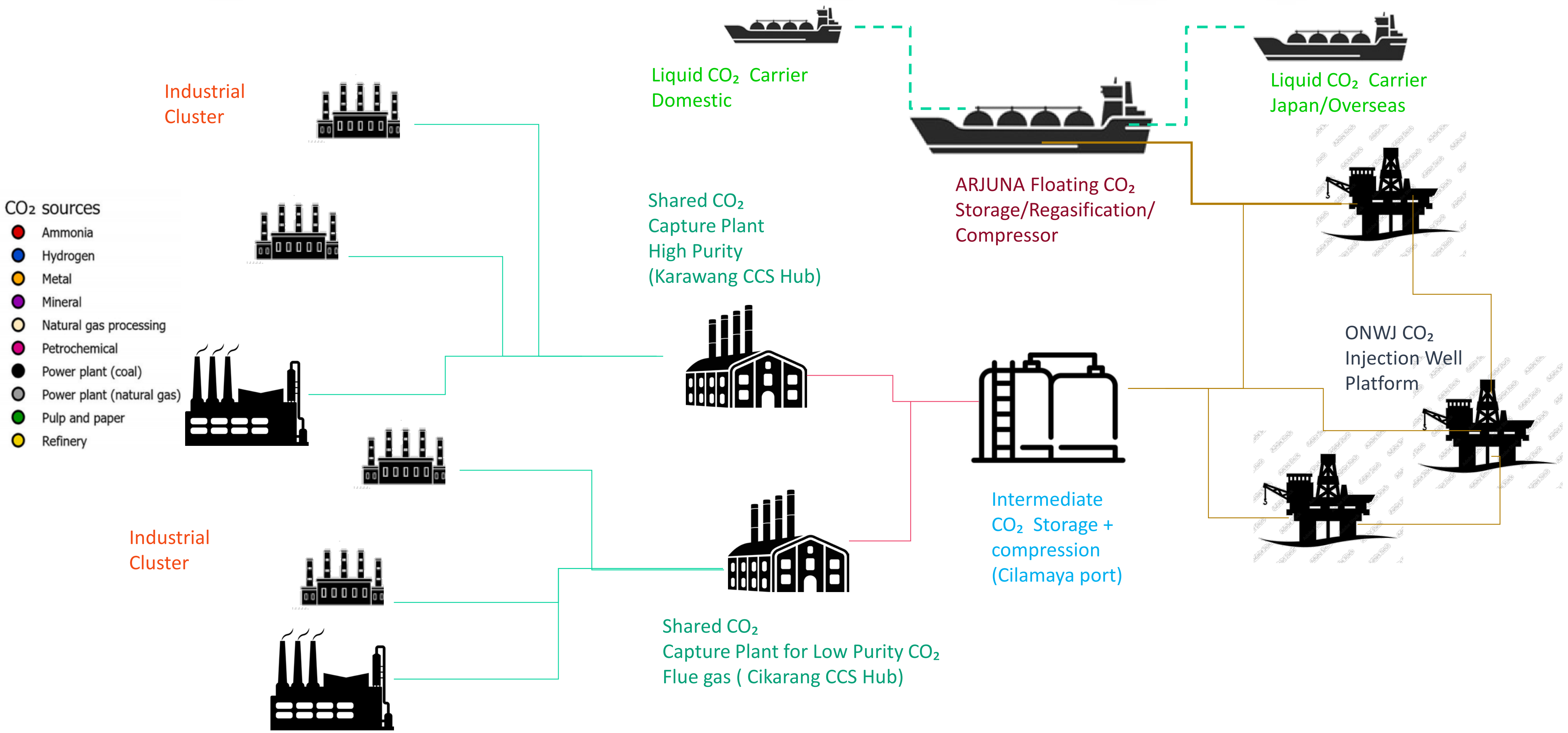
The opportunity of reusing Offshore Infrastructure

- The abandoned platform in the ONWJ area has the potential to serve as both an injection well and an observation well.

- A risk-management methodology can be incorporated to evaluate primary and secondary barriers in existing plugged and abandoned (P&A) and development wells to ensure long-term viability of CO_2 sequestration projects

- Depleted gas fields, close to economical life cessation, are deemed excellent geological stores because long-term safe storage is already proven, and immense geological knowledge has been acquired during production life. Moreover, there is great potential to repurpose the existing infrastructure (pipelines, platforms, and wells to some extent) as to minimize capital expenditure and delaying decommissioning costs. Repurposing existing production systems could also be an efficient way to achieve rapid deployment of CCS at large scale.

Multiple Sources – Multiple Storage Injections



Japan – Indonesia CCS Value Chain

- An effort to evaluate the feasibility of separating and capturing CO_2 emitted in Japan and then transporting it to Indonesia for storage.

- To initiate a joint study or any collaborative project under the Japan Credit Mechanism (JCM), a bilateral agreement between Japan and Indonesia is essential to discussing about Framework Agreement and Regulatory Harmonization. **Establish a Joint Committee**: Create a bilateral committee comprising representatives from both countries, including government officials, industry experts, and scientific advisors.

- To support CCS effectively under the JCM, we particularly concerning monitoring, reporting, and verification (MRV) to ensure accurate capture, transport, and storage of carbon without CO_2 leakages.

THANK YOU