The 15th Asia CCUS Network (ACN) Knowledge Sharing Conference

“ Decarbonization of Thermal Power Plants and CCS Business: Indonesia Case Study”

Wednesday, 24 July 2024

13:00 – Jakarta Standard Time

SUMITOMO CORPORATION

Energy Innovation Initiative SBU,

CCUS & Subsurface Energy Business Unit

Agenda

Jakarta Standard Time

13:00 – 13:05	Opening remarks, by Mr. Shigeru Kimura, Senior Research Fellow, ERIA
13:05 – 13:35	Decarbonization of Thermal Power Plants and CCS Business: Indonesia Case Study, presented by Soichiro Kunihiro, Sumitomo Corporation Moderated by Dr Gusti Sidemen, CCUS Fellow, ERIA
13:35 – 14:05	Open Discussion
14:05 – 14:15	Closing Remarks by Dr. Han Phoumin, Senior Energy Economist, ERIA

Contents

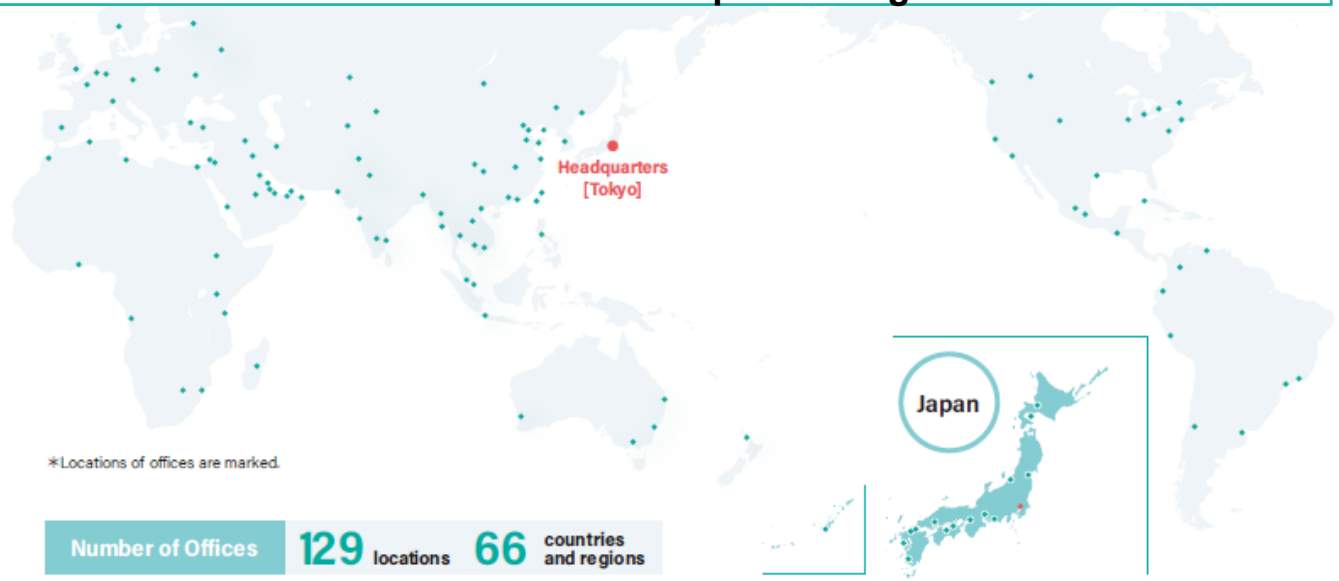
01

Introduction of Sumitomo Corporation

Sumitomo Corporation at a Glance

Organizational Change (April 2024 ～):

- **Transition from a product division structure to a Strategic Business Unit (SBU) system (i.e. 9 groups, 44 SBUs)**
- **Advance and deepen our business strategies and create new businesses to achieve our exponential growth**



Number of Offices 129 locations 66 countries and regions

as of March 31, 2023

Shareholders' Equity (equity attributable to owners of the parent)	US$28.4billion
Net Income	US$4.2billion
Number of Consolidated Subsidiaries and Associated Companies	886 (78countries and regions) Consolidated Subsidiaries 636 (Japan:135 Overseas:501) Associated Companies 250 (Japan:50 Overseas:200)
Number of Employees (Consolidated Base)	78,235

Corporate Evaluation — FortuneGlobal 500

Sumitomo Corporation has been ranked in the Fortune Global 500, an annual list compiled and published by US Fortune magazine, for 28 years, as one of the global companies leading the world's development.

International Financial Reporting Standards (IFRS)
The US Dollar amounts represent translations of Japanese Yen amounts at the rate of ¥133=US$1.

- Corporate Group
- Steel Group
- Automotive Group
- Transportation & Construction Systems Group
- Diverse Urban Development Group
- Media & Digital Group
- Lifestyle Business Group
- Mineral Resources Group
- Chemical Solutions Group
- Energy Transformation Business Group

(as of April 1, 2024)

Sumitomo Group's Business Fields

Based on nine "Groups" that concentrate the power of Sumitomo Corporation, we anticipate market changes and social needs in each business domain, and aim to improve corporate value by resolving social issues through value creation that transcends industry frameworks.

Energy Transformation Business Group

- Energy Innovation Initiative (EII) SBU
- Japan Energy Solution SBU
- Overseas Energy Solution SBU
- Indonesia Energy Solution SBU
- Gas Value Chain SBU
- Maritime Energy Solution SBU

Steel Group

Diverse Urban Development Group

Automotive Group

Media & Digital Group

Mineral Resources Group

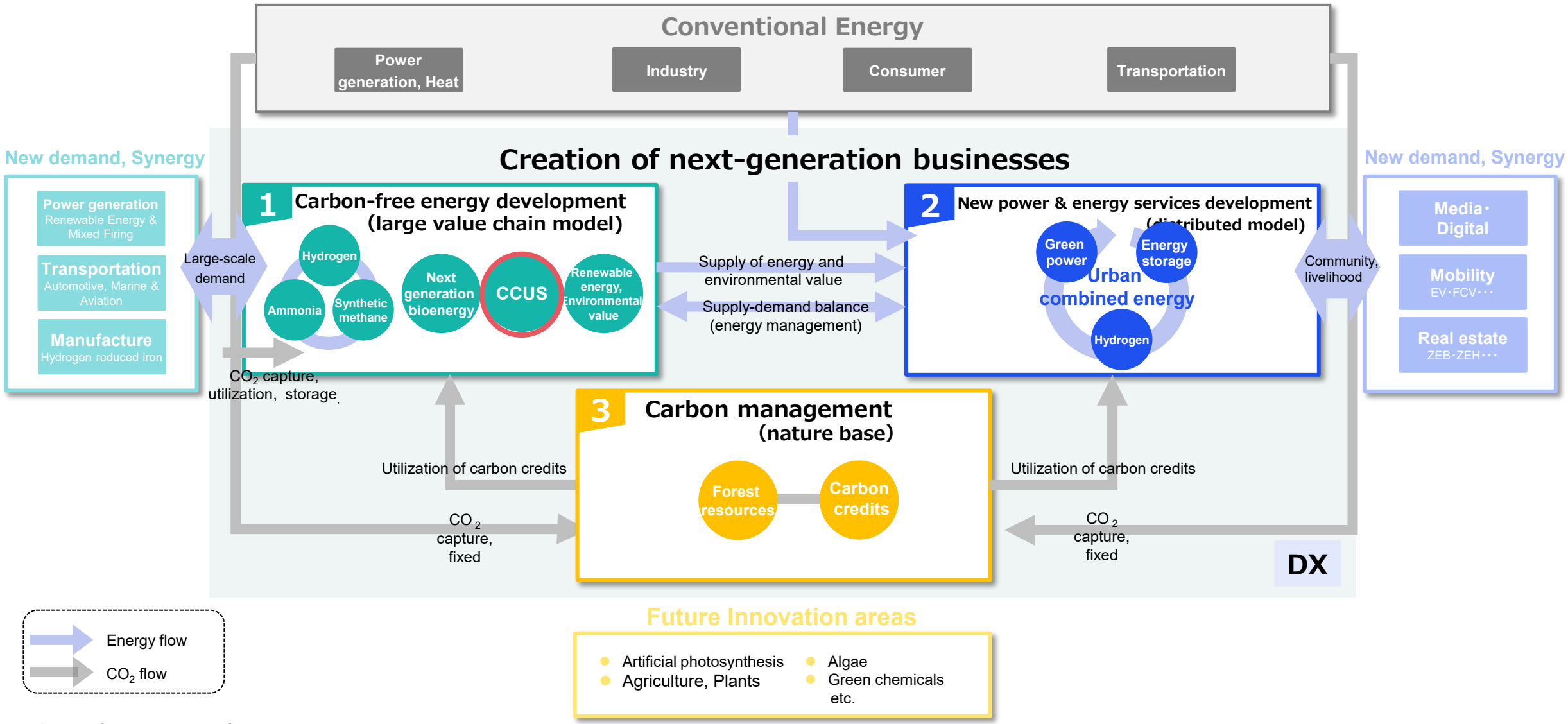
Transportation & Construction Systems Group

Lifestyle Business Group

Chemical Solutions Group

Sumitomo Corporation | Enriching lives and the world

Creation of next-generation businesses that generate “New demand, Synergy, and Innovation”



Projects

Strategy: Timeline x Region x Our Strength

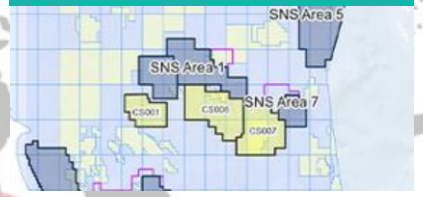
- **Short to Mid-term:** We will multiply our strengths and assets to quickly commercialize the CCS business in Europe and the U.S., where the CCS business is ahead of other regions, and to establish a foothold for the CCS value chain based on the Asia Zero Emissions Community concept.
- **Mid to Long-term:** Engage in large-scale CCUS business with the aim of further expanding business globally, based on the CCS/CCU business and functions that we have built up.

CCUS in Alberta

Partnership with N.Dakota

CCUS in Texas / Louisiana

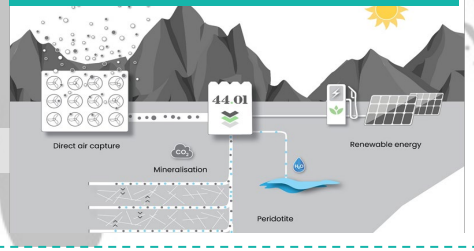
CS License in UK SNS



BECCS in Nordic

CCS Collaboration with SNOC

CCM (Mineralization) in Oman



Cross Border CCS

Asia Zero Emission

Blue H2 Projects in AUS

Start Ups／Utilization and business development for innovative technology

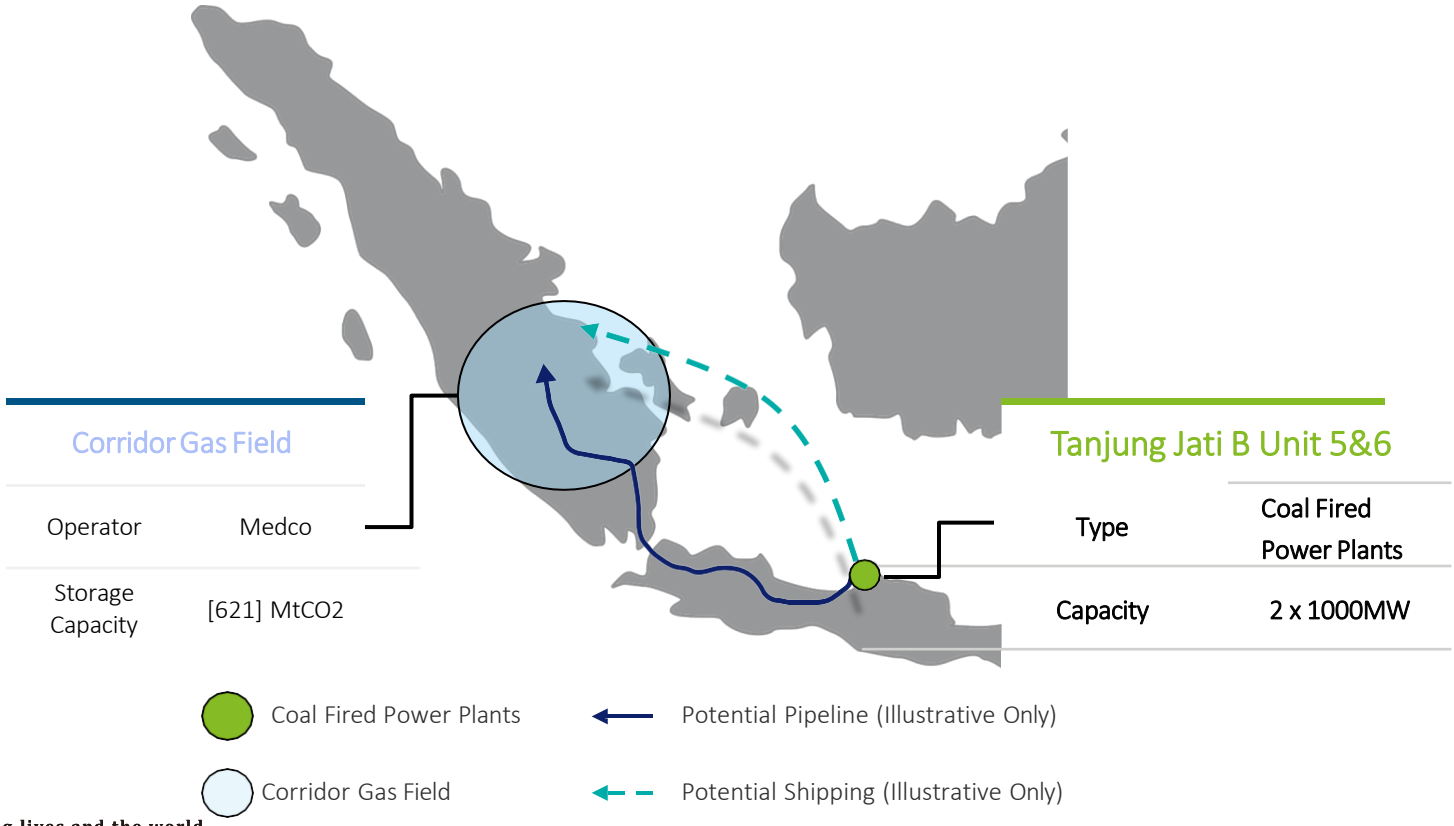
44.01	EARTH SCIENCE ANALYTICS	SUSTEC	Inherit
Mineralization	subsurface AI Solution	subsurface Analysis	CDR Developer

02 - 1

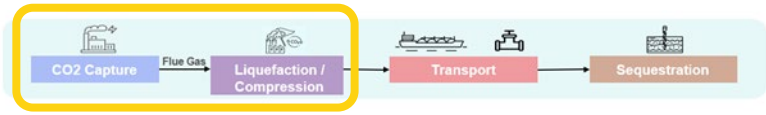
Overall Outline
of
Indonesia CCS Case Study

CCS Case Study in Indonesia (Oct 2023 – Mar 2024)

- SUMITOMO has conducted a feasibility study on the application of **decarbonisation technologies of CCS** to the **thermal power plants in Indonesia** upon assuming **CCS value chain** as shown below.
- Through this study, we aim to contribute to **Indonesia's decarbonisation**, **stable power supply & sustainable economic growth**, which is consistent with **AZEC's goal of contributing to the Energy Transition in Asia**.

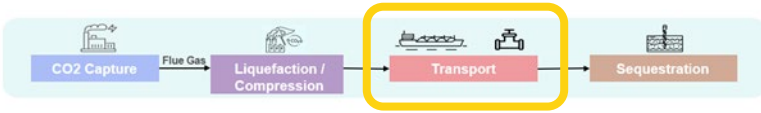


Tanjung Jati B 5&6 Overview

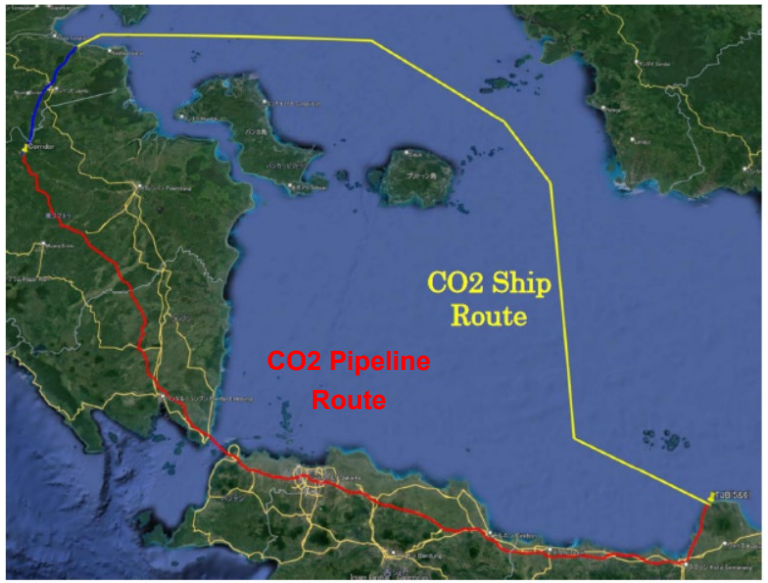


	TJB 5&6 Coal fired power plant
Project Company	PT Bhumi Jati Power
Sponsors	50% Sumitomo Corporation 25% The Kansai Electric Power Co. Inc. 25% PT United Tractors Tbk
Off-taker	PT PLN (Persero)
Project scheme	Build Own Operate Transfer (BOOT)
Term	25 years
Plant capacity	1,000MW x 2
Plant technology	Ultra Super-critical
- Turbine/generator	Toshiba
- Boiler	MHI
Coal (HHV)	4,000 – 5,250 kcal/kg
COD	Unit 5: Mar 2022 Unit 6: Sep 2022

Approach for the CCS Case Study



- Two cases for CO_2 transportation to be studied ;
  - ✓ **Shipping concept** as Case A
  - ✓ **Pipeline concept** as Case B



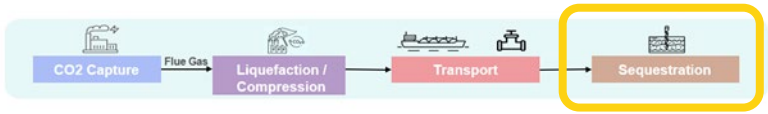
Case - A

CO_2 Capture → CO_2 → Liquefaction → Ocean Transport → Sequestration

Case - B

CO_2 Capture → CO_2 → Compression → Pipeline Transport → Sequestration

Corridor Gas Field Overview



- Operated by Medco, Corridor Gas Field has potential of approx. 600 Million Tonnes (Mt) CO_2 storage capacity on depleted reservoir
- There are several fields within Corridor Gas Field, Suban field is the largest depleted reservoir within Corridor Gas Field and expected with a capacity of approx.400Mt CO_2.

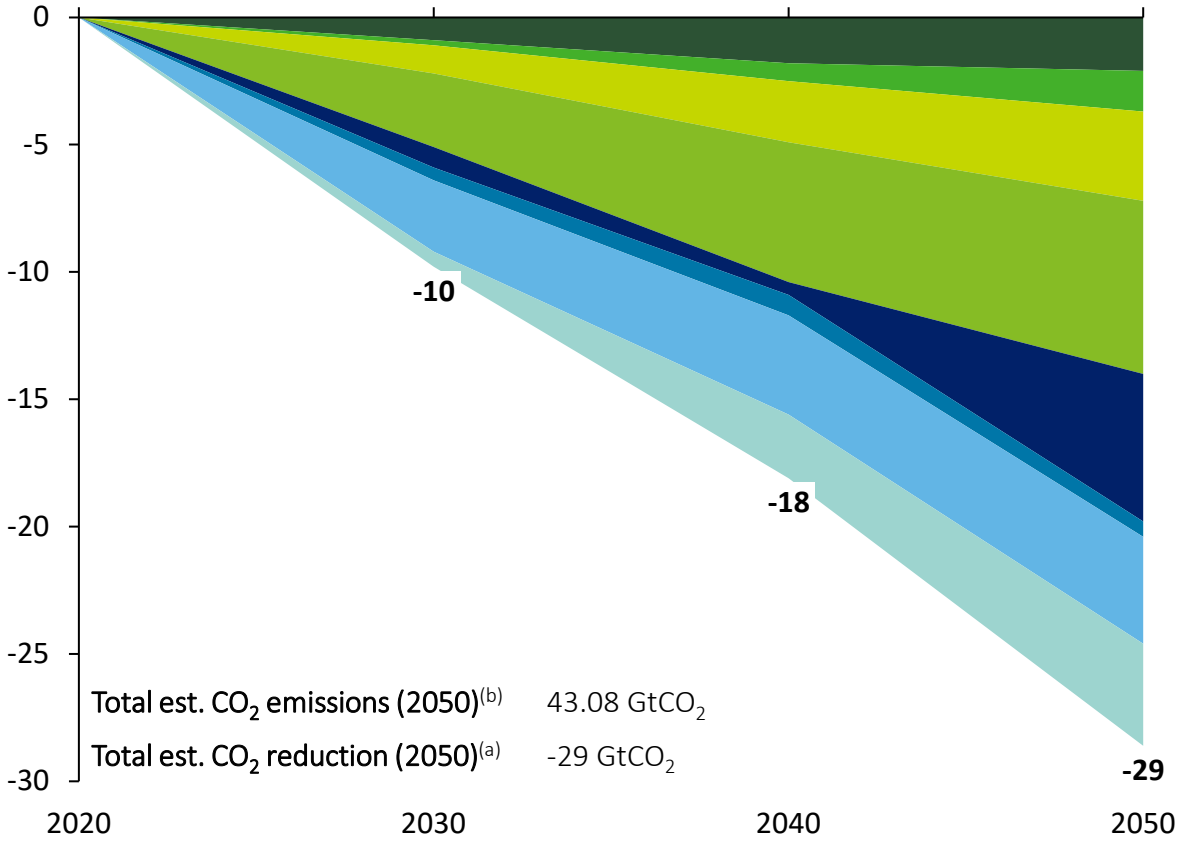
02 – 2

CCS Market Overview
of
Global and Indonesia

Global Market Landscape

➢ CCUS will play a key role in abating up to 4.1 GtCO2 of global CO2 emissions by 2050

CO_2 emissions reduction in Sustainable Development Scenario (Gt CO_2)[(a)]



Source % share (2050)[(1)]

Avoided demand[2]	7%
Hydrogen	6%
Bioenergy	6%
Other renewables[3]	24%
Electrification[4]	20%
Other fuel shifts[5]	2%
Technology performance	15%
CCUS	14%

Key Insights

- To achieve 2050 Net Zero Emissions (NZE) targets, carbon reduction technologies such as CCUS will be vital for hard-to-abate sectors (e.g. steel, chemicals, fertilizer, O&G, electricity and cement)
- Hard-to-abate industry emissions account for more than 25% of global GHG emissions
- Current applications of CCUS are low but expected to pick up rapidly

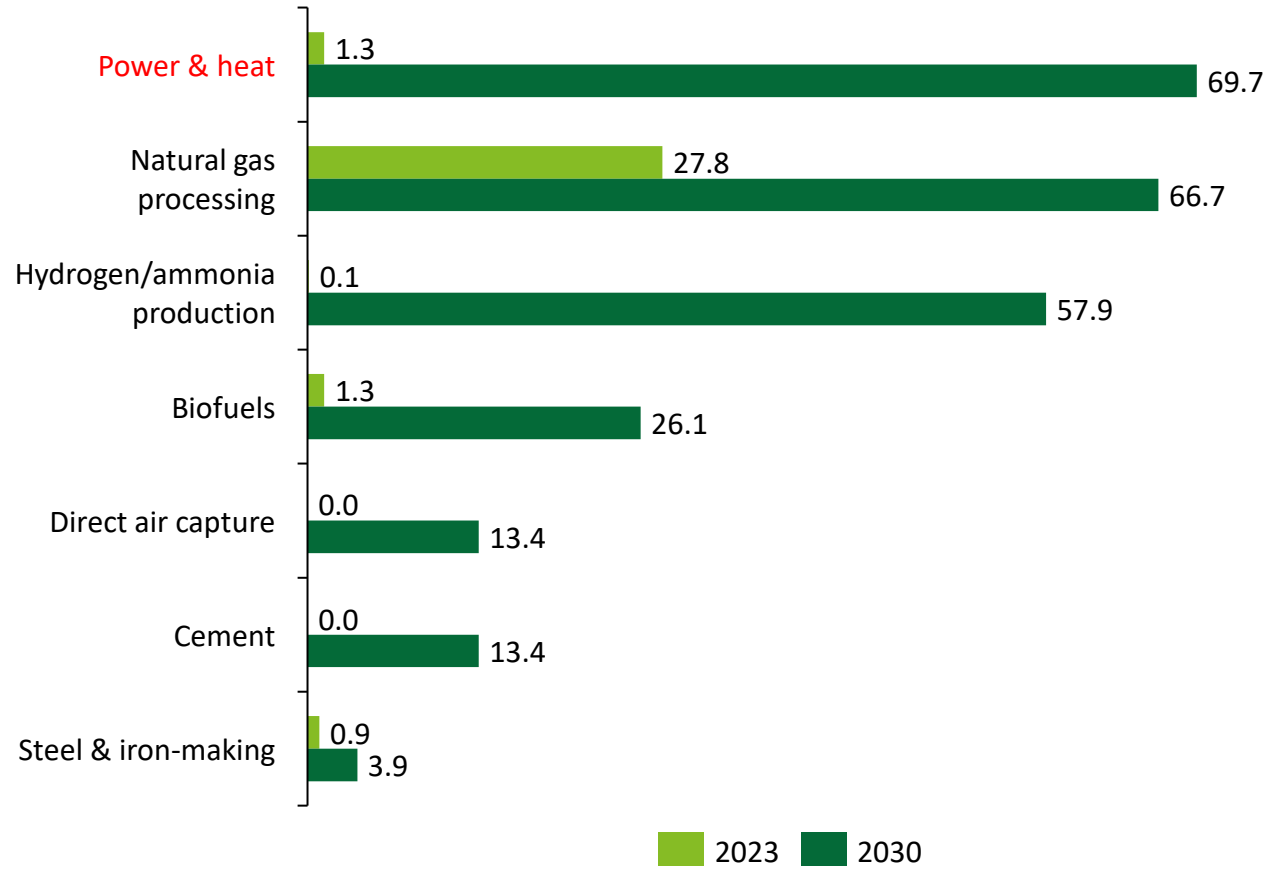
Notes: (1) Levers representing strategies to reduce emissions (2) Difference in energy or emissions from efficiency improvements in the use of resources *(i.e., extension of building lifetimes from using less steel)* (3) changes of electricity use *(i.e., shift to electric vehicles)* (4) changes for other renewables *(i.e., use of solar PV and wind)* (5) changes towards use of other fuels *(i.e., switches between fossil fuels or nuclear)*
Source: (a) IEA, (b) Statista, Monitor Deloitte analysis

(Ref: CCUS in the transition to net-zero emissions – CCUS in Clean Energy Transitions – Analysis - IEA

Global Market Landscape

➢ The majority of CCUS demand is expected to come from power generation, natural gas processing and hydrogen/ammonia production where CCUS already has notable existing use cases

Annual CO_2 capacity for CCUS projects by industries (Mt CO_2)[a]



Key Insights

- The primary energy source of Power generation is expected to continue to come from coal, *e.g., China produces more than 60% of its energy from coal; in APAC, average age of a power plant is ~12 years)* – it is expected that coal-fired power plants will be retrofitted with large-scale CO_2 capture technologies
- The second highest annual CO_2 capacity for CCUS projects is expected to come from the natural gas processing industry at ~28Mt of CO_2 capacity each year –**captured CO_2 is primarily used for enhanced oil recovery (EOR)**[b]
- The hydrogen and ammonia industries are expected to have high growth as **capturing carbon emitted from hydrogen and ammonia is cheaper than using renewable energy to produce such fuels at today's costs**[c]
- Change of usage proportion is also due to expected **growth of the power & heat industry** *(i.e., fossil fuel power plants seeing significant usage)*[b]

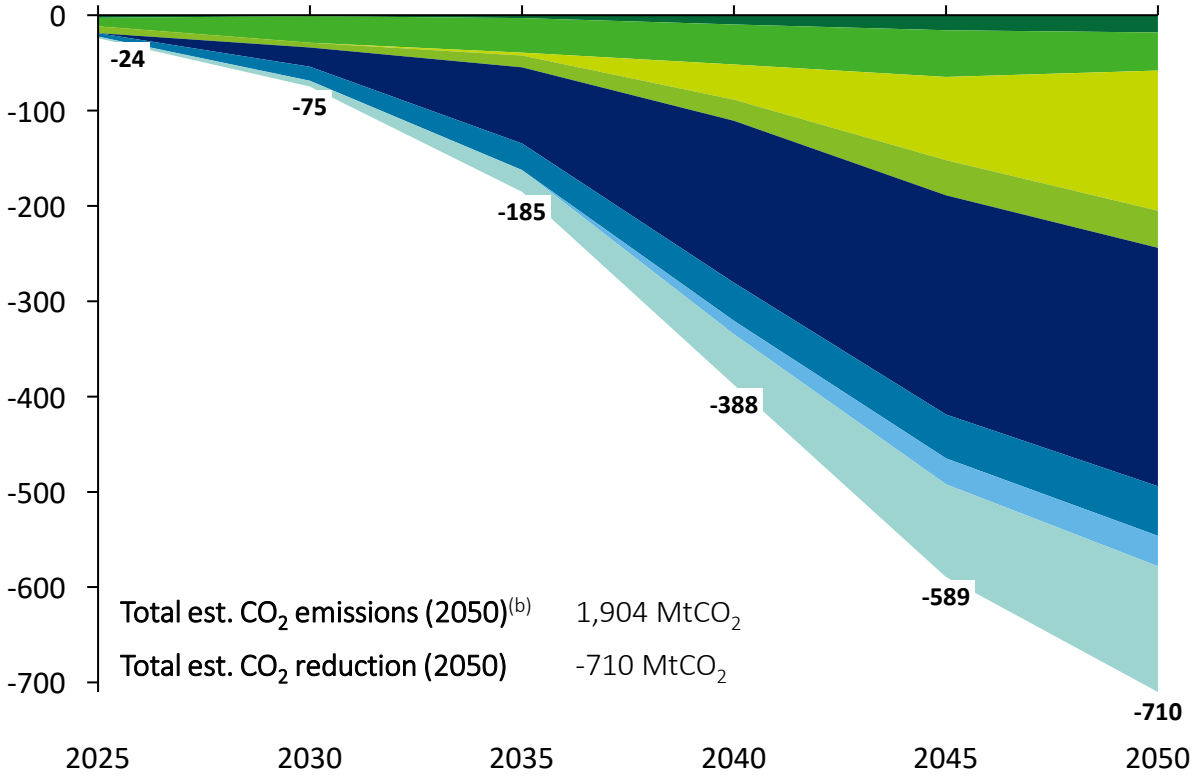
Source: (a) IEA, (b) GlobalData, (c) EnergyMonitor, Monitor Deloitte analysis

(Ref: Source 1: https://www.energymonitor.ai/carbon-removal/carbon-capture-where-is-it-working/?cf-view&cf-closed

Indonesia Market Landscape

➢ Inline with the global landscape, CCUS is expected to play a key role in Indonesia's CO_2 emission reduction effort contributing up to 135 Mtpa by 2050

CO_2 emission reductions from fuel combustion by measure in the Announced Pledges Scenario[1][a] ($MtCO_2$ pa)



Source % share[2] (2050)

Avoided demand[3]	3%
Energy efficiency	6%
Electrification	21%
Hydrogen and other fuel switching	5%
Renewables power generation	35%
Other renewables	7%
Other power decarbonization	5%
CCUS	19%

Key Insights

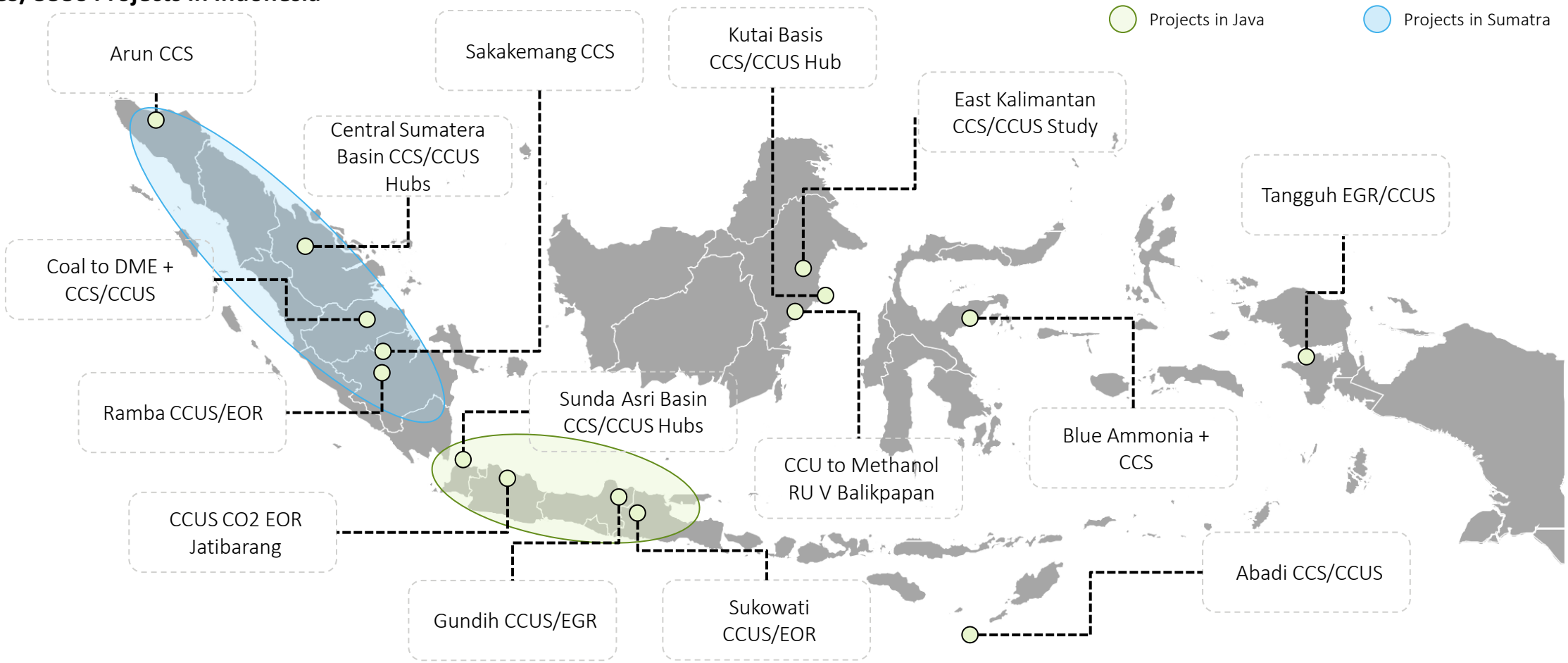
- CCS / CCUS is expected to play a significant role due to the Indonesian economy's reliance on crucial sectors such as manufacturing, steel, petrochemical, fertilizer and cement
- The most promising role for CCUS to play in Indonesia is to reduce emissions from industry manufacturing and the power generation sector
- Indonesia has the capacity to serve as a storage hub for countries with large manufacturing operations, who emit significant CO_2 emissions but **lack storage capacity in their geographies** (i.e., Japan, South Korea, etc.)[c]

Note: (1) Scenario assumes that all climate commitments made by governments and industries, including National Determined Contributions (NDCs) and longer-term net zero targets will be met on time (2) Percentages are rounded to the closest whole number, (3) Difference in energy or emissions from efficiency improvements in the use of resources *(i.e., extension of building lifetimes from using less steel)*
Source: (a) IEA, (b) ScienceDirect, (c) ANGEA, Monitor Deloitte analysis

Indonesia Market Landscape

- 15 CCUS projects are said to be in study/preparation stage targeting on-stream around 2030 with the majority concentrated in Sumatra and Java

CCS/CCUS Projects in Indonesia[(a)]



Source: (a) Ministry of Energy & Mineral Resources, Monitor Deloitte analysis

03 - 1

Current Assessment

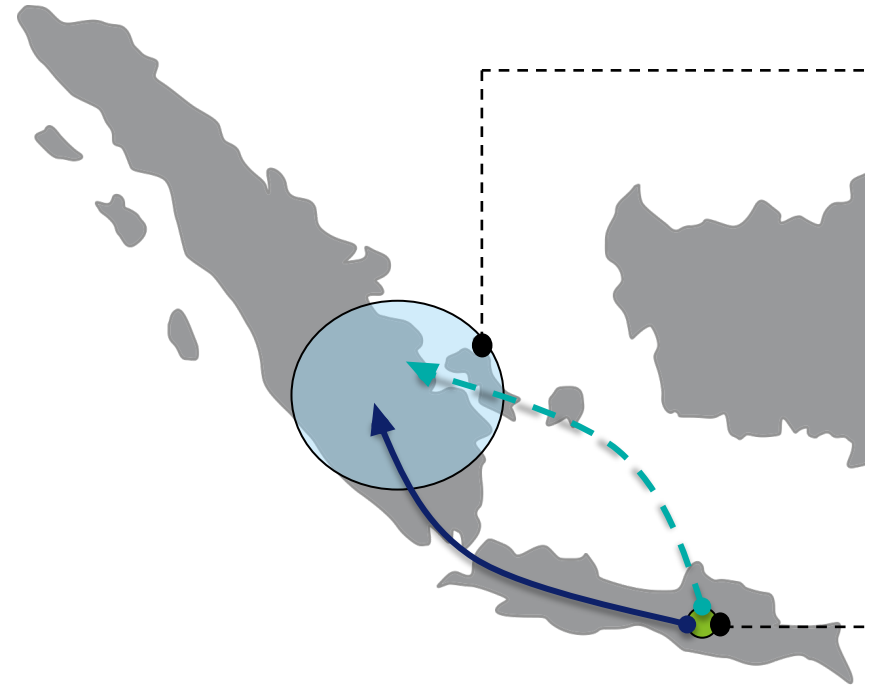
by

Indonesia CCS Case Study

CCS Value Chain Study / current assessment

➢ Original CCS project concept is based on capturing TJB Unit 5 & 6 carbon emissions, and transporting from Java to the Corridor Gas Field in Sumatera only for this study purpose

Project Plan



Corridor Gas Field

Company	Medco
Storage Capacity	Approx. 400 MtCo2 by Suban / Dayung / Sumpal Gas Fields

Tanjung Jati B Unit 5 and Unit 6

Company	PT Bhumi Jati Power
Project Partner	• Sumitomo Corporation (50%) • Other shareholders
Terms	25 years
Technology	Ultra Super-critical
Capacity	2 x 1000 MW
COD	• Unit 5: May 2022 • Unit 6: Sep 2022
Emissions	Approx. 6.5 MtCo2 p.a. each[1(a)]

Key Insights

Challenges

- Approximate distance from TJB unit 5 & 6 to the Corridor Gas Field is approx. 1,148 km using the pipeline transportation concept
- Non-existent infrastructure across capture, transport and storage throughout the value chain[(c)]
- CCS regulations applying to storage from oil and gas operation emissions in MEMR2/2023 and updating further in 2024 [(b)]

Opportunities

- All emissions[3] might be possibly stored within such potential storage subject to feasibility and further consideration

Note: (1) Emission amount is estimated conceptually, 3) This assumes constant emission amount from TJB unit 5 and unit 6 throughout its lifetime
Source: (a) concept basis , (b) MEMR2/2023 etc., (c) IEA, Monitor Deloitte Analysis

Next Stage / specific approach for business opportunities

➢ Key areas : “What needs to be established and available further ”

GOVERNMENT SUPPORT

A – Financial Incentives | Introduction of government subsidies, grants, tax incentives, overseas funds permissibility, and push towards green product premiums

B – Carbon Pricing | Increase planned US$2/ton to US$50/ton or above by 2030 and further

C – Policy expansion| Inclusion of all relevant industries for CCS, legal liability regulatory associated with CO_2 sequestration and working hub & clusters model

D – Roadmap | Inclusion of power plant + CCS as key government’s initiative

TECHNICAL IMPLEMENTATION

A – Storage feasibility | Proven studies for reliability and safety of CO_2 sequestration sites (depleted O&G reservoirs and/or saline aquifers)

B – Technology advancement | Successful technology applications at scale across CCS value chain (capture – transport – storage)

C – Capabilities readiness | Workforce re/up-skilling of CCS R&D and implementation across relevant sector

PARTNERSHIP & FINANCING AVAILABILITY

A – Strategic partnerships | Successful tie-up among stakeholders including potential technical and financial partners

B – Portfolio-based financing | CCS inclusion into broader risk assessment (e.g., power plant + CCS) allowing for risk profiles to be assessed at a portfolio-level hence lower borrowing costs

C - Funding innovation | Availability on ‘energy transition’ financials product to ensure acceptable risk and returns for investors and CCS players

CCS market evaluation and establishment, commercial CCS hub & cluster modelling, staged approaches to potential business models, etc. must be pursued from now on …

03 - 2

Overall Result
of
Indonesia CCS Case Study

1. Technical Specification & Conditions (for the case study purpose)

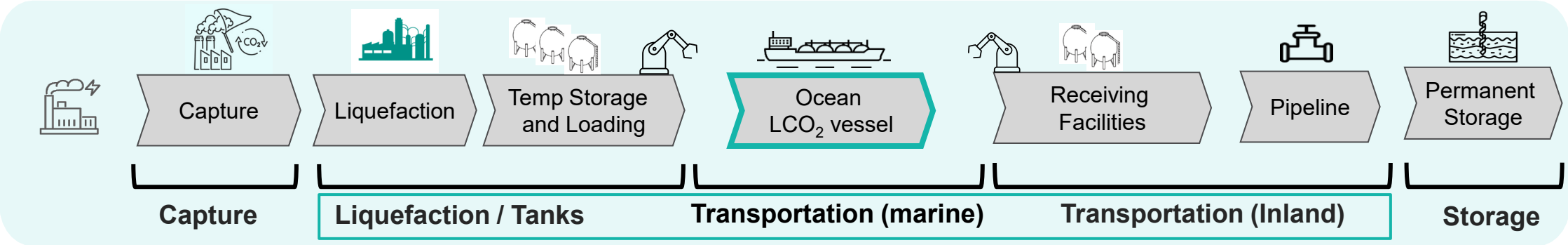
Category	Unit	CASE-A Ocean Transport 6.5Mt/y / 13.0Mt/y	CASE-B Pipeline Transport 6.5Mt/y / 13.0Mt/y	'2022 ERIA (Pipeline Tr.)
Capacity	MW	1,000 / 2 x 1,000	1,000 / 2 x 1,000	500
Type of Power Plant		USC Coal	USC Coal	USC Coal
Capacity Factor		86%	86%	80%
Capture Efficiency		95%	95%	90%
Captured CO_2	Mt-CO_2/year	6.5 / 13.0	6.5 / 13.0	2.87
Project Lifespan	Years	25	25	25
Total CO_2 amount	M t-CO_2	162.5 / 325	162.5 / 325	71.75
Ship	Ships x ton	6 x 28,000 / 7 x 48,000 ton	-	-
Pipeline	Inch x km	24in / 34in x 183 km	28in / 38in x 1,148 km	12in x 50 km
Injection well	number	9 / 17	9 / 17	6
Injection well	Depth (m)	2,000	2,000	2,000

Remarks : **The followings are not covered in this study.**

1. Cost of site purchase and land lease
2. Cost of special land clearing work for the site
3. Cost of soil improvement for unstable base and offshore facility ground
4. Cost of electricity, portable water, and industrial water for base utilities
5. Cost of coastal reclamation to secure land for both TJB extended area and ports in south Sumatra
6. Cost of abnormal seabed soil removal and navigation channel maintenance
7. Cost of removal and monitoring after project completion

Note: Estimated for the study purpose

2-1. Summary – Total Cost (Case-A Ocean Transportation)

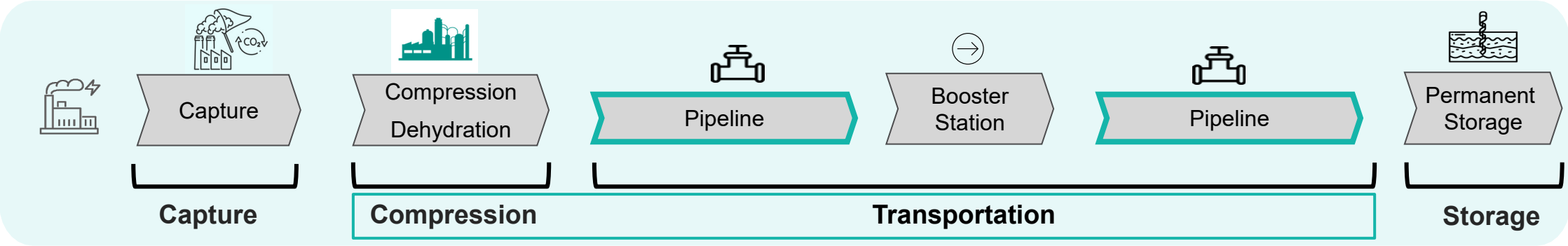


Unit : M USD

Category		1 Unit 6.5 M ton/year	2 Units 13.0 M ton/year
CAPEX	Capture	940.5	1706.7
	Liquefaction / Tanks / Loading	745.5	1,265.5
	Transportation	1,338.0	1,921.0
	Storage	470.4	843.6
Sub Total		3,494.4	5,736.8
OPEX	Capture	4,560.8	8,219.7
	Liquefaction / Tanks / Loading	1,298.2	2,327.2
	Transportation	2,318.6	3,770.8
	Storage	352.8	632.7
Sub Total		8,530.3	14,950.4
Total CAPEX/OPEX		12,024.7	20,687.2

Note: Estimated for the study purpose

2-2. Summary – Total Cost (Case-B Pipeline Transportation)



Unit : M USD

Category		1 Unit 6.5 M ton/year	2 Units 13.0 M ton/year
CAPEX	Capture	940.5	1706.7
	Compression / Dehydration	604.6	1,209.3
	Transportation	4,118.3	5,194.1
	Storage	470.4	843.6
Sub Total		6,133.8	8,953.6
OPEX	Capture	4,560.8	8,219.7
	Compression / Dehydration	906.9	1,813.9
	Transportation	3,096.1	3,905.6
	Storage	352.8	632.7
Sub Total		8,916.6	14,571.9
Total CAPEX/OPEX		15,050.4	23,525.5

Note: Estimated for the study purpose

2-3. Summary – Unit Cost

Case-A (Ocean Transportation)

Unit USD/t-CO_2

Category		1 Unit 6.5 M ton/year	2 Units 13.0 M ton/year	2022 ERIA *1
Unit Cost	Capture	33.9	30.5	45.9
	Liquefaction / Tanks / Loading	12.6	11.1	-
	Transportation	22.5	17.5	0.95
	Storage	5.1	4.5	15.9
Total Unit Cost		74.0	63.7	62.8

Case-B (Pipeline Transportation)

Unit USD/t-CO_2

Category		1 Unit 6.5 M ton/year	2 Units 13.0 M ton/year	2022 ERIA *1
Unit Cost	Capture	33.9	30.5	45.9
	Compression / Dehydration	9.3	9.3	-
	Transportation	44.4	28.0	0.95
	Storage	5.1	4.5	15.9
Total Unit Cost		92.6	72.4	62.8

*1：ERIA (Economic Research Institute of ASEAN and East Asia) (2022), 'Study on the Potential for Promoting Carbon Dioxide Capture, Utilisation, and Storage (CCUS) in ASEAN countries', ERIA, Study on the Potential for Promoting Carbon Dioxide Capture, Utilisation, and Storage (CCUS) in ASEAN Countries Vol. II (eria.org)

Note: Estimated for the study purpose

3. TJB5&6 Additional Levelized Cost of Electricity by CCS

➢ Case A (Ocean Transportation)

Category		Unit	1Unit (1000MW)	2 Units (2000MW)
Unit Cost	Capture	Cent US$/KWh	3.45	3.12
	Liquification/Tank	Cent US$/KWh	1.62	1.40
	Transportation	Cent US$/KWh	2.90	2.19
	Storage	Cent US$/KWh	0.80	0.71
Total Unit Cost		**Cent US$/KWh**	**8.77**	**7.42**

➢ Case B (Pipeline Transportation)

Category		Unit	1Unit (1000MW)	2 Units (2000MW)
Unit Cost	Capture	Cent US$/KWh	3.45	3.12
	Compression/Dehydration	Cent US$/KWh	1.24	1.24
	Transportation	Cent US$/KWh	6.97	4.40
	Storage	Cent US$/KWh	0.80	0.71
Total Unit Cost		**Cent US$/KWh**	**12.46**	**9.47**

(Note: Estimated for the study purpose)

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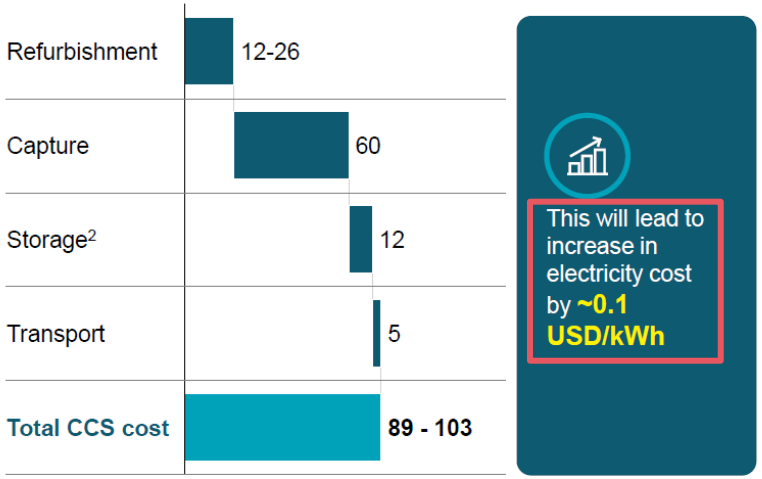
Way forward

The CCS implementation will result in electricity cost increase; financing or incentive support from govt. is required

Average costs to implement CCS EOR in coal plant, USD / tCO_2



This will lead to increase in electricity cost by **~0.1 USD/kWh**

Estimated this time :

Unit : USD/t-CO2

	2 Units 13.0 M ton/year	2 Units 13.0 M ton/year	2unit 13Mton	2unit 13Mton
Capture	30.5	30.5	3.12	3.12
Liq. / Comp.	11.1	9.3	1.40	1.24
Transport	17.5	28.0	2.19	4.40
Storage	4.5	4.5	0.71	0.71
	63.7	72.4	7.42	9.47
	Ocean Trans.	Pipeline Trans.	Ocean	Pipeline

How to make CCS project economically viable

- **Profit sharing** between CCS and reservoir owner on EOR implementation
- **Project cost support** from government adjusting to the increasing LCOE
- **Carbon tax adjustment** in the CCS project to support the funding

PLN

Scaling Up CCS Retrofits in PLN's Coal Power Plants as Key Level in Decarbonization

3 December 2023

Special mechanism like profit sharing etc.

Government support for financing CCS projects

Incentive support for CCS development

… to be expected in the future

Next step

To scale up the CCS technology for Indonesian power sector

- **Establish partnership with stakeholders** to conduct further technical studies and implement pilot on the remaining power plants
- **Propose the regulation** to enable CCS projects to enhance availability of carbon storage across country and funding support
- **Explore the financing option** for CCS project to be economically viable for Indonesian power industry with mix of ownership and carbon tax

Thank you
for
your support and cooperation

Terima kasih

Contact information : Soichiro Kunihiro at Sumitomo Corporation
Email : soichiro.kunihiro@sumitomocorp.com