

Japan-Asia CCUS Forum 2021

CO₂ Ship Transportation

Current Status and Approach to Challenges

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Japan CCS Co., Ltd.

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Current Status of CO₂ Transportation

(Slide 3–9)

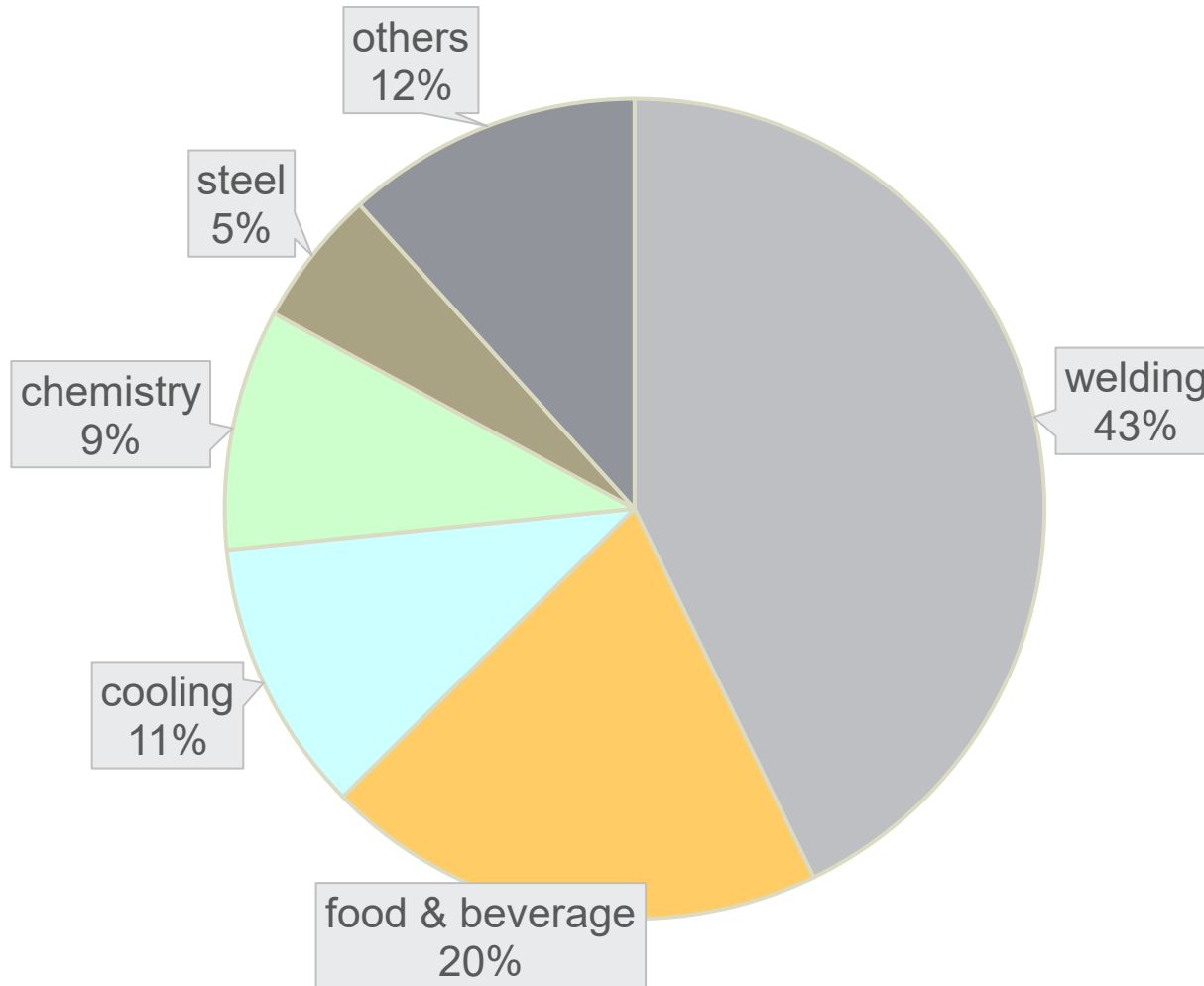
Approach to Challenges

– Step toward Actual Utilization –

(Slide 10–17)

Current Status of CO₂ Transportation

Ex. Factories - 674,982 Tons (2020.4-2021.3)



Data Source : Japan Industrial and Medical Gases Association (JIMGA)







Japan:

- CO₂ for industrial use is transported in the form of liquid.
- **Tank trucks** are mainly used (land / car ferry).
- No record / experience of transportation for CCUS.
- ➔ Establishment of CO₂ transport will lead to development of CCS.

Overseas (as comparison) :

- 5 dedicated CO₂ tankers are under operation in Europe.
- **Pipelines** are used for CCS/EOR.

Fleet List of CO₂ tankers in the world

Vessel Name	FROYA	EMBLA	GERDA	HELLE (ex. CORAL CARBONIC)	IDUNA (ex. YARA GAS III)	AMAGI MARU (※)
Gross Tonnage	2,506 t	2,506 t	2,506 t	1,825 t	2,198 t	199 t
Cargo Tank Capacity	1,800m ³	1,800m ³	1,800m ³	1,250m ³	1,250m ³	365m ³
Cargo Temperature (lowest)	-30°C	-30°C	-30°C	-40°C	-30°C	-30°C
Maximum Pressure	19.0 bar (1.9 MPa)	19.0 bar (1.9 MPa)	19.0 bar (1.9 MPa)	18.0 bar (1.8 MPa)	20.0 bar (2.0 MPa)	25.0 bar (2.5 MPa)
						

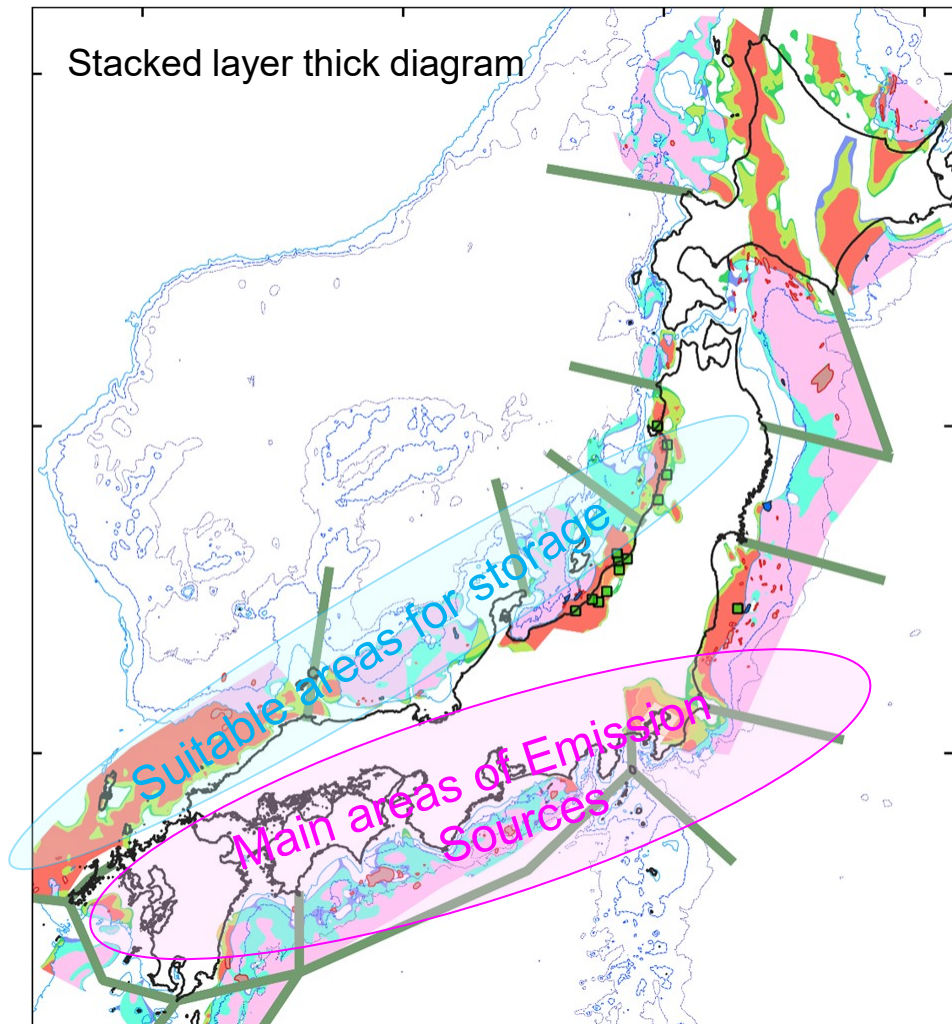
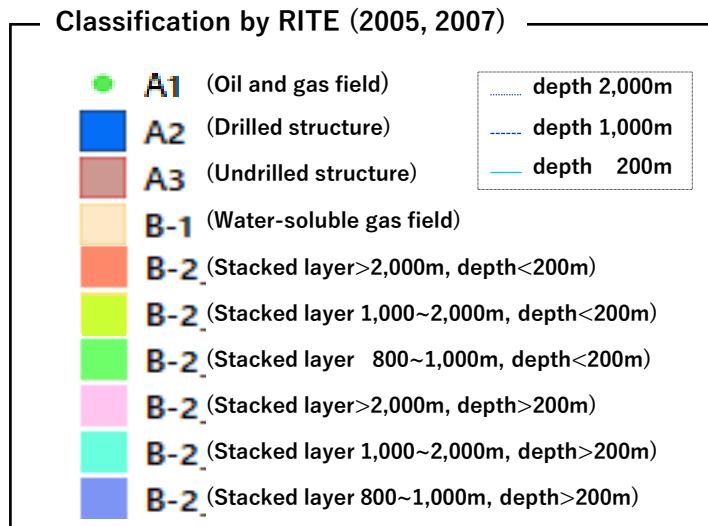
(※) It is recorded that only one CO₂ dedicated tanker was operated in Tokyo Bay in 1980's.

Mode	Phase	Distance	Quantity	Advantage
<p>Tank truck</p> 	<p>Liquid</p> <p>Temp:-20°C Press:2MPa</p>	<p>Short (<100km)</p>	<p>Small</p>	<p>Frequency</p>
<p>Pipeline</p> 	<p>Dense</p>	<p>Short to Long</p>	<p>Large</p>	<p>Cost effective for plain</p>
<p>Ship/Vessel</p> 	<p>Liquid</p> <p>Temp:unfixed Press:unfixed</p>	<p>Long (>200km)</p>	<p>Large</p>	<p>Flexibility and Cost effective for overseas</p>

Conditions: 1 Million tons per year / over 200km

- **Tank truck** – “disadvantageous”
quantity not sufficient of units and drivers ➡ costly
- **Pipeline** – “disadvantageous”
construction cost on hilly country like Japan
- **Ship/Vessel** – “advantageous”
the most suitable for large-scale and long-distance transportation as an energy efficient mode per ton-mile.

Locations of main emission sources and potential storage sites in Japan

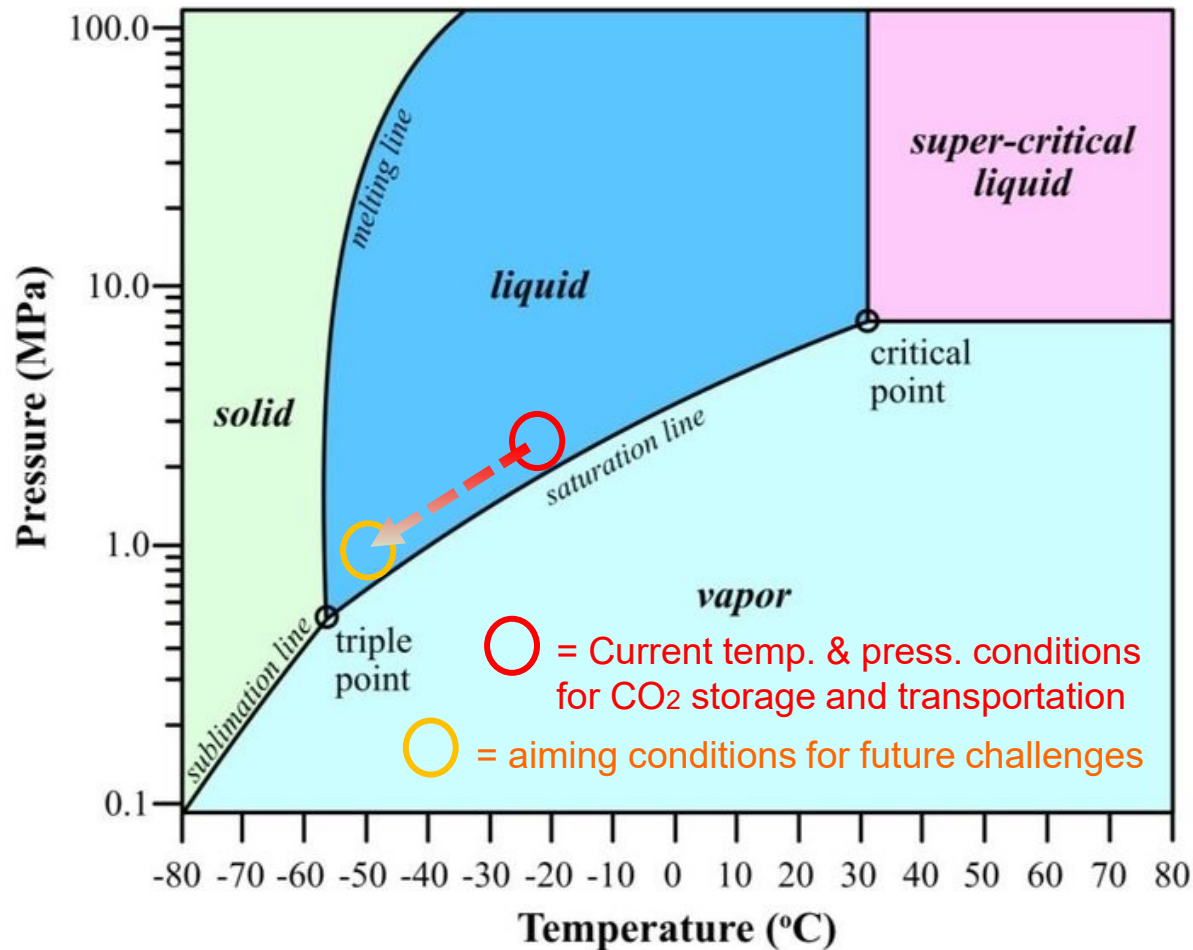


Edited by JCCS (FS by RITE 2005, 2007)

Approach to Challenges

– Step toward Actual Utilization –

CO₂ Triple point (-56.6°C / 0.518MPa)



a. Why the current temperature & pressure are preferred?

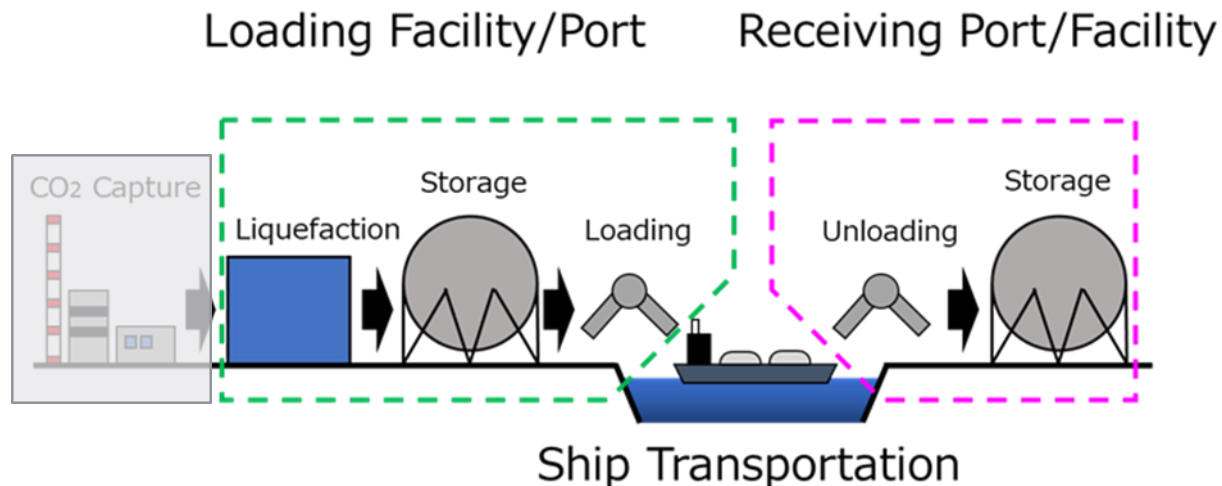
Far from Triple Point, which means lower operation risks.

b. Suitable cargo conditions for larger on-shore storage tanks and tanks equipped on CO₂ tankers

To identify the optimal conditions of liquified CO₂ in terms of temperature and pressure in order to make tank capacity larger suitable for on-shore storage tanks and large liquified CO₂ tankers for long-haul. Under such conditions safety operation with minimized risk is adequately secured.

【Purpose of the Project】

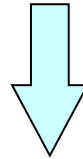
For the purpose of the safe and efficient transportation of CO₂ emitted from factories and thermal power plants etc. for carbon recycle or CCS, NEDO and Contractors will develop **the integrated transportation system** (CO₂ liquefaction, ship transportation and tank storage) **under optimal temperature and pressure conditions.**



NEDO project for challenges (2)



New Energy and Industrial Technology
Development Organization



commission

JCCS Japan CCS Co., Ltd.

ENAA
Engineering Advancement Association of Japan

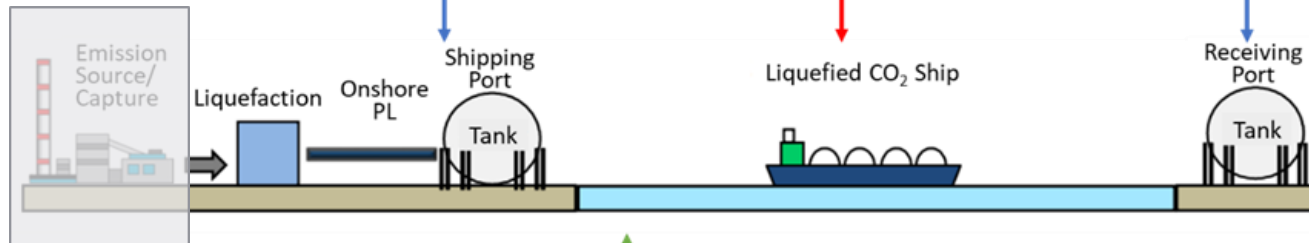
(Subcontractors)

(Subcontractors)



R & D of CO₂ liquefaction/storage systems,
social implementation of large-sized ships

R & D of
transport ships



Feasibility Study

(Overall study)

(Steel industry)



Note: figure adapted from METI document

【Goal】

To complete the efficient preparations for the social implementation of CO₂ transportation for CCUS of **approx. 1 Million tons per annum as of 2030**

Research and development for the goal

1. Technology development for CO₂ liquefaction system
2. Technology development for liquefied CO₂ mass storage system
3. Conceptual / Basic design of large liquefied CO₂ carrier
4. Research and development on stability in CO₂ ship transport and specification examination of liquefied gas combined ship
5. Survey on trends in domestic CO₂ emission sources and domestic and overseas CO₂ transportation businesses
6. Examination of business model (domestic steel industry)

【Demonstration as technology development】

As the demonstration tests to verify the technology establishment, **10,000 tons** of liquified CO₂ will be **annually** transported from a coal-fired power plant in **Maizuru** (Kyoto pref.) to a base in **Tomakomai** (Hokkaido). A 999GT sized CO₂ tanker will be used for this demonstration test.



【Schedule】

FY 2021 – 2026 (planned)

THEMES

1. **Research and development** to establish liquefied CO₂ ship transport technology (FY2021-2026)
2. Liquefied CO₂ ship transport **demonstration**
 - Engineering, procurement and construction of land-based equipment (FY2021-2023)
 - Marine Transport Demonstration Test (FY2023-2026)
3. **Commercialization survey** of shipping for the purpose of CCUS (FY2021-2026)

