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CCUS Policy Challenges for 2024: Towards materialization of CCS and carbon recycling projects

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Key points

- The year 2023 featured the acceleration of policy efforts to introduce CCS (Carbon Capture and Storage) in Japan. In 2024, Japan is expected to enact a CCS business act for establishing a framework for CCS projects and make progress in feasibility studies on advanced CCS projects selected in 2023.

- In order to commercialize CCS, it is essential to provide policy support for both initial investment (capital expenditure, or CAPEX) and operational expenditure (OPEX). Other countries that are leading the way in CCS projects have support packages for both CAPEX and OPEX. In 2024, Japan is expected to deepen discussions on the introduction of similar support packages.

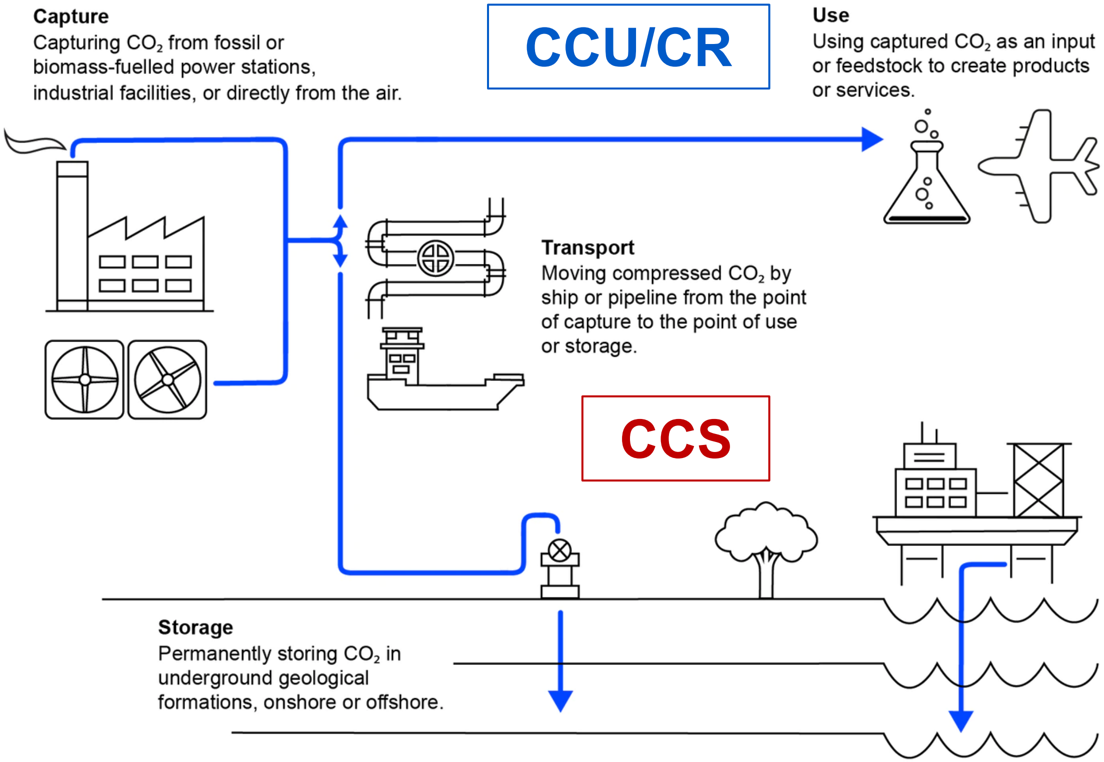
- Carbon recycling (CR) is a decarbonization technology based on a novel idea that considers captured CO2 as a useful resource and makes effective use of it. In 2023, the Japanese government’s CR roadmap was revised. In 2024, support for technological development aimed at further cost reductions should be promoted, with the consideration of model cases being deepened for inter-industry collaboration in the commercialization of CR.

Significance of CCUS

- Significance of CCUS: CCUS allows CO2 as a main factor behind climate change to be captured for utilization or underground storage, contributing to decarbonizing energy demand sectors where removing fossil fuels is difficult to achieve.
- CCU technologies include carbon recycling to consider captured CO2 as a carbon resource and reutilize it for various carbon compounds.
- “Carbon management” has recently begun to be used to represent a concept of CCUS including direct air capture and other negative-emission technologies.

CO2 capture sources

- Fossil-fired power plants
- Industrial complexes
- Remote emission sources (incineration plants, etc.)
- Air (direct air capture)
- CO2 emissions from biofuel



Source: International Energy Agency

Current status of CCS: Selection of specific projects for feasibility studies

- In June 2023, JOGMEC selected the following seven advanced CCS projects.
- Projects that are diverse in terms of storage locations, capture sources, and CO2 transportation methods have been selected for ongoing feasibility studies, with final investment decisions expected around 2026 for starting CO2 storage in 2030.
- The seven projects are expected to capture and store **13 million tons of CO2 annually.**

Advanced CCS projects subject to ongoing feasibility studies

Storage location	Capture sources	Transportation method	Storage site
Tomakomai, Hokkaido	Oil refining and thermal power plants	Pipeline	Depleted oil/gas fields or under the seabed
Sea of Japan side of Tohoku Region	Steel and cement plants	Ship, pipeline	Under the seabed
Higashi Niigata	Chemical, paper, and thermal power plants	Pipeline	Depleted oil/gas fields and under the seabed
Tokyo metropolitan region	Steel plants, etc.	Pipeline	Under the seabed
Northern and western Kyushu	Oil refining and thermal power plants	Ship, pipeline	Under the seabed
Malaysia	Oil refining, chemical, and other plants	Ship, pipeline	Overseas (Malaysia)
Oceania	Steel plants, etc.	Ship, pipeline	Overseas (Oceania)

Source: Agency for Natural Resources and Energy, “CCS Policy” (September 2023), p18

CCS policy trend: Enactment of CCS business act

- In the absence of any CCS business act at present, the following measures are required
  - Business operators must establish rights to use specific underground reservoirs for CO2 storage.
  - The scopes of and periods for business operators' legal responsibilities must be specified.
  - A system to appropriately monitor domestic underground storage must be developed.
  - The London Protocol requirements for international transportation and storage of CO2 must be satisfied.
- The following measures are considered for a new act for which a bill will be submitted to the National Diet during its ordinary session in 2024:
  - Position of CO2: Position CO2 as **resource** and clarify CO2 ownership
  - Storage business: Establish a **storage business right, limit security and monitoring responsibilities** after storage, and set **durations** for such responsibilities
  - Transportation business: Establish a transportation business registration system, set quality standards for CO2 for transportation
  - CO2 separation and capture business: Establish a CO2 separation and capture as a registration business, set quality standards for CO2 for transportation
  - Expropriation and use of land: Set provisions for the use or expropriation of land for exceptional cases, establish procedures for using public land for constructing CCS facilities
  - International transportation and storage: Enact domestic legislation to deposit the tentative application of an amendment to Article 6 of the London Protocol with the International Maritime Organization to enable CO2 exports for marine CCS

Source: Agency for Natural Resources and Energy, "How a CCS business act should be" (March 2023)

Assumed challenges after CCS Business Act establishment

- Securing storage sites
  - Sufficiently large and economically viable domestic and overseas storage sites will have to be secured.
- Providing business operators with incentives
  - As incentives are required for business operators who pay additional costs to continue CCS, foreign CCS-promoting countries have adopted a combination of capital expenditure (CAPEX) support (subsidies) and operational expenditure (OPEX) support (tax incentives, carbon pricing, etc.).
  - A detailed institutional design is required along with budgetary measures.
- Support for cost reductions
  - Development of domestic CCS/CR hubs to achieve economies of scale
  - Early commercialization of advanced CCS projects and utilization of knowledge gained through these projects
- Promoting citizens' understanding and securing public acceptance
  - Increasing public awareness about the significance, effectiveness, and safety of CCS by disseminating information on an ongoing project (Tomakomai demonstration project) and the acceleration of CCS introduction initiatives in foreign countries
- Developing arrangements for international CCS
  - Support for CCS-related law and regulation development in CCS-accepting countries, institutionalization of credit programs for international CCS

(Reference) Foreign CCS introduction policies

- CCS projects other than those for enhanced oil recovery (EOR) are difficult to sustain without policy support
- Foreign countries have introduced policy support for both capital expenditure (CAPEX) and operational expenditure (OPEX).

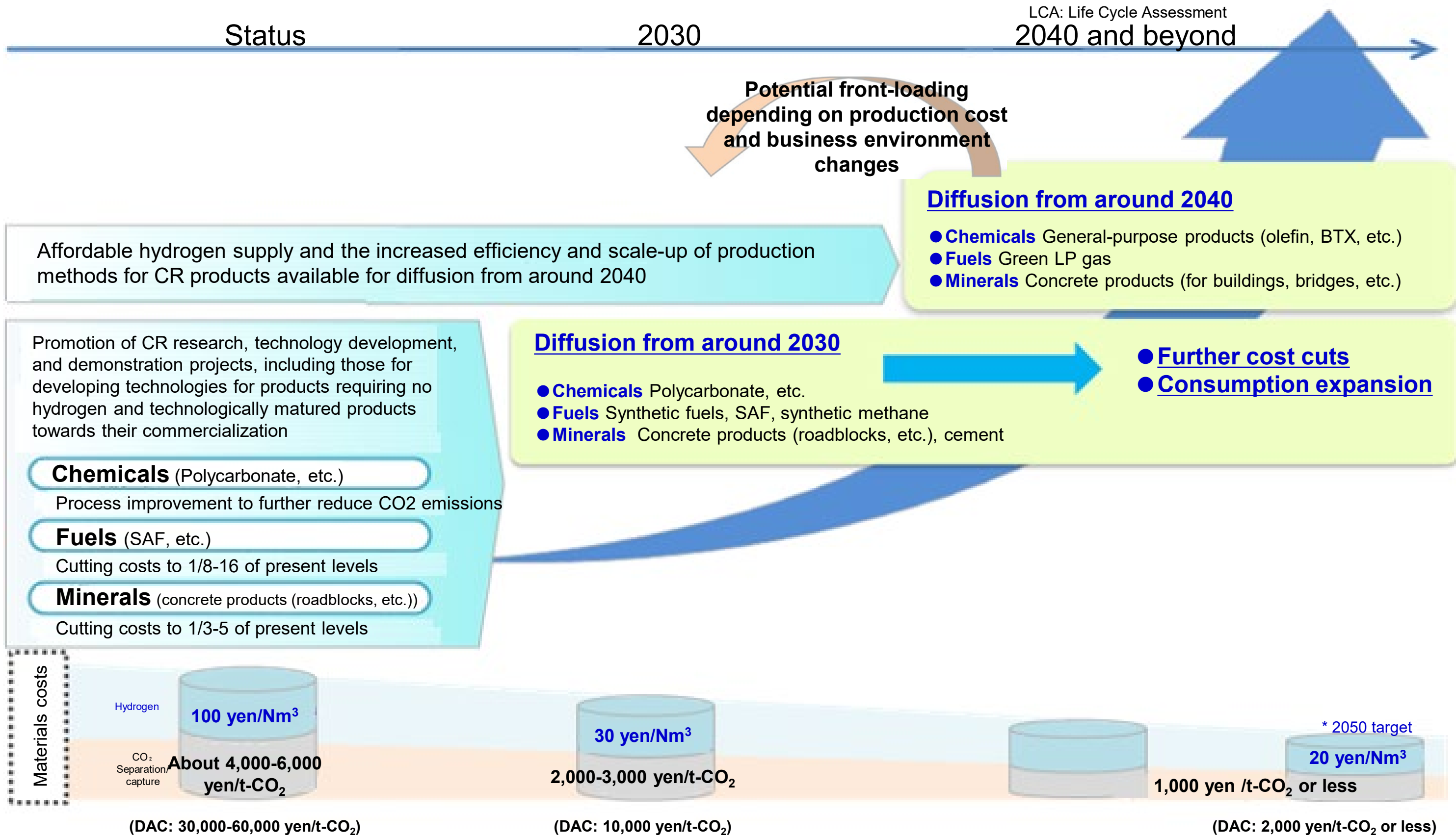
Foreign CCS support policies

Country	CAPEX support	OPEX support	Representative projects
U.S.	Direct subsidies	Tax credits according to scales and purposes (expanded under the Inflation Reduction Act)	Many CCS projects, including EOR projects, are underway
Canada	Direct subsidies (federal and provincial)	Emission credit provision, direct subsidies (10 years) (Alberta Province)	Quest (in operation)
Norway	Direct subsidies	Emission credit provision	Sleipner (in operation)
Australia	A direct subsidy system had been available, but new subsidy applications are suspended under the current administration	Exemption from emission quotas, emission credit provision	Gorgon (in operation)
U.K.	Direct subsidies	Emission credit provision, direct subsidies, feed-in tariff (pipeline transportation)	Five domestic CCUS hubs are under consideration

Source: Prepared from Agency for Natural Resources and Energy, "Reference for interim report by a long-term CCS roadmap panel (May 2022)

Carbon recycling (CR) policy trends

- The Japanese government revised the Carbon Recycling Roadmap in June 2023.
  - The revised roadmap assumes carbon recycling potential at **100-200 million tons by 2050.**
  - The roadmap proposes specific types and models of inter-industry cooperation in CR technology introduction and summarizes the roles of startup businesses and research institutes that will undertake carbon recycling in the future.



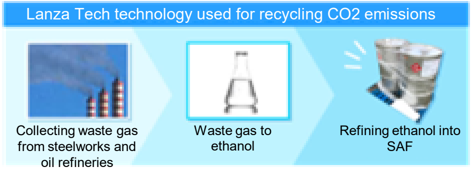
Source: Agency for Natural Resources and Energy, “Carbon Recycling Roadmap” (Jun 2023), p8

(Reference) Examples of CR products (fuels)

- CR products are divided into three categories: (1) fuels, (2) chemicals, and (3) mineralized products. Among fuels, sustainable aviation fuels (SAF) are expected to take the lead through the introduction of international regulations.)

SAF production from alcohol using microbial catalyzers (ATJ: alcohol to jet) **Fuel/SAF**

[Implementor countries]	・U.S., Japan	[Overview] ・In October 2019, Lanza Tech of the United States and Mitsui jointly conducted a demonstration Boeing 777 flight from Seattle to Haneda, using SAF that Lanza Tech made from waste gas. ・The demonstration flight test confirmed not only the purchase and use of SAF but also the know-how for SAF transportation from a plant to an airport, mixing SAF into conventional jet fuel, product guarantee, and aircraft fueling. ・Later, Lanza Tech and ENEOS participated in a relevant NEDO project.
[Participants]	・Lanza Tech (microbial catalyzers) ・ANA (SAF use) ・ENEOS (product guarantee, plant assessment) ・Mitsui & Co. (Alcohol procurement, coordination)	
[CO2 sources]	・Waste gas from steelworks and oil refineries	
[Hydrogen sources]	—	
[Product]	・Jet fuel (SAF)	
[Use]	・Aviation fuel	
[Status]	・On October 30, 2019, a demonstration flight from Seattle to Haneda was conducted using SAF made by Lanza Tech. ・Lanza Tech participated in a relevant FY2017-2020 NEDO project along with ENEOS (then JXTG Energy). ・The project aims to establish an integrated biojet fuel production technology for commercialization in FY2030.	[Source]ANA



(Reference) Examples of CR products (Chemicals)

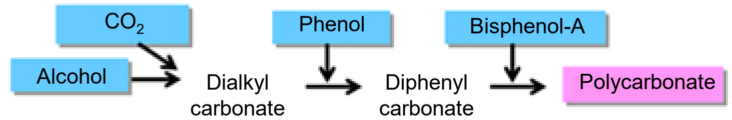
- Among CR chemicals, polycarbonate has been commercialized. A future challenge is to use CR technology for producing basic chemicals (olefin and aromatics) that feature higher general versatility and greater CR potential.

Polycarbonate (DRC process for DPC production)

Chemicals/Polycarbonate

[Implementor country]	・Japan
[Participant]	・Asahi Kasei (chemical production)
[CO2 sources]	・(Undecided)
[Hydrogen sources]	—
[Product]	・Polycarbonate
[Use]	・Engineering plastics
[Status]	・Technology development under a FY2014-2016 NEDO project ・Later, demonstration tests were conducted over two years at Asahi Kasei's Mizushima plant (Kurashiki, Okayama Prefecture). ・Achievements include a production capacity of 1,000 tons per year and continuous operation over more than 1,000 hours.

[Overview]
・Technology to produce polycarbonate (PC) from CO2 and alcohol
・The technology does not use deadly phosgene gas used for conventional PC production or ethylene oxide (EO) used for the non-phosgene process (EO process for DPC production).
・The technology uses easily available alcohol and is free from any ethylene center, easing constraints on production locations.
・The technology contributes to simplifying chemical reactions, reducing energy consumption, and cutting production costs.
・PC is used as an excellent engineering plastic for various purposes.



(Reference) Examples of CR products (Mineralization)

- Given that mineralized products need no hydrogen, unlike fuels or chemicals, and cost less, their commercialization is expected to make progress depending on demand creation through public procurement.

Commercialization of “CO2-SUICOM,” which absorbs and fixes CO2 during concrete manufacturing

Mineralization/concrete

[Implementor country]	・Japan
[Participants]	・Kajima Corporation (construction) ・Tokyo Gas Co. (Case for an elementary school in Yokohama)
[CO2 sources]	・Combustion gas from city gas equipment (Case for an elementary school in Yokohama)
[Hydrogen sources]	—
[Product]	・Concrete
[Uses]	・Foundation blocks for solar photovoltaic panels ・Interlocking blocks for sidewalks, car stops for auto parks, bottom and side plates for a DEW rain garden system
[Status]	・Sales channels are being expanded.

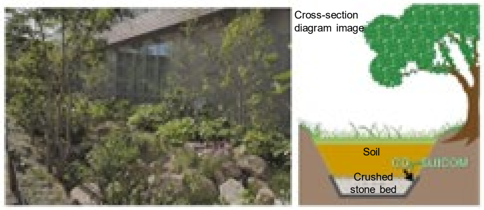
[Overview]

・In cooperation with Tokyo Gas Co., Kajima Corporation has manufactured the eco-friendly “CO2-SUICOM” concrete while absorbing and fixing CO2 emissions from gas equipment and adopted the concrete for foundation blocks for solar photovoltaic panels on the roof floor of an elementary school in Yokohama.

・Kajima has also adopted the concrete for interlocking blocks for sidewalks, car stops for auto parks, and bottom and side plates for a DEW rain garden system at its Kajima Technical Center, a work experience research facility for Kajima group employees.

・The CO2-SUICOM concrete has a near-neutral pH through carbonation curing to prevent soil from having high pH and is increasingly used as a plant-friendly material.

Solar photovoltaic panels and CO2-SUICOM introduced at Yokohama City Motomachi elementary school



A DEW rain garden system adopting the CO2-SUICOM concrete for bottom and side plates

[Source] Kajima Corporation

See ㉛ among inter-industry collaboration cases in Carbon Recycling Roadmap [Additional Volume 2]

CR policy challenges

- Technology development and social implementation
  - The government should support technology development to further reduce costs and develop a public perception where added costs and low-carbon values of CR products are accepted.
- Inter-industry cooperation
  - CO_2 emitters and users must cooperate to implement CR projects of certain scales.
  - A model case for visible CR should be developed to stimulate interest and investment in CR projects.
  - While large industrial complexes are expected to take leadership in inter-industry cooperation, CR technology introduction models should be considered for the decarbonization of dispersed rural CO_2 emission sources such as waste disposal plants in the future.
  - Given that CO_2 emitter and user for CR are different, the roles of CO_2 management business operators should be considered, including the adjustment of CO_2 supply and demand for stable CR business operations and the management of CO_2 traceability, transportation and utilization.
- Environmental value assessment and international development
  - To develop standardization and other mechanisms to adequately assess CR's effect on reducing CO_2 emissions, Japan should enhance cooperation with foreign countries and companies with which Japan shares an interest in CR. Specific international projects should be developed.
  - The government should promote networks between startup companies and research organizations developing CR technology and support human resources development to foster and increase CR business players.