

Trends Related to CCS Business Environment Establishment in Japan — Background and Final Summary of the CCS Long-Term Roadmap —

Research & Coordination Group

Makoto Nomura, Deputy Group Leader, Chief Researcher

Jun-ichi Shimizu, Associate Chief Researcher

1. Introduction

Reduction of greenhouse gases (GHGs) is an important global challenge. Under the Paris Agreement (effective November 4, 2016), which is the international framework for tackling climate change issues in 2020 and later, efforts will be made to keep the average global temperature increase well below 2°C compared with the pre-industrial level, and limit it to 1.5°C as a common long-term goal for the world. It also stipulates that global GHG emissions should peak out as soon as possible, and we should ensure a balance between GHG emissions and absorption by forests, etc. in the second half of this century¹⁾.

Japan is working to reduce GHG emissions to achieve carbon neutrality (CN) by 2050 and a 46% reduction in GHG emissions (compared with the 2013 level) by FY2030, based on the “Plan for Global Warming Countermeasures,” the “Strategic Energy Plan,” etc. Under these circumstances, the CCS Long-Term Roadmap Study Group, which was established in January 2022, published the “Final Summary by the Long-Term CCS Roadmap Study Group” in March 2023 as a result of its year-long activities. This article reports on its overview. (Table 1 shows the main policies for carbon dioxide capture and storage (CCS)/carbon capture utilization (CCUS) in Japan for the immediate future.)

Table 1 Main policies for CCS/CCUS

<p>Roadmap for Carbon Recycling Technologies (formulated June 7, 2019)²⁾</p> <ul style="list-style-type: none"> Carbon recycling technology, which treats CO₂ as a resource, separates and recovers it, and reuses it as diverse carbon compounds, and it is one of the promising options for the future, and we will accelerate innovation in this area.
<p>Environment Innovation Strategy (formulated January 21, 2020)³⁾</p> <ul style="list-style-type: none"> We position carbon recycling and CCUS technologies, which are essential for a significant reduction in CO₂ emissions, as one of the priority areas. Therefore, we will promote the realization of decarbonized and inexpensive energy supply technologies, and make the greatest possible contribution to the reduction of GHG emissions domestically and globally. In particular, we aim to achieve a CO₂ separation and recovery cost of 1,000 yen/t-CO₂ by 2050 as a low-cost CO₂ separation and recovery technology that will be the foundation for CCUS/carbon recycling.
<p>Policy speech by Prime Minister Suga (October 26, 2020)⁴⁾</p> <ul style="list-style-type: none"> He declared, “our country aims to achieve zero overall GHG emissions by 2050, or a carbon-neutral, and decarbonized society by 2050.”
<p>Green Growth Strategy Through Achieving Carbon Neutrality in 2050 (formulated on June 18, 2021)⁵⁾</p> <ul style="list-style-type: none"> This is a further embodiment of the growth strategy (an industrial policy to tackle the challenging goal of achieving carbon neutrality by 2050) formulated on December 25, 2020. The power sector will demonstrate the importance of pursuing all options, such as maximizing the introduction of renewable energy and the use of nuclear power, as well as promoting decarbonization through use of hydrogen, ammonia and CCUS.

Long-Term Strategy under the Paris Agreement as Growth Strategy (Cabinet decision on October 22, 2021)⁶⁾

- While the previous long-term strategy was approved by the Cabinet on June 11, 2019, this was the resulting strategy which later positioned the 2050 carbon neutrality declaration in October 2020 as the basic idea and was decided by the Cabinet.
- Measures against global warming are not a constraint on economic growth, but the key to transforming the economy and society in a major way, encouraging investment, increasing productivity, and creating a major shift in industrial structure and strong growth.
- It states that in order to achieve carbon neutrality by 2050, we will strive to introduce renewable energy to the maximum extent possible, promote the implementation of hydrogen and CCUS in society, and try to secure public trust in nuclear power, so that we can make sustained use on the necessary scale on the premise of ensuring safety.

Plan for Global Warming Countermeasures (Cabinet decision on October 22, 2021)⁷⁾

- It presents goals related to the amount of GHG emissions control and absorption, basic matters related to measures to be taken by businesses, citizens, etc., and measures to be taken by the national and local governments to achieve the goals.
- It specifies that Japan will aim to reduce GHG gas emissions by 46% by FY2030 compared with the FY2013 level, and that it will continue to take on the challenge to reach the 50% reduction level.

The 6th Strategic Energy Plan (Cabinet decision on October 22, 2021)⁸⁾

- It will lay out a path for energy policy to achieve new reduction targets of carbon neutrality by 2050, namely, a 46% reduction by FY2030, and aim for a further 50%.
- In order to achieve carbon neutrality by 2050, we will strive to introduce renewable energy to the maximum extent possible, promote the implementation of hydrogen and CCUS in society, and try to secure public trust in nuclear power, so that we can make sustained use on the necessary scale and on the premise of ensuring safety.
- In order to introduce CCS on the premise of commercialization by 2030, the roadmap for CCS implementation will be drawn up and shared, and efforts will be made to build a model base jointly between the government and private sector for technological development, suitable site development, transportation demonstration, business environment establishment, and network optimization.
- In addition to securing a stable supply of oil, natural gas, and mineral resources, we will develop a new “comprehensive resource diplomacy” to promote, in an integrated manner, the construction of hydrogen and ammonia supply chains and the securing of suitable sites for CCS using the networks we have cultivated with resource-rich countries through resource diplomacy.

1.1. Positioning of CCS Technologies in the 6th Strategic Energy Plan

The 6th Strategic Energy Plan⁸⁾, which was approved by the Cabinet in October 2021, has two main objectives. One is addressing the issue of climate change. The plan lays out a path for an energy policy to realize the ambitious reduction targets of “carbon neutrality by 2050,” announced by Prime Minister Suga in his policy speech in October 2020, and “reduction in GHG emissions by 46% by FY2030 (compared with FY2013) and aim for a higher 50% reduction” announced at the meeting of the Global Warming Prevention Headquarters in April 2021. The other objective concerns overcoming the challenges posed by Japan’s energy supply

and demand structure. The initiatives presented are based on the basic policy of “S + 3E (safety + stable energy supply, improved economic efficiency, environmental compliance)” while advancing measures to combat climate change.

In the 6th Strategic Energy Plan, CCS is positioned as a technology that should be fully utilized together with CCU to reduce CO₂ emissions from industries where decarbonization at thermal power plants as well as decarbonization using electrification and hydrogen are considered difficult. CCS is also positioned as an important technology for securing the necessary resources and fuel in a stable manner into the future. CCS is thus seen

as one of the “key” options along with renewable energy, nuclear power, hydrogen and ammonia, and CCU to achieve both decarbonization and energy stability in our country. In addition, as a response to the utilization of CCS, it is clearly stated that a long-term road map will be prepared and shared with the relevant parties in order to establish the technology, reduce costs, develop an environment for suitable land development, and have commercialization.

2. CCS Long-Term Roadmap Study Group

As specified in the 6th Strategic Energy Plan, the CCS Long-Term Roadmap Study Group was established in January 2022 to examine the establishment and cost reduction of CCS technologies, development of suitable sites, and development of an environment for commercialization, and prepare a long-term CCS roadmap⁹⁾. The CCS Long-Term Roadmap Study Group is comprised of members from academia, industry, research institutions, etc., and has held five discussions on a monthly basis after holding its first meeting in January 2022 to publish the Intermediate Summary in May 2022.

Furthermore, in September 2022, the “CCS business domestic law review working group” to discuss various issues for the establishment of domestic laws on CCS businesses, and the “CCS business cost and implementation scheme review working group” to discuss the current cost and future cost targets for the entire CCS value chain and how government support should be provided, were established to hold intensive discussions.

Based on the findings of these two working groups, the discussion to prepare the final summary was held at the 6th meeting of the CCS Long-Term Roadmap Study Group (joint meeting of CCS business cost and implementation scheme review working group and CCS business domestic law review working group) on January 26, 2023.

3. Overview of the “Final Summary by the CCS Long-Term Roadmap Study Group”¹⁰⁾

This section provides an overview of the “final summary by the CCS Long-Term Roadmap Study Group,” which was published in March 2023.

3.1. Global trends toward CCS commercialization

The global situation surrounding CCS has shifted from skepticism to policy adoption. In addition to the bipartisan Infrastructure Investment and Jobs Act (IIJA), the United States enacted a 10-year CCS program worth 50 trillion yen (the Inflation Reduction Act) in August 2022, which has been described as an “unprecedented CCS boom,” and has had a major impact on international opinions. China specified the annual storage amount of 2 billion tons as its target for 2050, and is shifting to promoting CCS, including building relationships with other countries, in addition to domestic development. While Germany had been negative about the CCUS, it started at the end of last year to accept it and began to develop domestic policies. Other countries are also moving toward the introduction of CCS policies, ushering in the “era of great competition” for CO₂ storage land. In addition, many ongoing projects are developing aquifer storage areas without enhanced oil recovery (EOR).

3.2. CCS Long-Term Roadmap

3.2.1. Basic philosophy

The basic philosophy of the CCS Long-Term Roadmap is stated as follows; “the purpose of this roadmap is to promote sound development of CCS businesses in our country while minimizing social costs by implementing CCS systematically and rationally, thereby contributing to economic and industrial development of our country, securing stable energy supply and achieving carbon neutrality.”

3.2.2. Goals of the CCS Long-Term Roadmap

Based on the results of the IEA’s estimate of CO₂ recovery amount under the global decarbonization scenario and Japan’s share of CO₂ emissions, the estimated annual CCS storage amount as of 2050 is approximately 120 million to 240 million tons. If CCS is to be introduced in 2030, it will be necessary to launch CCS projects every year for 20 years until 2050 to increase the annual storage amount by approximately 6 million to 12 million tons, and postponing the implementation of CCS will make it difficult to secure the annual storage amount necessary to achieve carbon neutrality by 2050.

Therefore, with the aim of achieving an annual CO₂ storage amount of approximately 120 million to 240 million tons as of 2050, the goal is to establish the business environment (cost reduction, public understanding, promotion of overseas CCS, and legal development), and launch CCS businesses by 2030 with a view to commencing full-fledged operations in 2030 and onward.

3.2.3. Specific actions

The following specific actions will be taken as needed, with the period until the start of the CCS business in 2030 designated as the period of business model development and the period after that as the period of full-scale CCS development.

- (1) Government support for CCS businesses
- (2) Initiatives to reduce CCS costs
- (3) Promotion of public understanding of CCS businesses
- (4) Promotion of overseas CCS businesses
- (5) Examination for the development of the CCS Business Act
- (6) Development and review of the “CCS action plan”

(1) Government support for CCS businesses

- ① Support for advanced, model-oriented CCS businesses

In order to establish a business model that can be expanded laterally for the spread and expansion of the CCS businesses in the future, the government will select “advanced CCS businesses” led by business operators and provide more intensive support with the aim of starting the businesses by 2030.

Specifically, support will start for three to five projects with different combinations of CO₂ recovery sources, transportation methods, and CO₂ storage areas to establish diverse CCS business models, and they will aim to secure an annual storage amount of 6 million to 12 million tons by 2030.

As a model, the project will focus on large-scale operations and dramatic cost reduction through the clustering of CO₂ recovery sources and formation of hubs of CO₂ storage areas.

When selecting a project, matters will be confirmed with a focus on whether business is heading in a direction to gain people’s understanding of CO₂ storage areas, and whether it will contribute to the development of CCS projects in the future, in addition to examining the early feasibility, scalability and economic efficiency of the project.

Table 2 Possible sources of CO₂ recovery, methods of transport, and patterns of CO₂ storage

Source of CO ₂ recovery	Method of transportation	CO ₂ storage area
Thermal power plants	Pipelines Ships	Underground in a land area
Steelworks		Under the seabed (coastal areas)
Chemical plants		Under the seabed (offshore)
Cement plants		
Paper mills		
Hydrogen production plants, etc.		

- ② Promotion of development of suitable sites for CCS/geological structure survey

While geological structure surveys have been con-

ducted for the purpose of oil and natural gas development in the past, they will also be conducted for the purpose of CCS starting in FY2023. In the future, Japan Organization for Metals and Energy Security (JOGMEC) will examine plans for investigation of suitable sites for CCS and loan survey data to private companies.

Research to date has estimated that there are storage reservoirs amounting to a total of 16 billion tons at 11 sites. For the time being, analysis and evaluation of economic efficiency, etc. have been conducted by private companies and they are expected to lead to development activities such as exploratory drilling. However, data on coastal areas that are close to CO₂ emission sources and are expected to be lower in transportation costs, are scarce, making development difficult.

In addition, fault risk assessment is one of the important factors when considering suitable sites for CCS. The International Energy Agency (IEA) will urgently examine development of the method to assess the risks from geographic faults, although no previous demonstration project has recognized their relationship with earthquakes.

③ Examination of sustainability of CCS businesses

Although we will provide CAPEX support for the launch of the CCS businesses for the time being, we will examine the CCS business models for operational support, which will start in 2030, with reference to the latest findings from the UK and other countries that are ahead of us.

In addition, seamless support measures will be examined from the perspective of ensuring the sustainability of CCS for CSS businesses after the “advanced CCS businesses,” based on the status of cost reduction and development of the business environment.

(2) Initiatives to reduce CCS costs

By setting the CCS cost targets for 2050 as one-fourth or lower for the separation and recovery costs, 70% or less for the transportation costs, and 80% or lower for storage costs, we expect to reduce the overall CCS costs in 2050 to approximately 60% or less compared with 2023. In addition, the target cost of separation and recovery by 2030 will be about half of the 2023 level.

To achieve these goals, the government will create research and development guidelines and promote research and development as well as demonstration of technologies that can significantly reduce costs.

Table 3 Results of CCS cost reduction estimate under certain conditions (RITE)

Yen/tCO ₂	Current	2030	2050 Rate of reduction from the current cost
Separation and recovery [1]	4,000	2,000-yen level (2,000)	1,000 yen or less (1,000)
Transportation [2] (PL 20 km)	2,600 (500,000 tCO ₂ /year)	2,600 (500,000 tCO ₂ /year)	1,600 (3 million tCO ₂ /year)
Transportation [3] (Ship 1,100 km)	9,300 (500,000 tCO ₂ /year)	9,300 (500,000 tCO ₂ /year)	6,000 (3 million tCO ₂ /year)
Storage (land) [4]	6,200 (200,000 tCO ₂ /year/well)	6,200 (200,000 tCO ₂ /year/well)	5,400 (500,000 tCO ₂ /year/well)
Storage (at sea) [5] *Grounding	6,900 (200,000 tCO ₂ /year/well)	6,900 (200,000 tCO ₂ /year/well)	5,400 (500,000 tCO ₂ /year/well)
Total			
PL + land: [1] + [2] + [4]	12,800	10,800	8,000 (38% reduction)
PL + at sea: [1] + [2] + [5]	13,500	11,500	8,000 (41% reduction)
Ship + land: [1] + [3] + [4]	19,500	17,500	12,400 (36% reduction)
Ship + at sea: [1] + [3] + [5]	20,200	18,200	12,400 (39% reduction)

(Source) The 3rd CCS business cost and implementation scheme review working group (October 31, 2022)

(3) Promotion of public understanding of CCS businesses

For the time being until 2030, CCUS briefings will be held in each region at the initiative of the national government to provide careful explanations to give people an understanding of the significance and burden of CCS, the safety of CCS, the investment effect in the region, the effect of job creation, and the effect of promoting consumption, etc., and dispel concerns about CCS. In areas where CO₂ storage sites will be located, a mechanism will be examined to support hubs and clusters centering on the CCS operated by local governments or private entities, related industries, and job creation activities.

(4) Promotion of overseas CCS businesses

Since utilization of the promising overseas storage potential would be one of the leading options, we will start concrete negotiations with several countries on the premise of CO₂ exports from Japan.

In addition, the government will support the acquisition of interests by Japanese companies through the "Asia CCUS Network" based on the Asia Energy Transition Initiative (AETI), which is led by Japan, through the provision of risk money by JOGMEC, etc. It will also support the launch of the Joint Crediting Mechanism (JCM) and an international credit system derived from CCS.

(5) Examination for the development of the CCS Business Act

The background to the need for measures in the legal system regarding CCS businesses is explained below.

- The application of laws and regulations to CCS businesses (Mining Act, Mine Safety Act, etc.) is not clear, and the rules to be followed on the business operator side and the system of national supervision are ambiguous.
 - There are no rules for preparing, measuring, transporting and providing data on the composition of gases in the CCS value chain of CO₂ separation and recovery, transport and storage.
 - There is no mechanism to eliminate or prevent interference from third parties in order to ensure long-term business stability.
 - While the establishment of CCS needs to be carried out with the understanding of residents, there is no state of compliance with security regulations, no mechanism for compensation for damages, etc., and it is not clear what the business operator should explain to residents.
 - The security and monitoring responsibilities of the storage operator are unclear, and the business viability cannot be ensured unless the responsibility is eliminated.
- To this end, examination will be made with the following policies:
- Establish the CCS Business Act as a new law as soon as possible.
 - In light of the CCS value chain, the scope of the Business Act should cover "separation and recovery," "transportation," and "storage," and the policy is to require notification in principle in order to lower the barriers to introduction, since "separation and collection" projects are likely to be carried out by CO₂ emitters in many cases, and "transportation" projects can be carried out by various means, such as pipelines and ship transportation.
 - On the other hand, since the "storage" business has many things in common with the oil and natural gas business, the planned policy is to adopt a permit system and take measures to enable exclusive use of the CO₂ storage reservoirs. In addition, referring to mining legislation, the policy is to take measures such as the establishment of a "common

system for land and sea” and a “new storage business right,” the development of a security system and clarification of liability for compensation (no-fault liability), and the limitation of monitoring responsibility.

- In addition to the measures to provide a legal framework for the export of CO₂ to promote overseas CCS, the policy is to make recovered CO₂ available for sale to promote CCU/carbon recycling.

(6) Development and review of the “CCS action plan”

A CCS action plan will be developed and reviewed in a timely manner after a more detailed review of CCS annual storage amount targets, cost targets, technology development guidelines and suitable site investigation plans. Therefore, a panel of experts will discuss the matter this fiscal year.

The “annual storage amount target” will be further refined based on the progress of other decarbonization initiatives, as well as the refinement of the annual storage amount target to be achieved by 2050 by gathering industry opinions.

With regard to “cost targets/technology development guidelines,” technical development guidelines will be prepared to achieve the targets after reviewing the CCS cost targets as necessary. Further refinements will be made based on progress in reducing costs.

With regard to the “suitable site investigation plan,” efforts will be made to estimate the location of suitable sites for CO₂ storage in areas where existing data are available, while also examining the possibilities of geological structure surveys in coastal areas. The methods for assessment of risks posed by geographic faults will also be examined.

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