CCS Project for Sustainable Society

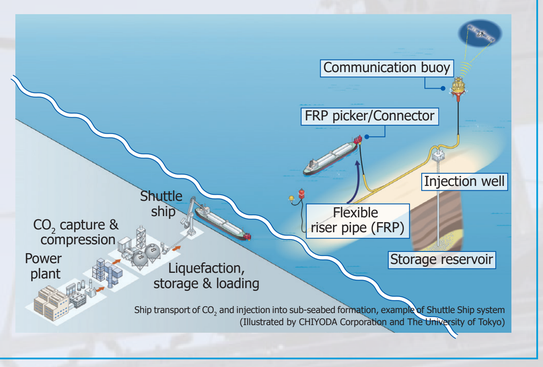
Bridge towards a sustainable future

Ministry of the Environment

The Ministry of the Environment of Japan (MOEJ) is proceeding with a major five-year (FY2016-2020) CCS Project for a Sustainable Society, recognizing that carbon dioxide capture and storage (CCS) technology is indispensable to achieve the goal of long-term climate change mitigation. Led by a consortium of 18 organizations, the project consists of four tasks, including construction and operation of Japan's first large-scale facility for amine-based chemical absorption of CO_2 to capture the majority of emissions from a thermal power plant.

Preliminary research

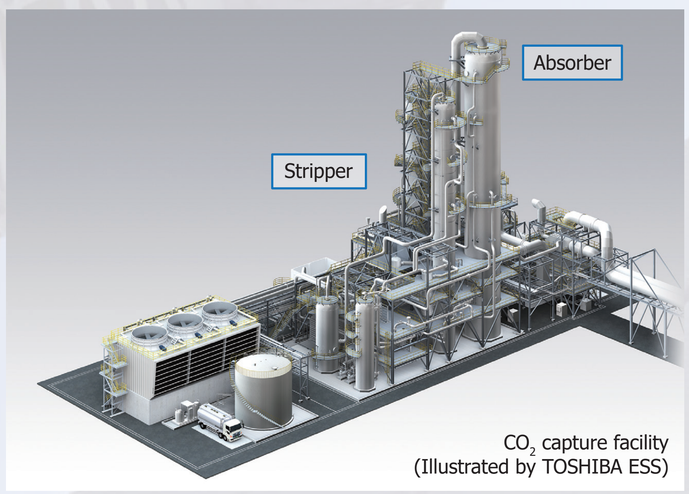
Potential CO_2 storage sites in Japan are distributed in marine areas. Therefore, in the preliminary phase from FY2014 to FY2015, pre-feasibility studies on ship-based CO_2 transport and offshore storage was conducted. A research on the emissions and environmental impact of the amine-based CO_2 capture process was carried out using Toshiba's pilot facility at Mikawa Power Plant of Sigma Power Ariake (Omuta City, Fukuoka Prefecture). The results have led to a conceptual design of a large scale capture plant to be used in the integrated CCS demonstration. Based on these results, a demonstration project plan was also prepared.



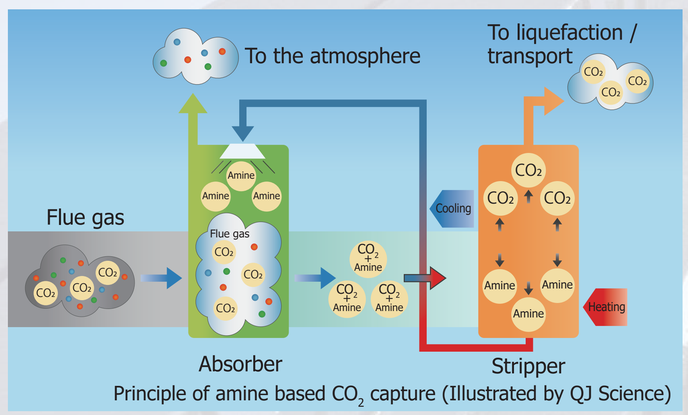
Ship transport of CO_2 and injection into sub-seabed formation, example of Shuttle Ship system (Illustrated by CHIYODA Corporation and The University of Tokyo)

Task 1: Demonstration of CO_2 capture technologies

Construction of a large-scale demonstration facility is underway that can capture more than 500 tons of CO_2 per day, which represents 50% of the CO_2 emission from the Mikawa Power Plant. In addition to verifying the performance and operability of this facility integrated with the power plant, technological issues will be identified and costs associated with installation of the CO_2 capture facility at a thermal power plant will be assessed. In parallel with the construction work, research activities on the emissions and environmental impact of the amine-based CO_2 capture process have been carried out. Such activities include examination of environmental impact assessment methodology, engineering studies to minimize the environmental burden associated with the operation of a larger scale CO_2 capture facility, and verification that there will be almost no environmental impact associated with the demonstration facility.



CO_2 capture facility (Illustrated by TOSHIBA ESS)



Principle of amine based CO_2 capture (Illustrated by QJ Science)

When the flue gas from the thermal power plant contacts the amine solution, the amine absorbs CO_2. By subsequently heating the solution, the amine and CO_2 are separated and therefore CO_2 in high concentration can be captured.

World's first biomass power plant equipped with a CO_2 capture facility

The Mikawa Power Plant has already installed an advanced circulation-type fluidized bed boiler that can burn not only coal but also biomass for power generation. The power plant will become the world's first biomass power plant fitted with a CO_2 capture facility, and the construction work will be completed in early FY2020. This facility is innovative as it captures CO_2 that has been absorbed from the atmosphere by plants and will lead the way to Bioenergy with carbon dioxide capture and storage (BECCS) that can reduce the CO_2 concentration in the atmosphere.

Task 2: Study on ship transport of CO_2 and injection into a sub-seabed geological formation

In Japan, potential areas for CO_2 storage are unevenly distributed in marine areas. Accordingly, a key issue for a large-scale deployment of CCS is to use such storage sites as efficiently as possible by rationally matching them with the large-scale CO_2 emission sources that are widely distributed across the country. Accordingly, this project aims to create technology for ship transport and sub-seabed injection of captured CO_2, that is widely compatible with a range of distances between CO_2 emission sources and storage sites as well as a variety of water depths at the CO_2 storage sites.


Image of CO_2 transport ship (Illustrated by Uyeno Transtech & MHIR)

Task 3: Study of stable undersea CO_2 storage

In order to know exactly how much CO_2 can be stored in our country, we need to judge appropriately whether we can store CO_2 in offshore areas, in addition to coastal regions. For this reason, we are making efforts to identify issues related to stable undersea CO_2 storage, including the potential for leakage of stored CO_2 as well as monitoring methods and leak repair methods. We are also studying and organizing leakage mitigation measures.

Task 4: Study on formation of enabling environment for smooth introduction of CCS in Japan

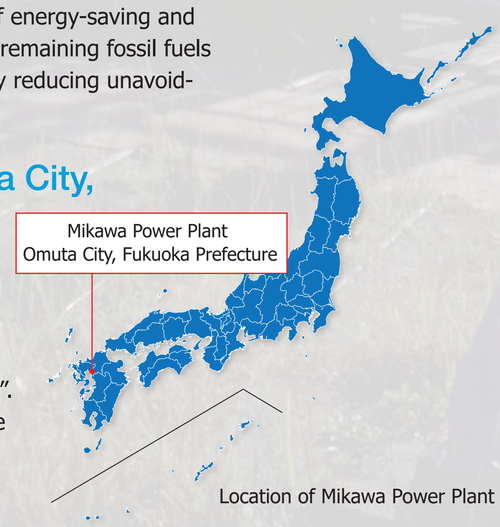
In this project, in addition to demonstration and technical research, detailed study is being conducted on the development of strategies and associated tools to facilitate the introduction of CCS in Japan. Activities of this task include: studies on policies and measures to create enabling environment, development of strategies for consensus building and related tools, study on a full-chain CCS system suitable to Japan, development of a roadmap and action plans for a large-scale deployment of CCS. In addition knowledge sharing and management platform has been developed to support integrating the whole range of tasks in the project.

Technology acting as a bridge to a "Decarbonized Society"

The world is heading toward a "Decarbonized Society" by promoting widespread use of energy-saving and renewable energy technologies. For the time being, however, we are likely to depend on remaining fossil fuels to a certain extent. CCS is a technology acting as a bridge to a "Decarbonized Society" by reducing unavoidable CO_2 emissions associated with the use of fossil fuels.

CO_2 capture demonstration project has started in Omuta City, where once flourished with the coal mining industry

Home to the CO_2 capture demonstration of this project, Mikawa Power Plant is located in Omuta City, Fukuoka Prefecture, which flourished with the coal mining industry between Meiji and Showa eras. To commemorate this, Miike Coal Mine, Miyanohara Pit, and Miike Port were registered on the UNESCO World Heritage List in 2015 as the "Sites of Japan's Meiji Industrial Revolution: Iron and Steel, Shipbuilding and Coal Mining". A "revolutionary" CO_2 capture demonstration project which leads to BECCS as an ultimate measure against climate change was launched in this historic city.



Location of Mikawa Power Plant

Schedule of this project

FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020
Preliminary research						
		Demonstration of CO_2 capture technologies				
				Study of CO_2 transport by sea and injection into a geological formation		
		Study of stable undersea CO_2 storage				
		Comprehensive study of social environment for CCS suited to Japan				

The Long-term Strategy under the Paris Agreement (Cabinet decision, June 11, 2019)

–Japan proclaims a "decarbonized society" as its ultimate goal and aims to accomplish it ambitiously as early as possible in the second half of this century. Toward that end, Japan has set a long-term temperature goal of reducing GHG emissions by 80% by 2050, and will boldly take measures towards its realization *(Chapter 1: Basic Concepts, 2. Japan's Long-term Vision, p.15).*

–It is also necessary to identify concrete targets in terms of costs and efficiencies in the key areas for decarbonization such as hydrogen, carbon dioxide capture and storage (CCS), carbon dioxide capture and utilization (CCU), renewable energy, storage batteries and nuclear energy, as well as challenges and systems including collaboration both in Japan and overseas *(Chapter 1: Basic Concepts, 3. Basic Principles in Policy towards the Long-term Vision, p.16).*

What is CO_2 Capture and Storage (CCS)?

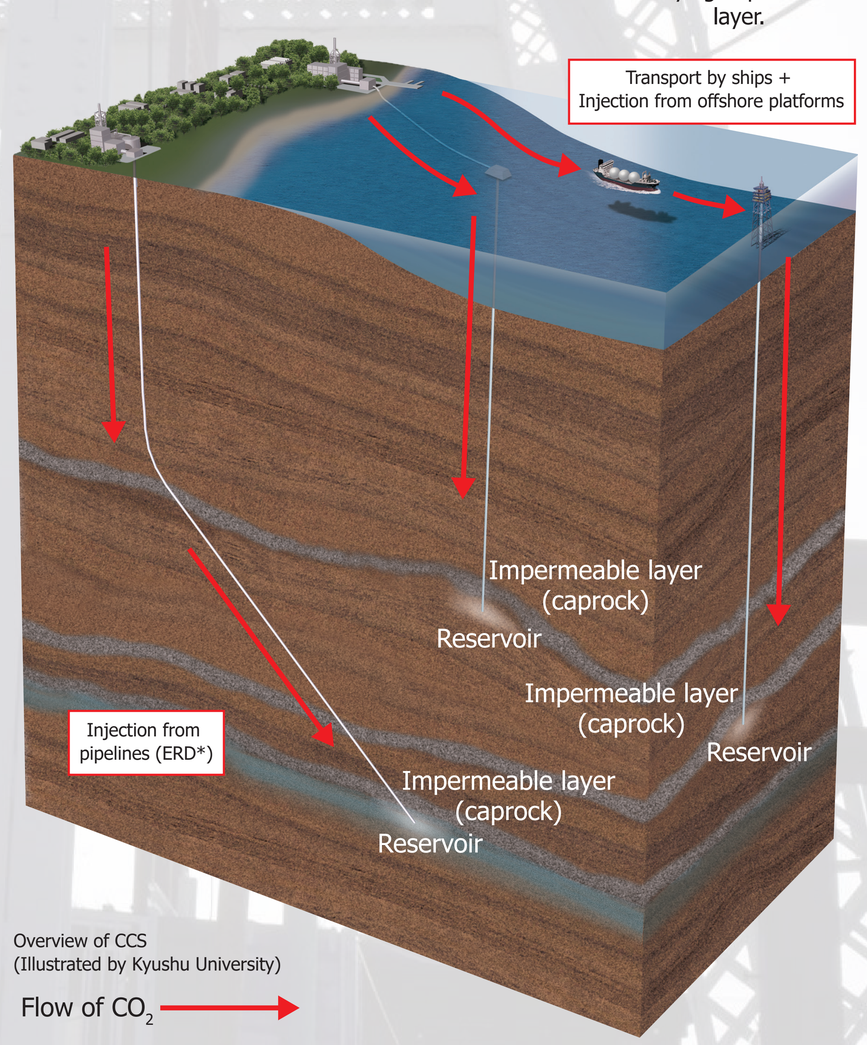
While the impacts of climate change have become widely recognized through experiencing a series of heavy rains and an increasing number of extremely hot days, the "Paris Agreement" came into effect in November 2016. On such a background, the global community is working to achieve the goal to limit global warming to well below 2°C and aiming for 1.5°C above pre-industrial level by the end of the century.

CCS is a technology consisting of 1) capturing CO_2 from large emission sources such as thermal power plants or manufacturing facilities, 2) transporting it via pipeline or ships to storage sites and 3) injecting it into an underground reservoir. CO_2 is then confined by an overlying impermeable layer (also called a caprock) that prevents leakage into the atmosphere. CCS has been recognized as an indispensable tool along with other technologies such as renewables and energy conservation to meet the objectives mentioned above by many international bodies such as IPCC and IEA.

Step 1 Capture
Capture of CO_2 from large-scale sources

Step 2 Transport
Ship transport & injection from offshore platform

Step 3 Storage
Injection of CO_2 into an underground formation deeper than 800 m, which is covered by an overlying impermeable layer.



Overview of CCS (Illustrated by Kyushu University)

Flow of CO_2 →

* ERD: Extended Reach Drilling is highly deviated drilling starting from the land area to an undersea reservoir.

CCS = Carbon dioxide Capture and Storage

Project members

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Background photograph: A vertical scaffold at the Miyanohara coal mine (World Heritage)