



Techno-Societal Governance of Carbon Capture and Storage

- Facilitate Taiwan's Carbon Reduction Targets with Carbon Capture and Storage.
- Societal Communication to Accelerate Carbon Capture and Storage.
- Creating a Carbon Capture and Storage Value Chain.

Background

In 2022, Taiwan's National Development Council (NDC) released the "Taiwan's Pathway to Net-Zero Emissions in 2050". This includes plans to have thermal power plants generate 20% to 27% carbon-free electricity by equipping them with Carbon Capture, Utilization, and Storage (CCUS) technology [1]. Enhancing carbon recycling and industrial applications could optimistically reduce 4.6 million metric tons of CO₂ annually by 2030 through CCUS technology. [2] Therefore, developing large-scale commercial Carbon Capture and Storage (CCS) projects has significant potential for carbon reduction. These projects not only effectively support 2030 carbon reduction goals but, by referencing the strategies of Japan and South Korea and incorporating cross-border CCS as an option, can significantly accelerate Taiwan's progress toward achieving 2050 net-zero emissions targets.

Additionally, in order to successfully promote and implement CCS applications, it is important to balance the creation of new industrial value chains and employment opportunities while ensuring effective societal communication to achieve a just net-zero transition.

Global Outlook and Domestic Progress

(1) Global Outlook and Domestic Progress of Carbon Capture and Storage

According to the Global CCS Institute's (GCCSI) "Global Status of CCS 2023" report [3], there are now 392 CCS facilities worldwide, including 41 operational, 26 in construction, 121 in the advanced development phase, and 204 in the early development phase. These facilities have an expected capacity to store 12 gigatonnes (Gt) of CO₂ by 2050. The report also notes that future CCS facilities will develop toward CCS hubs. Additionally, international CCS projects are enhancing public acceptance of CCS chiefly through transparent disclosures of public information, the release of policy information, participatory communication mechanisms, creating social opportunities while reducing risks, and

evaluating the effectiveness of public dialogues to dynamically adjust relevant strategies.

Domestically, Taiwan's CPC Corporation (CPC) and the Taiwan Power Company have initiated CCS pilot projects, with capacities of 300,000 tons [4] and 30,000 tons [5], respectively. However, CPC previously faced challenges in terms of societal communication with the public during its attempt to conduct a CCS pilot project in the Yonghe Mountain area of Miaoli County. Therefore, before the two aforementioned CCS pilot projects commence, those in charge with their development have begun gradually planning and implementing CCS-related societal communication with the public.

These initiatives include showcasing CCS research results by organizing net-zero-related events [6] and establishing official websites [7].

Additionally, creating CCS exhibition hall [8] and planning educational display centers will help foster closer relationships between developers and stakeholders by sharing and explaining information related to CCS with the public in an accessible manner.

(2) Challenges and Opportunities of Developing Domestic Carbon Capture and Storage

In terms of the CCS technology and storage potential, the cost of CCS technology in Taiwan remains high, and there is a lack of CO₂ transportation pipelines and technologies to monitor offshore storage. Moreover, there are no clearly defined storage sites or precise assessments of potential storage capacity. Thus, it is difficult to develop large-scale demonstration projects or commercial applications.

Regarding regulations and support measures, there is a lack of clear guidelines for CCS development, regulatory procedures, and economic incentive mechanisms. In addition, the development of green finance mechanisms is hindered by the high initial costs of CCS

infrastructure, the absence of clear commercial models, and relatively high technical risks. Additionally, Taiwan lacks effective and innovative strategies to facilitate societal communication with the public in matters related to CCS.

Therefore, in addition to improving regulations and establishing mechanisms for societal communication with the public and the technology sector, Taiwan needs to focus on enhancing the efficiency of carbon capture technologies while reducing their costs. Currently, several state-owned enterprises have initiated small-scale pilot projects for carbon storage. In the future, Taiwan can accelerate the development of CCS technologies and carbon storage sites by learning from the international projects' success in CCS site development and experience in industrial value chain formation.

Additionally, Taiwan can refer to mature domestic and international energy certification mechanism and methods for benefits evaluation. By utilizing the Monitoring, Reporting, and Verification (MRV) mechanism for carbon credits or providing Carbon Free Electricity Certificates (CFEC)[9], environmental benefits can be concretely demonstrated, thereby stimulating industrial incentives to invest in CCS development.

Strategic Planning Frameworks

The comprehensive strategy for “Techno – Societal Governance of Carbon Capture and Storage” incorporates cross-agency collaboration and a mechanism to delegate responsibilities. The National Science and Technology Council (NSTC) and the Ministry of Economic Affairs are jointly responsible for the research and development of key CCS technologies, accelerating technological advancement and social governance by connecting international capabilities between industry and academia, and gradually forming Taiwan's CCS industry value chain. At the same time, this strategy also involves cooperation with the Ministry of Environment and other relevant agencies to develop socio-technical communication strategies while improving domestic regulatory frameworks and support measures.

This comprehensive strategic plan focuses on three major goals: (1) Evaluating potential sites while promoting large-scale demonstration sites for carbon capture and storage. (2) Developing domestic CCS technology and a decarbonized value chain. (3) Enhancing public support for carbon capture and storage.

As shown in the figure below, these strategies will effectively achieve Taiwan's 2050 net-zero targets by

aligning with six key strategies under four developmental sectors, which cover the economy, environment, society, and government.

Strategy 1: Develop Critical Technology for Carbon Capture and Storage

To effectively promote domestic CCS development and the formation of a value chain, it is essential to develop cost-effective carbon capture technologies. For example, high-efficiency and low-cost chemical absorption techniques, pressure swing adsorption/vacuum pressure swing adsorption, as well as low-cost and high-permeability membrane technologies.

In terms of carbon storage, the focus is on identifying potential storage sites and planning for development and operations, including regional development and management, improving geological data, and establishing integrated site-scale databases. Other important areas include long-term monitoring and management research, safety assessments for storage, and environmental monitoring technologies.

Domestic industries that urgently need to reduce emissions should utilize these technologies. At the same

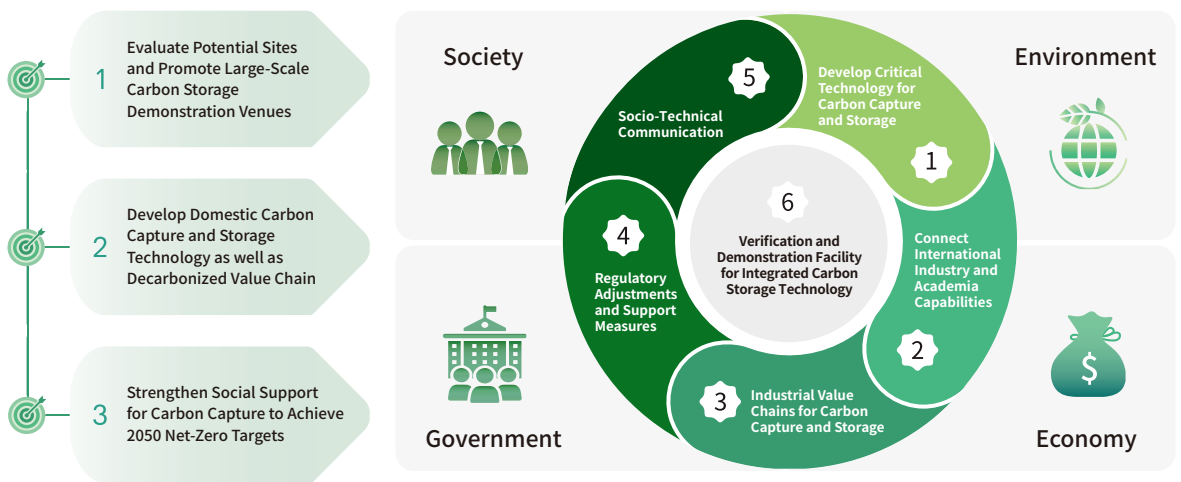


Figure 1 Strategic Plan for Techno – Societal Governance of Carbon Capture and Storage

Source: Taiwan Science and Technology Office for Net-zero Emission (T-STONE) (2024).

time, promoting the development of carbon transport and storage technologies will expand the scale of CCS technology development while fostering the formation and growth of the CCS industry.

Strategy 2: Connect International Industry and Academia Capabilities

Taiwan can accelerate its CCS development through international cooperation because mature technologies and projects have already been developed in other countries. This strategy chiefly involves collaborating with international entities to jointly develop key technologies that have certain levels of technological maturity while incorporating technologies into domestic projects that have already been put into practice in other countries.

In addition, Taiwan can accelerate its process of technological application by signing memorandums of understanding (MOUs) with leading international CCS institutions, such as the National Energy Technology Laboratory (NETL) in the US, CO2GeoNet in Europe, Technology Centre Mongstad (TCM) in Norway, or CO2CRC in Australia, and leveraging foreign sites to validate Taiwan's technological achievements.

Furthermore, before Taiwan's domestic CCS value chain and storage sites are fully developed, it is possible to form an international carbon storage business model by strengthening ties with international carbon storage industry.

Strategy 3: Industrial Value Chains for Carbon Capture and Storage

Establishing an industry value chain is a crucial step in promoting CCS technology development. It is also necessary to assess the economic feasibility of the CCS

value chain, as well as the demand and feasibility of carbon storage both domestically and internationally. Once feasibility is confirmed, Taiwan can establish a Carbon-Free Electricity Certificate (CFEC) system, allowing electricity users to concretely declare the environmental benefits of using carbon-free electricity generated by thermal power plants with CCS technology.

Additionally, incorporating a carbon credit trading mechanism can further promote the establishment and development of a CCS industry value chain. The formation of this value chain will drive economic growth, generate CCS-related employment opportunities, and support the creation of CCS-related academic courses. These trained professionals can then create a positive cycle of development by entering the industry value chain.

Strategy 4: Regulatory Adjustments and Support Measures

The implementation of CCS technology relies on establishing appropriate regulations, providing policy incentives and creating support measures. After reviewing domestic regulations related to CCS, existing laws governing carbon capture appear to accommodate the potential development of CCS. Moreover, Taiwan has determined that it already has experience in transporting and temporarily storing CO₂. However, specific regulations related to carbon storage are still lacking.

In the future, the NSTC will work with the Ministry of Environment to jointly discuss and develop CCS management sub-laws and related regulations under the Climate Change Response Act. In addition, Taiwan will facilitate the domestic planning and promotion of CCS by referencing international CCS regulations.

Strategy 5: Socio-Technical Communication

Social governance is a crucial part of developing CCS technology. From the perspective of a socio-technical system, enhancing social acceptance and successfully implementing policies hinges upon establishing effective strategies for socio-technical communication. The first step in this process is to identify key issues, understand the positions and information needs of each stakeholder, and develop narratives regarding the opportunities and risks created by CCS.

In terms of participatory communication, transparent disclosure of information and policies, knowledge translation, and communication approaches tailored to local contexts can improve society's understanding and acceptance of CCS technologies and policies. Moreover, by evaluating the effectiveness of ongoing communication strategies, dynamic adjustment of these approaches can help gradually establish consensus with stakeholders while facilitating the successful implementation of CCS at the local level.

Strategy 6: Verification and Demonstration Facility for Integrated Carbon Storage Technology

Establishing an integrated technology verification and demonstration site for carbon storage can help develop applicable business models and standards by serving as a reference for planning Taiwan's CCS storage sites. After referencing international CCS operating models, such as Japan CCS Co., Ltd., Norway's Northern Lights JV DA, and the UK's Net Zero Teesside Power Limited, Taiwan should establish a national-level CCS company (Taiwan CCS Corporation, hereafter referred to as TCCS). The operational and financial planning for the TCCS pilot site would include aspects such as construction and operational methods, human resource management, financial budgets, funding plans, and assessments of profits and risks.

Additionally, validate strategies for socio-technical communication by setting up a CCS environmental education center. A technology verification site that integrates capture, transport, injection, storage, simulation, and monitoring will assess the feasibility of CCS technology implementation.

Potential Benefits

The development of carbon capture technology in Taiwan has begun to focus on improving efficiency, reducing costs, and pursuing more technically feasible solutions. Certain state-owned and private enterprises have initiated small-scale carbon storage pilot projects while gradually strengthening cooperation and exchanges with international organizations with experiences in CCS. The "Techno-Societal Governance of Carbon Capture and Storage" Strategic Plan aims to comprehensively verify the technical, economic, social, and environmental feasibility of CCS, with the goal of establishing a large-scale (tens of thousands of tons) integrated technology verification demonstration site for carbon storage by 2030. This will accelerate the implementation of CCS in Taiwan, support the net-zero transition for hard-to-abate industries, and foster the development of a CCS industrial ecosystem.

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