Socio-Technical Governance of Carbon Capture and Storage

Background

In 2022, the National Development Council (NDC) published the “Taiwan's Pathway to Net-Zero Emissions in 2050”, establishing a strategic framework for national decarbonization. A critical component of this pathway is integrating Carbon Capture, Utilization, and Storage (CCUS) technology into thermal power generation, with a target of achieving 20%-27% carbon-free electricity [1]. Projections from the 2025 “Carbon Reduction Action Plans by Six Major Sectors” indicate that enhancing carbon recycling and industrial applications via CCUS could reduce CO_2e emissions by approximately 1.76 million tons annually by 2030 [2]. Consequently, the development of large-scale commercial CCS projects is identified as a vital mechanism for meeting 2030 reduction goals and accelerating progress toward the 2050 net-zero target. To ensure successful implementation, the strategy emphasizes balancing the creation of an industrial value chain with effective communication to facilitate a just transition.

Global Outlook and Domestic Progress

(1) Global Outlook

The Global CCS Institute’s "Global Status of CCS 2023" reports 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 are expected to have a capacity to store 12 gigatonnes (Gt) of CO_2 by 2050 [3]. The industry trend is shifting toward developing CCS hubs. Successful international projects demonstrate that public acceptance is significantly enhanced through transparent disclosure, participatory communication mechanisms, and dynamic strategy adjustments informed by the effectiveness of public dialogue.

(2) Domestic Progress

Taiwan’s CPC Corporation (CPC) and Taiwan Power Company have initiated pilot projects with storage capacities of 300,000 tons [4] and 30,000 tons [5], respectively. Acknowledging historical challenges with social communication in the Yonghe Mountain area of Miaoli County, current developers are implementing proactive engagement strategies before project commencement. These measures include establishing official information websites, CCS exhibition halls, and educational display centers to foster closer relationships with stakeholders and improve social communication [6, 7, 8].

(3) Challenges of Developing Domestic CCS

The development of domestic CCS infrastructure faces barriers across technical, regulatory, and social dimensions:

A. Technical:

High technology costs persist, compounded by a lack of CO_2 transport infrastructure and offshore monitoring technologies. Furthermore, precise assessments of potential storage capacity and clearly defined storage sites are currently absent, impeding large-scale commercial applications.

B. Regulatory & Financial:

There is a deficiency in clear guidelines for CCS development, regulatory procedures, and economic incentive mechanisms. High initial capital requirements and undefined commercial models hinder the development of green finance mechanisms.

C. Social Governance:

Taiwan currently lacks effective, innovative strategies for socio-technical communication regarding CCS.

Strategic Planning Framework

The "Socio-Technical Governance of Carbon Capture and Storage" strategy employs a cross-agency collaboration and a mechanism to delegate responsibilities. The National Science and Technology Council (NSTC) and the Ministry of Economic Affairs are responsible for CCS R&D and value chain development, while the Ministry of Environment leads the regulatory frameworks and conducts socio-technical communication in collaboration with the other ministries. The strategic plan focuses on three major goals: (1) Evaluating potential sites while promoting large-scale CCS demonstration sites; (2) Developing domestic CCS technology and a decarbonized value chain; and (3) Enhancing public support for CCS. As shown in the figure below, these strategies will effectively achieve Taiwan's 2050 net-zero targets by aligning with six key strategies across four developmental sectors: economy, environment, society, and governance.

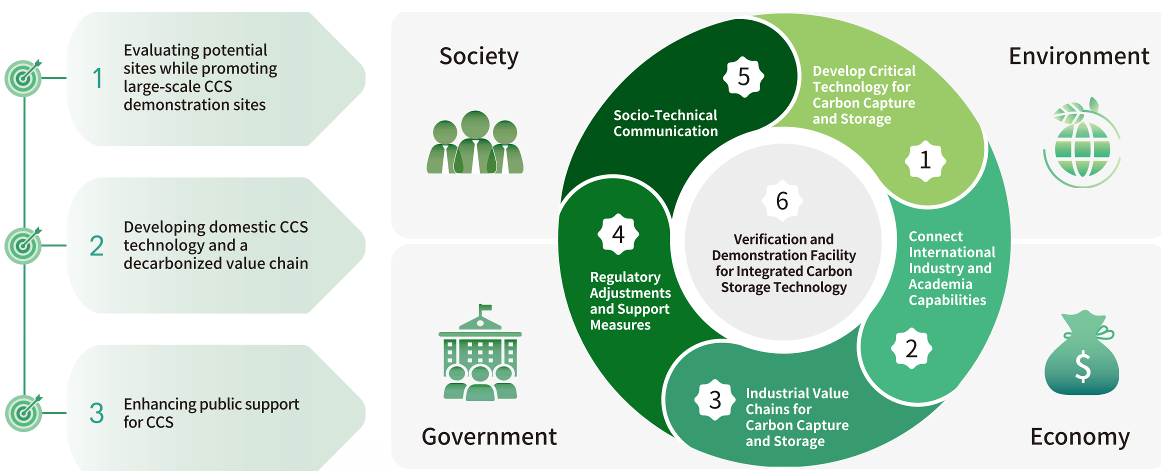

Figure 1 Strategic Plan for Socio-Technical Governance of Carbon Capture and Storage

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

Implementation Strategies

Strategy 1: Develop Critical Technology for Carbon Capture and Storage

Development efforts will focus on cost-effective capture technologies (e.g., chemical absorption, pressure swing adsorption/vacuum pressure swing adsorption, and membrane) and geological storage solutions. This includes identifying potential storage sites, regional development planning, the establishment of integrated site-scale databases, and the implementation of long-term safety and environmental monitoring technologies. At the same time, promoting the development of carbon transport and storage technologies will expand the scale of CCS technology development.

Strategy 2: Connect International Industry and Academia Capabilities

The strategy prioritizes partnerships with benchmark CCS institutions (e.g., NETL, CO_2GeoNet, TCM, and CO_2CRC) to accelerate technological advancement. Co-developing mature technologies with international developers reduces R&D costs and enhances domestic capabilities. Additionally, linking with global CCS hubs and enterprises facilitates the adoption of international business models and management practices.

Strategy 3: Industrial Value Chains for Carbon Capture and Storage

Upon confirming economic feasibility, the plan proposes a Carbon-Free Electricity Certificate (CFEC) system to quantify the environmental benefits of CCS-equipped power generation [9]. Furthermore, the introduction of carbon credit trading mechanisms will provide further economic incentives, while the establishment of CCS-related academic programs and training courses will cultivate talent and support green employment.

Strategy 4: Regulatory Adjustments and Support Measures

While existing regulations cover capture and transport, specific laws for carbon storage are lacking. The NSTC and the Ministry of Environment will collaborate to formulate CCS management sub-laws and related regulations under the Climate Change Response Act, drawing on international CCS regulations to facilitate domestic implementation.

Strategy 5: Socio-Technical Communication

Effective socio-technical communication requires identifying critical issues for key stakeholders and developing narratives that address both opportunities and risks. Strategies include transparent information disclosure, knowledge translation, and localized communication approaches. Continuous evaluation and dynamic adjustment of communication strategies are essential for building consensus.

Strategy 6: Verification Demonstration Facility for Integrated Carbon Storage Technology

To validate business models and standards, establishing a national-level entity is recommended. This entity will manage a pilot site integrating capture, transport, injection, and monitoring to assess technical feasibility. This site will also house a CCS environmental education center to validate and refine socio-technical communication strategies.

Potential Benefits

The "Socio-Technical Governance of Carbon Capture and Storage" Strategic Plan aims to comprehensively assess the technical, economic, social, and environmental feasibility of CCS, with the goal of establishing a pilot-scale (tens of thousands of tons) integrated technology verification demonstration site for carbon storage by 2030. This will accelerate the implementation of commercial 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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