OVERALL PICTURE OF CO2 CAPTURE, TRANSPORT, AND STORAGE PLANS IN TWO MAJOR CCS REGIONS

—PROJECT CHARACTERISTICS OF THE US AND COUNTRIES BORDERING THE NORTH SEA AND FACTORS SPECIFIC TO THE TWO REGIONS—

Ryoji Horita
Social Research Dept., Industrial & Social Studies Div.
Mitsui & Co. Global Strategic Studies Institute

SUMMARY

- Advancements are being made in carbon capture and storage (hereinafter referred to as “CCS”), as evidenced by an increase in total capture capacity, expansion of geographical distribution, and application to a wider range of emission sources. In terms of projects under construction or in the planning phase, the US and the countries bordering the North Sea[1] (hereinafter referred to as “the NS”) account for approximately three-quarters of the world's carbon capture capacity, and the two regions are expected to drive expansion of CCS activities going forward.

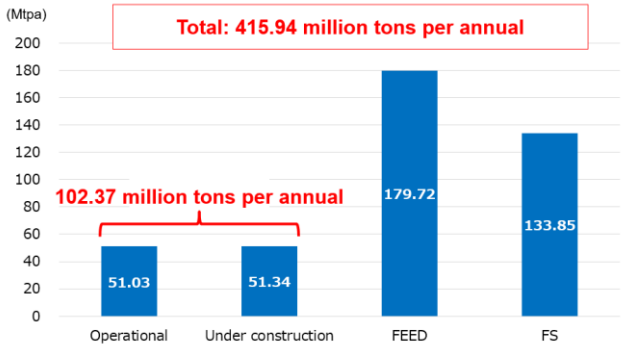
- A comparison of the US and the NS shows different characteristics in capture, transport, and storage plans. Major factors defining these regional characteristics are differences in policies such as incentives and regulations, in the types of industries that were developed in the region before the introduction of CCS, and in geological structures.

- Trends to watch in the US include potential reductions in policy support, while the NS could see moves toward more favorable rules for emissions trading schemes that would allow for Europe-wide storage.

1. NEW DEVELOPMENTS IN THE FIELD OF CCS

The capture capacity of CCS projects has continued to increase since 2017. In 2024, total capture capacity, including projects in the planning phase, exceeded 400 Mtpa, and the capture capacity of projects currently operational and under construction reached 100 Mtpa (Figure 1).

Figure 1: Global carbon capture capacity by status (as of 2024)



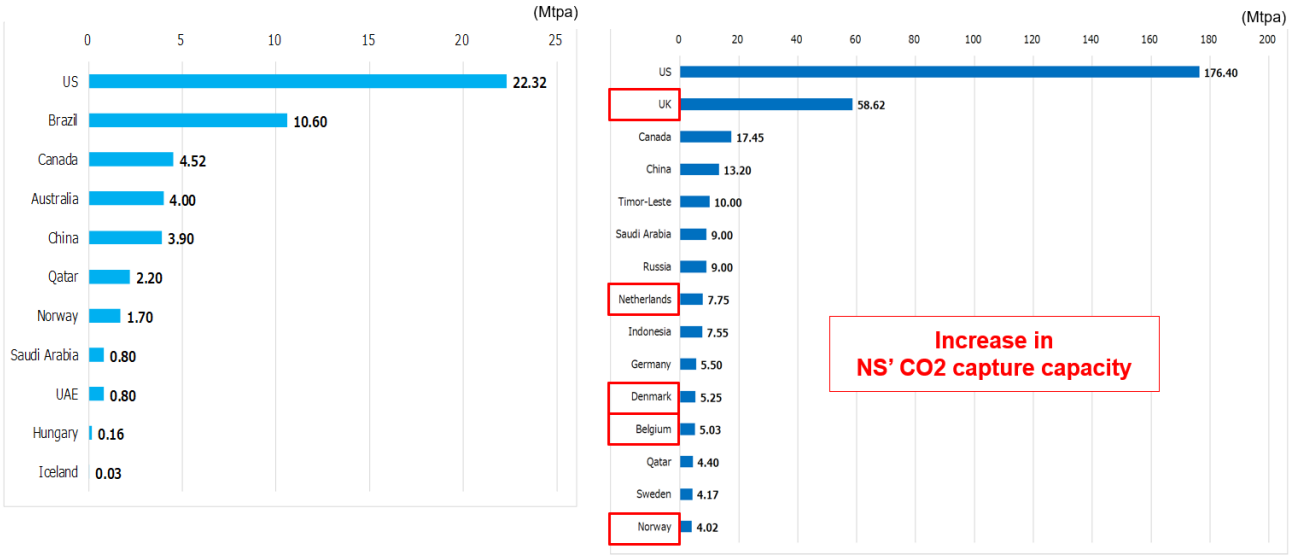
Note: “FEED” and “FS” in the figure refer to Front End Engineering Design and Feasibility Study, respectively.

Source: Compiled by MGSSI based on Global CCS Institute, Global Status of CCS 2024, https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf (accessed April 7, 2025)

[1] Seven countries: the UK, Netherlands, Germany, Denmark, Belgium, Norway, and France

Meanwhile, the breakdown of capture capacity for operational projects versus those under construction/planning looks quite different. In terms of geographic distribution, for the former projects, capture capacity is large in the US, Brazil, and other countries; while in the latter projects, capacity is increasing in the NS in addition to the US, with the two regions accounting for approximately three-quarters of global capture capacity (Figure 2). As for capacity broken down by emissions source, for the operational projects, capture capacity is mainly centered on natural gas and LNG; while those under construction/planning are seeing an expansion in capacity for various emission sources, including electricity/heat, and hydrogen[2]. (Figure 3).

Figure 2: Carbon capture capacity of each country (left: operational, right: under construction/planning (Top 15))



Source: Compiled by MGSSI based on Global CCS Institute、Global Status of CCS 2024, https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf（accessed April 7, 2025）

Figure 3: Carbon capture capacity by emissions source (left: operational, right: under construction/planning)

Note: "Hydrogen" includes hydrogen, ammonia, and fertilizers, and "biofuels" include bioethanol, etc.

Source: Compiled by MGSSI based on Global CCS Institute, Global Status of CCS 2024, https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf（accessed April 7, 2025）

This report focuses on the US and the NS as the centers of new CCS project development, and provides an overall picture of CO2 capture, transport, and storage plans, and then identifies the characteristics and factors specific to each of the two regions.

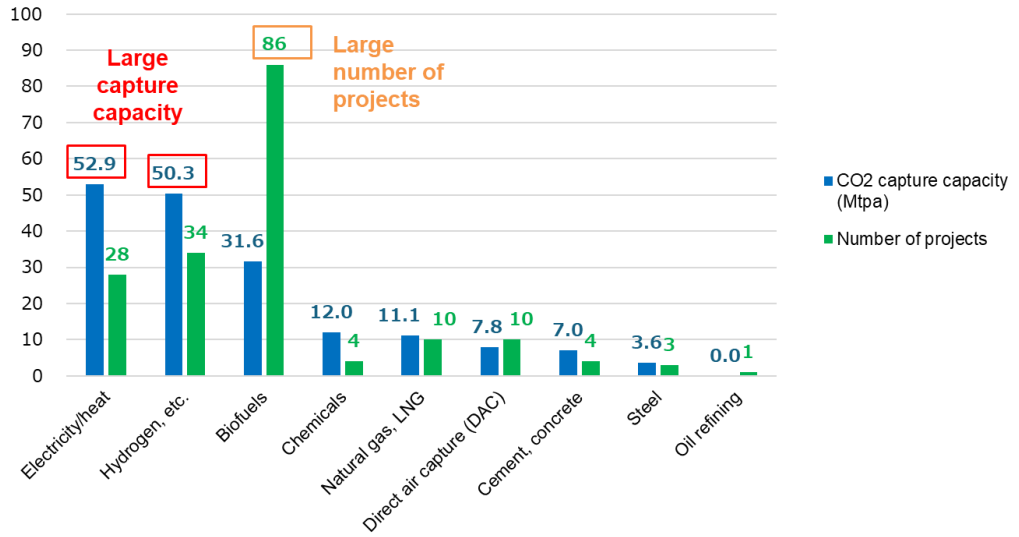
2 "Hydrogen" includes hydrogen, ammonia, and fertilizers

2. CAPTURE, TRANSPORT, AND STORAGE PROJECTS UNDER CONSTRUCTION OR PLANNING IN THE TWO MAJOR REGIONS (THE US AND THE NS)

2-1. Capture

In the US, carbon capture capacity by emissions source is large for electricity/heat and hydrogen, while biofuels stand out in terms of the number of projects (Figure 4). The main sources of emissions vary widely by region, from electricity/heat and hydrogen on the West Coast and Gulf Coast to biofuels in the Midwest (Figure 5). The operational years of projects related to hydrogen and biofuels are concentrated in the years up to 2029, while those for many projects related to electricity/heat are undecided (Figure 6).

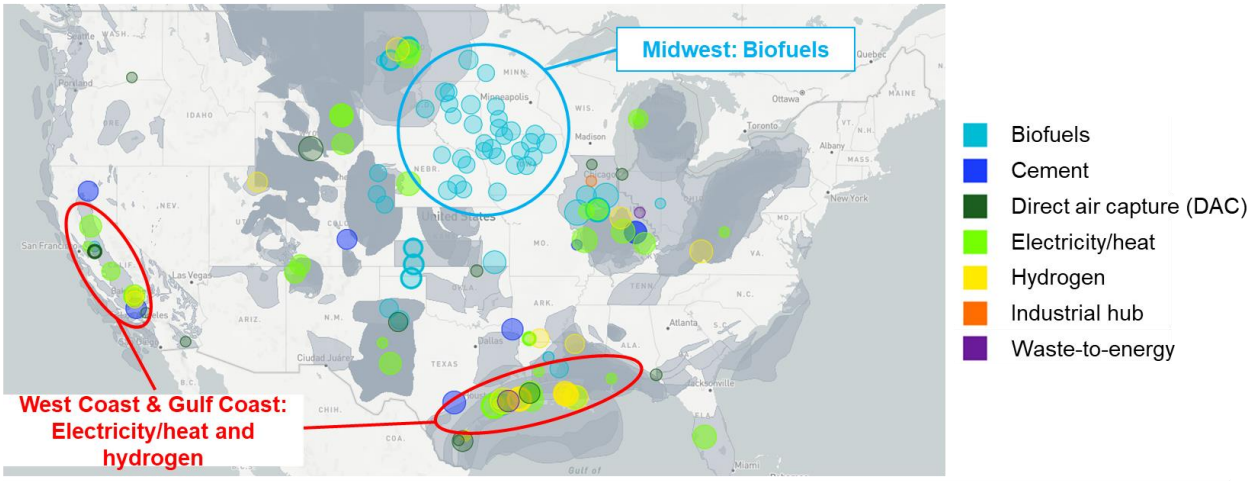
Figure 4: US carbon capture capacity and number of projects by emissions source



Notes: The carbon capture capacities of projects for which capacity is "under evaluation" are not included in the calculation. "Hydrogen, etc." includes hydrogen, ammonia, and fertilizers, and "biofuels" include bioethanol, etc.

Source: Compiled by MGSSI based on Global CCS Institute、Global Status of CCS 2024, https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf（accessed April 7, 2925

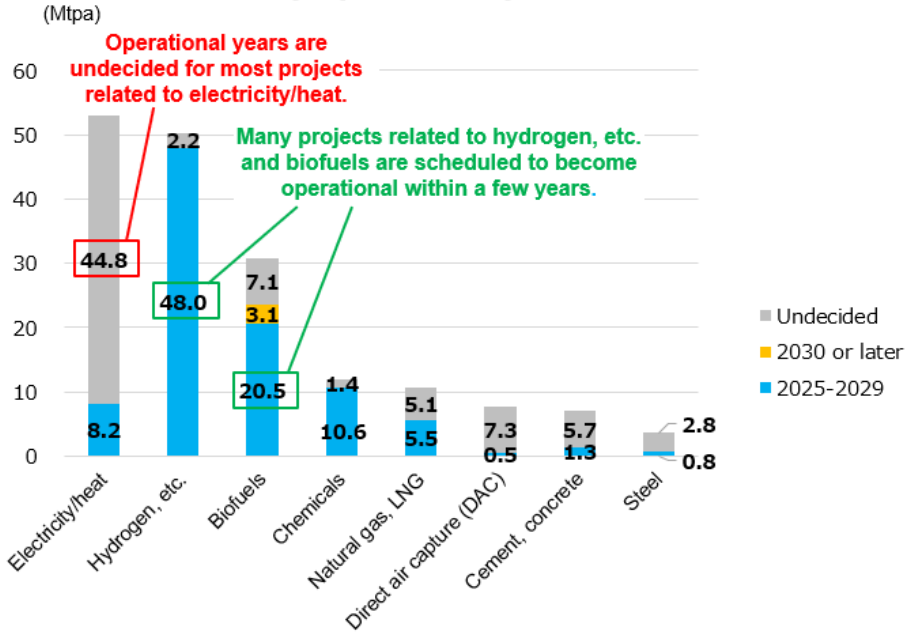
Figure 5: Location and type of emission sources in the US



Note: The size of the circles in the figure is proportional to the size of the carbon capture capacity. Circles with thick lines indicate projects that are operational, and those with thin lines indicate projects in the planning stage.

Source: Compiled by MGSSI based on Clean Air Task Force、US Carbon Capture Activity and Project Map、https://www.catf.us/ccsmapus/ (accessed April 7, 2025)

Figure 6: Carbon capture capacity for each emissions source in the US by operational year



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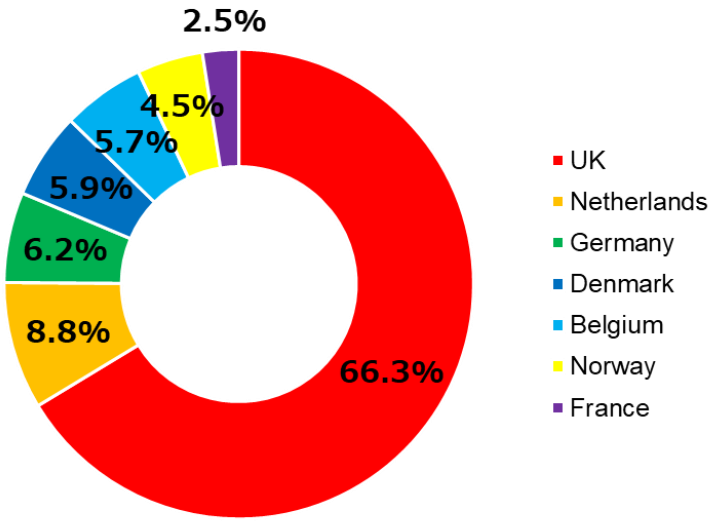
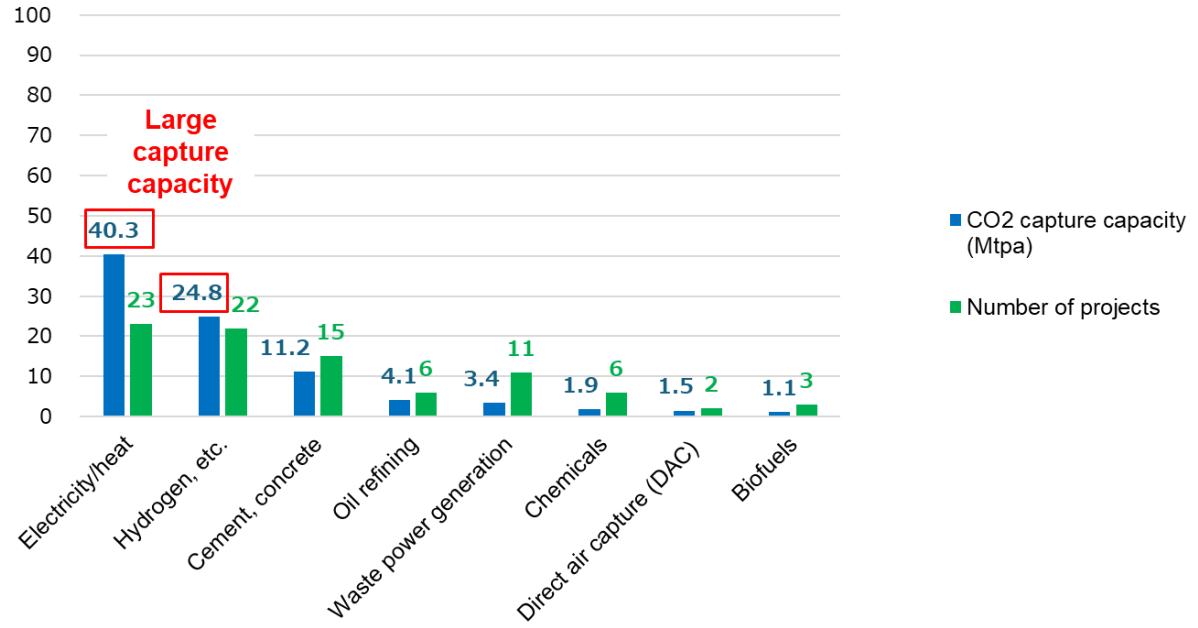
In the NS, the UK accounts for just under 70% of the region's total capture capacity, while each of the other six countries accounts for less than 10% (Figure 7), highlighting the UK's dominant share. Carbon capture capacity and the number of projects are high for electricity/heat and hydrogen (Figure 8), and are concentrated in the areas bordering the North Sea (Figure 9). As for operational year, most of the projects related to electricity/heat and hydrogen are scheduled to start operation by 2029 (Figure 10).

Figure 7: Each country's carbon capture capacity as a percentage of the total in the NS



Source: Compiled by MGSSI based on Global CCS Institute, Global Status of CCS 2024, https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf (accessed April 7, 2025)

Figure 8: NS carbon capture capacity and number of projects by emissions source



Notes: The carbon capture capacities of projects for which capacity is "under evaluation" are not included in the calculation. "Hydrogen, etc." includes hydrogen, ammonia, and fertilizers, and "biofuels" include bioethanol, etc.

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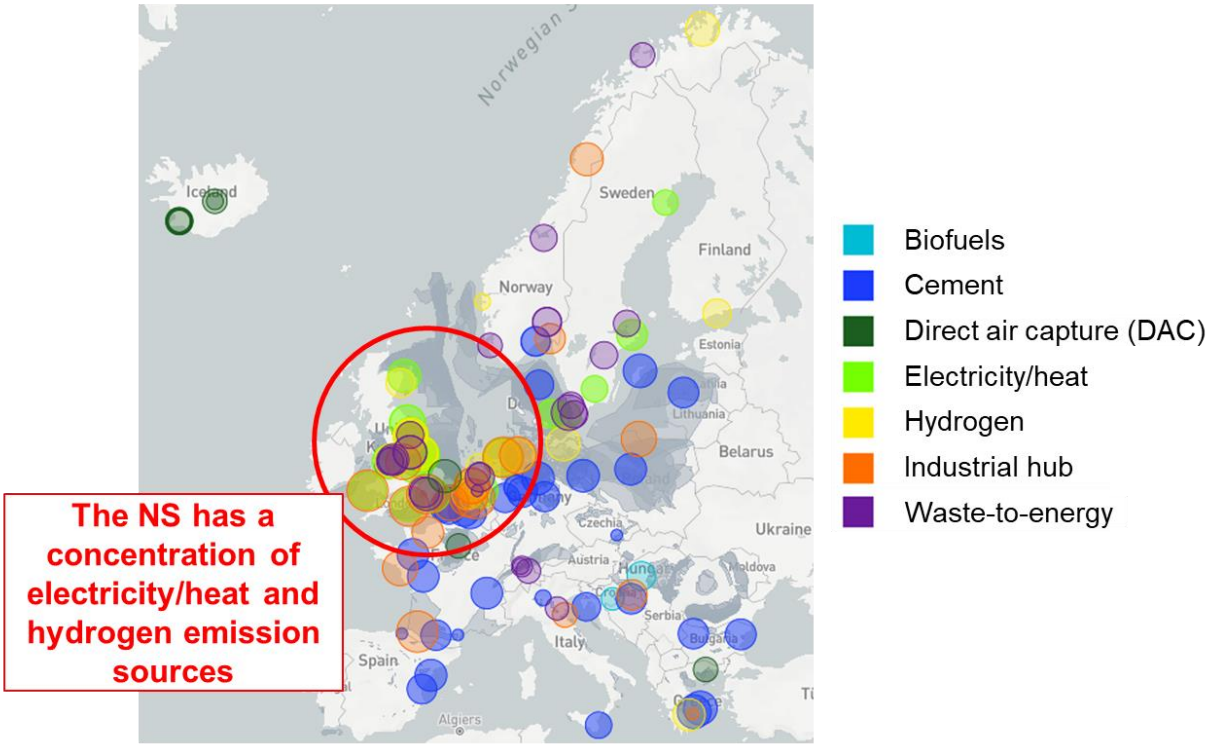
Figure 9: Location and type of emission sources in the NS



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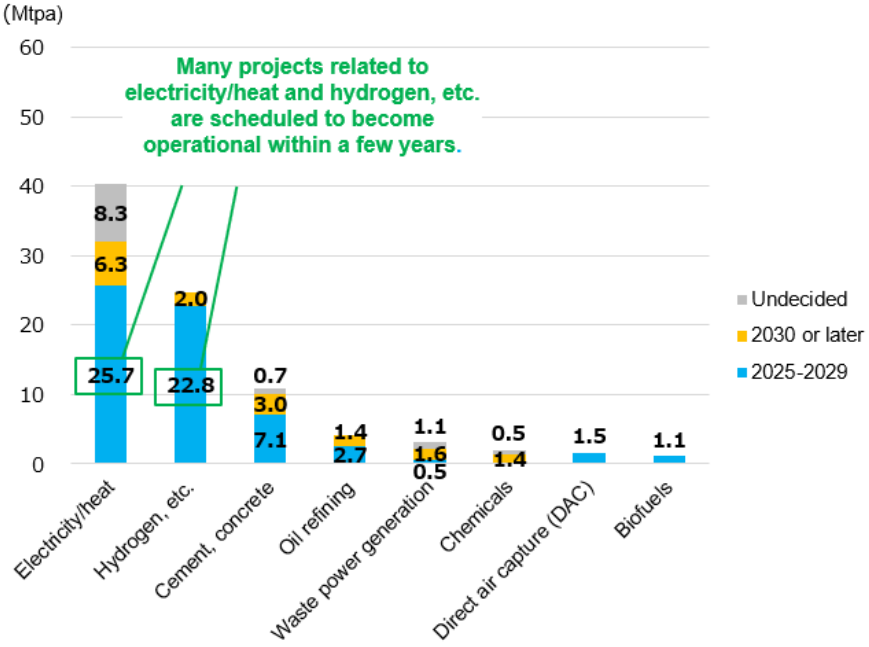
Source: Compiled by MGSSI based on Clean Air Task Force、US Carbon Capture Activity and Project Map, https://www.catf.us/ccsmapus/ (accessed April 7, 2025)

Figure 10: Carbon capture capacity for each emissions source in the NS by expected year of project startup



Notes: The carbon capture capacities of projects for which capacity is "under evaluation" are not included in the calculation. "Hydrogen, etc." includes hydrogen, ammonia, and fertilizers, and "biofuels" include bioethanol, etc.

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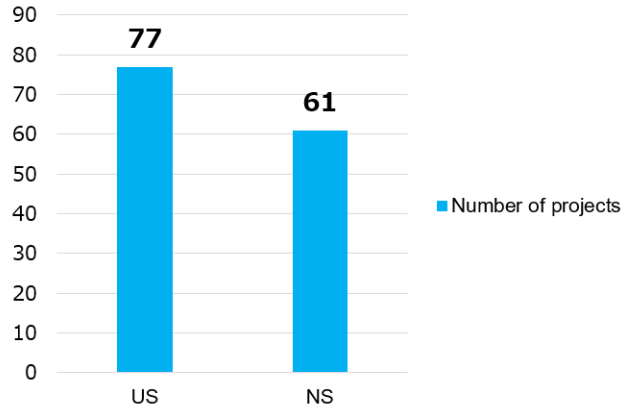
2-2. Transport

There are many transport and storage (hereinafter referred to as "T&S"[3]) projects in both regions, with the two regions accounting for approximately three-quarters of T&S projects globally. In the US, the number of T&S projects is the second highest after biofuel projects, and in the NS, the number of T&S projects is the highest of all CCS projects (Figure 11).

Figure 11: Number of T&S projects

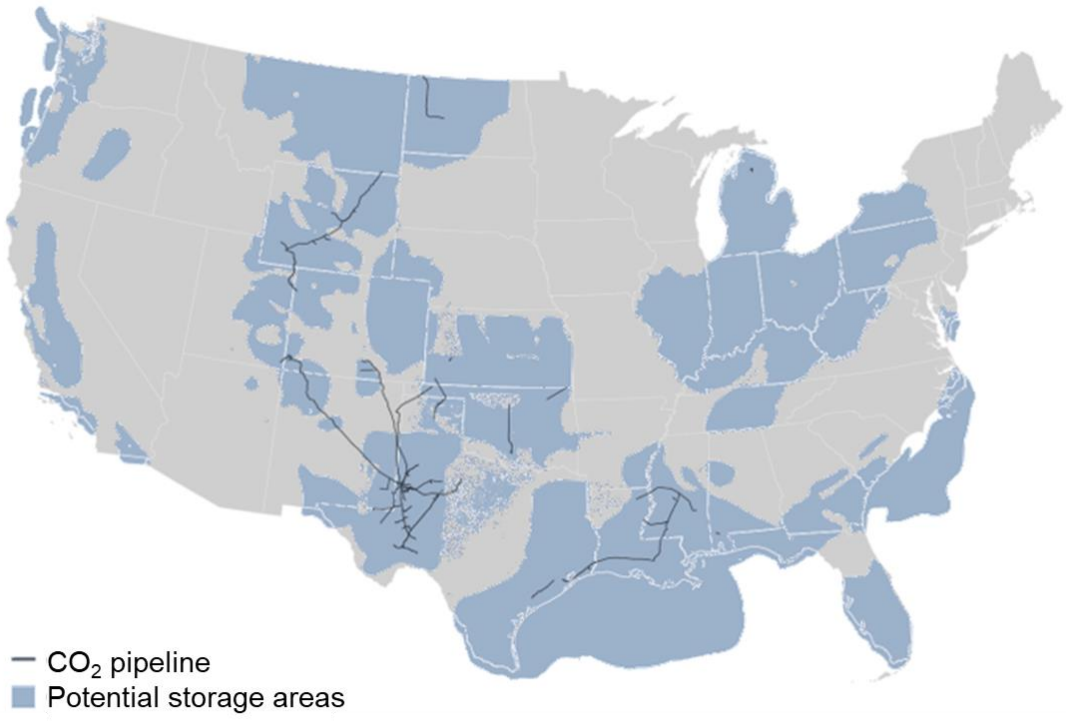


Source: Compiled by MGSSI based on Global CCS Institute、Global Status of CCS 2024、https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf (accessed April 7, 2025)

[3] T&S stands for "Transport and Storage", and refers to projects specialized in the transport and storage of CO2, or projects where the emission sources are diverse and cannot be narrowed down to one specific source type.

In the US, there are nearly 9,000 km of pipelines in operation[4], primarily for enhanced oil recovery (hereinafter referred to as “EOR”) (Figure 12). It is estimated that more than 32,000 km of new pipelines for CCS purposes will be needed by 2050 to meet decarbonization targets[5].

Figure 12: Locations of existing CO2 pipelines in the US



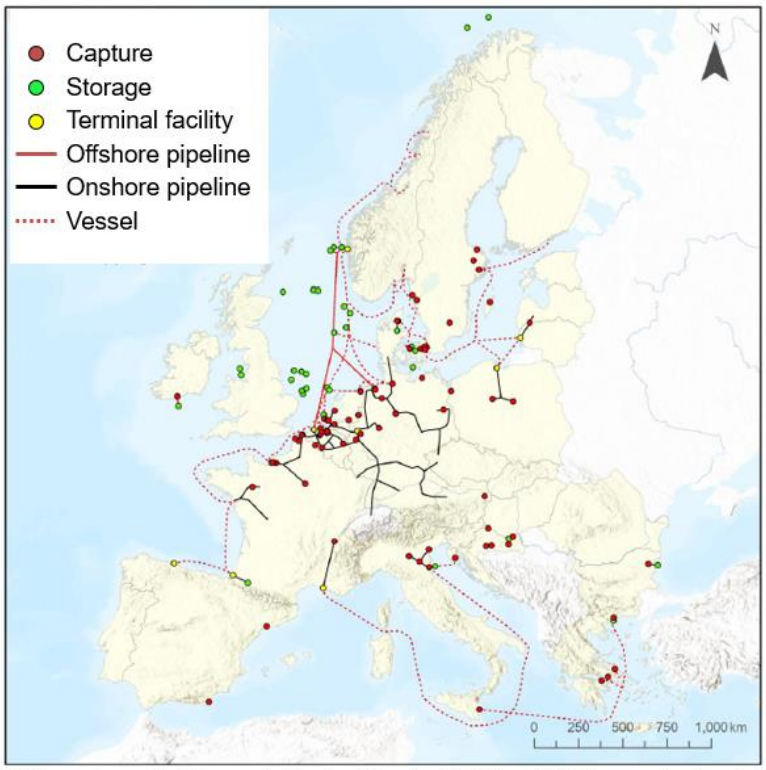
Source: Compiled by MGSSI based on Global CCS Institute、Building Our Way to Net-Zero: Carbo n Dioxide Pipelines in the United States, https://www.globalccsinstitute.com/wp-content/uploads/2024/05/Building-Our-Way-to-Net-Zero-Carbon-Dioxide-Pipelines-in-the-United-States.pdf (accessed April 7, 2025)

In the NS, there are few existing pipelines, but multiple pipeline plans have been announced (Figure 13). There are also facilities already under construction, such as those by Porthos of the Netherlands. The scenario presented by the JRC[6] estimated that the region will need approximately 7,000 km of pipelines by 2030, and over 15,000 km by 2050[7].

In parallel with the pipeline, maritime transport is also being considered. In Norway's Longship CCS Project, CO2 will be collected from domestic cement plants and waste-to-energy plants in Phase 1 and from overseas electricity and fertilizer plants in Phase 2, then transported by ship to the receiving terminals and transferred by undersea pipelines to underground storage reservoirs (Figure 14).

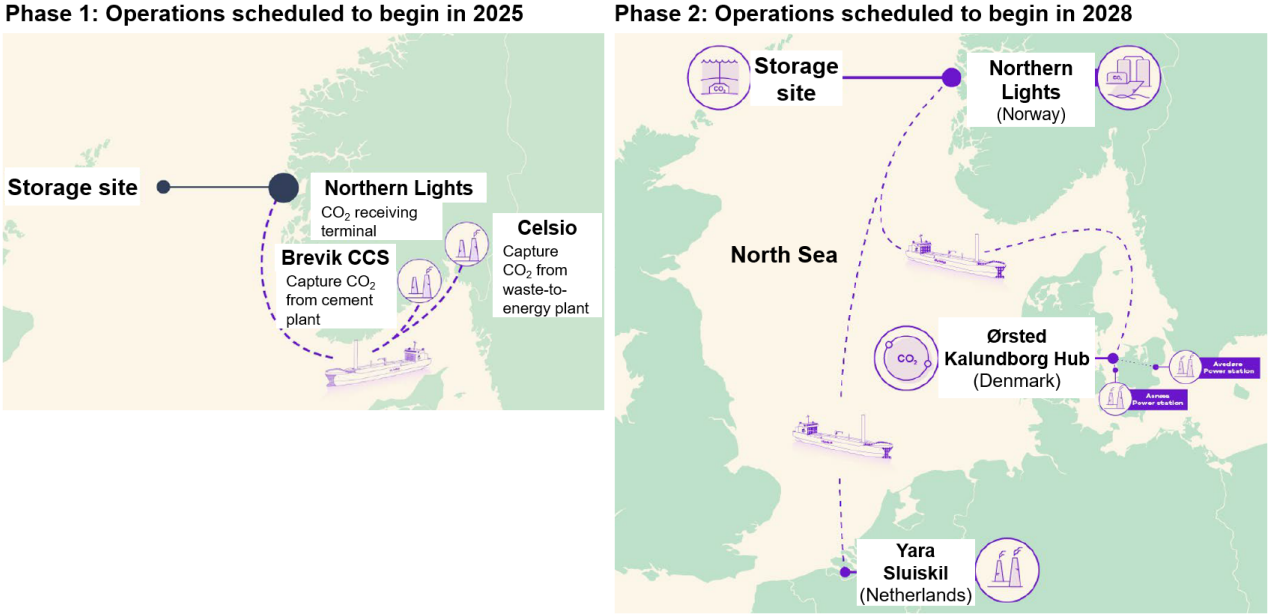
[4] IEA, CCUS Policies and Business Models, https://iea.blob.core.windows.net/assets/d0cb5c89-3bd4-4efd-8ef5-57dc327a02d6/CCUSPoliciesandBusinessModels.pdf
[5] Global CCS Institute, Building Our Way to Net-Zero: Carbon Dioxide Pipelines in the US, https://www.globalccsinstitute.com/wp-content/uploads/2024/05/Building-Our-Way-to-Net-Zero-Carbon-Dioxide-Pipelines-in-the-United-States.pdf
[6] JRC（Joint Research Centre）: An organization that provides scientific advice to the European Commission to assist in policy making.
[7] Joint Research Centre, Shaping the future CO_2 transport network for Europe, https://publications.jrc.ec.europa.eu/repository/bitstream/JRC136709/JRC136709_01.pdf

Figure 13: CCS plans announced in and around the NS



Source: Compiled by MGSSI based on Joint Research Centre, Shaping the future CO2 transport network for Europe, https://publications.jrc.ec.europa.eu/repository/bitstream/JRC136709/JRC136709_01.pdf (accessed April 7, 2025)

Figure 14: Schematic of Longship CCS Project



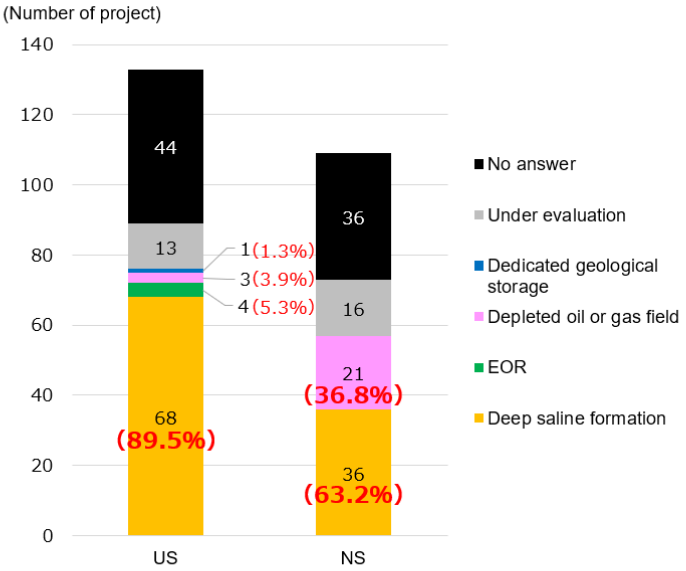
Source: Compiled by MGSSI based on Workshop on cross-border transport and storage of CO2 from CCS projects in the Asia-Pacific region, Northern Lights press releases, https://pubpjt.mri.co.jp/seminar/h06pn000000001wm-att/10_seminar20240208-10. (accessed April 7, 2025)

2-3. Storage

Of the plans that have decided on a storage destination, approximately 90% of those in the US have chosen deep saline formation (Figure 15). Abundant saline formations exist along the Gulf Coast, Midwest, West Coast, and elsewhere in the US (Figure 16).

Meanwhile, in the NS, approximately two-thirds of plans have decided on deep saline formations, and one-third have opted for depleted oil and gas fields (Figure 15). Storage sites are concentrated around the North Sea (Figure 17).

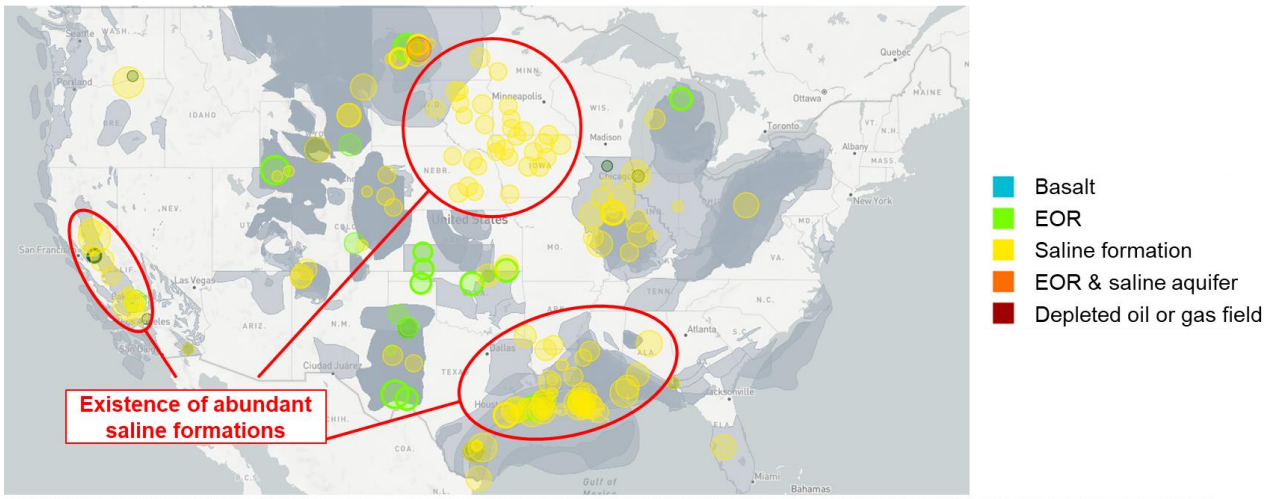
Figure 15: Planned carbon storage reservoirs in the US and the NS



Note: The red figures indicate the percentage of plans for each type of storage site for which the storage locations have been decided (out of a total of 76 in the US, and 57 in the NS).

Source: Compiled by MGSSI based on Global CCS Institute, Global Status of CCS 2024, https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf (accessed April 7, 2025)

Figure 16: Carbon storage locations and types in the US



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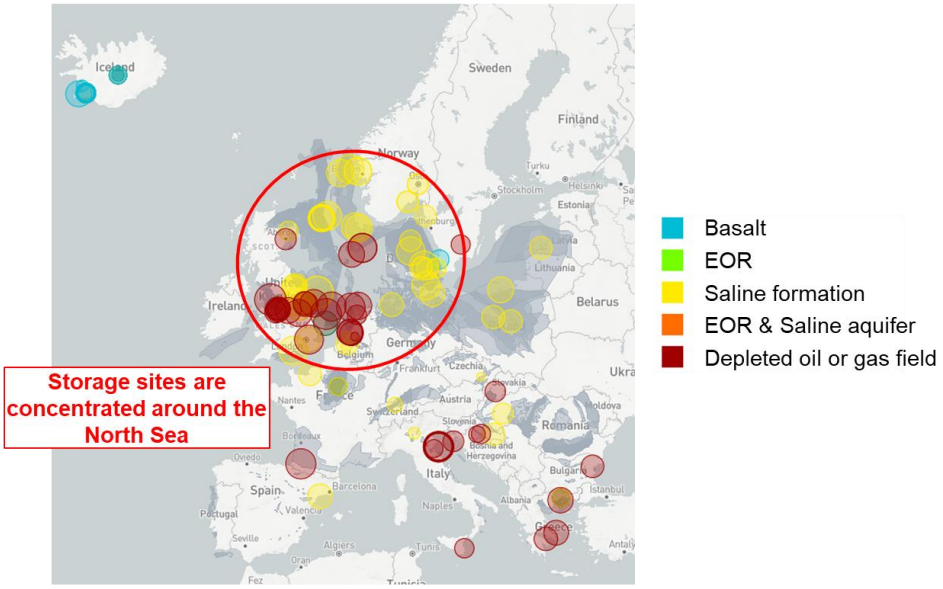
Source: Compiled by MGSSI based on Clean Air Task Force, US Carbon Capture Activity and Project Map, https://www.catf.us/ccsmapus/ (accessed April 7, 2025)

Figure 17: Carbon storage locations and types in the NS



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Source: Compiled by MGSSI based on Clean Air Task Force, US Carbon Capture Activity and Project Map, https://www.catf.us/ccsmapus/ (accessed April 7, 20225)

3. SIMILARITIES AND DIFFERENCES IN PLANS

The similarities and differences between plans in the two regions are organized by capture, transport, and storage functions (Figure 18). The factors behind each are then examined.

3-1. Capture

A common feature of carbon capture in both regions is that emissions from hydrogen involve large capture capacities, with facilities scheduled to begin operation relatively early. In the US, plans are thought to be driven by policy support, such as the Inflation Reduction Act (hereinafter referred to as “IRA”), and by expectations for exports to high-demand countries such as Japan and South Korea. In the NS, plans are likely supported by increased demand due to regulations, such as the Emissions Trading Scheme (hereinafter referred to as “ETS”), and as well as by potential profits from trading surplus emission allowances.

As for differences, two in particular can be noted. The first is that biofuel projects are proceeding only in the US. The Midwest is a major producing region of bioethanol, which is used in gasoline blending and the production of SAF[8]. Regarding SAF in particular, exports are expected to expand due to increased demand from the EU, Singapore, and other countries where the use of SAF is expected to become mandatory. Although assistance under the IRA is available for SAF production, to qualify for assistance, CO2 emissions-reducing CCS facilities must be installed[9]. These factors are presumed to be the reason why biofuel projects are proceeding in the US.

[8] SAF（Sustainable Aviation Fuel）:Refers to aviation fuel produced from circular materials.

[9] Japan Organization for Metals and Energy Security (JOGMEC), “Energy Transition in the US - A New Energy Wave Driven by the Inflation Reduction Act (IRA)” https://oilgas-info.jogmec.go.jp/_res/projects/default_project/_page_/001/010/071/2403_h_k_us_ira_ene_tra_r.pdf

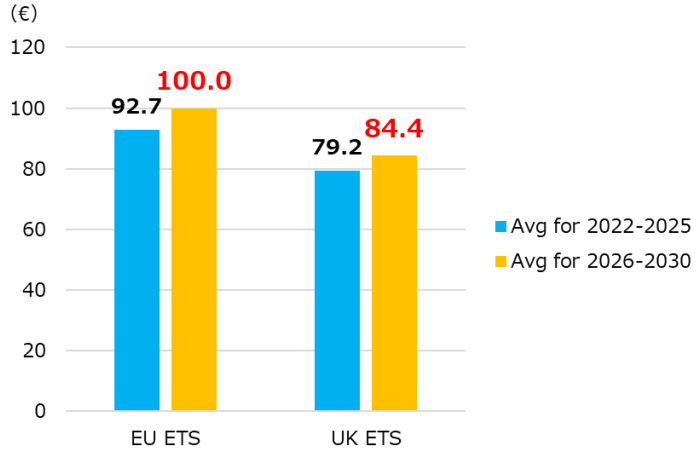
Figure 18: Similarities and differences of project planning in the two regions

Supply chain	Similarity/ difference	US	NS
Capture	Similarity	**Large capture capacity for hydrogen, etc. Projects scheduled to be operational before 2030**	
	Difference	**Large capture capacity and number of projects for biofuels**	**Small capture capacity and number of projects for biofuels**
		Operational year **undecided** for many **electricity/heat** projects	Many **electricity/heat** projects **scheduled to startup before 2030**
Transport	Similarity	Large **number of T&S projects**	
	Difference	Primarily by **pipeline**	**Pipeline + vessels**
Storage	Similarity	Many **saline formations**	
	Difference	**Few depleted oil and gas fields**	**Many depleted oil and gas fields**

Note: "Hydrogen, etc." includes hydrogen, ammonia, and fertilizers, and "biofuels" include bioethanol, etc.
Source: Compiled by MGSSI

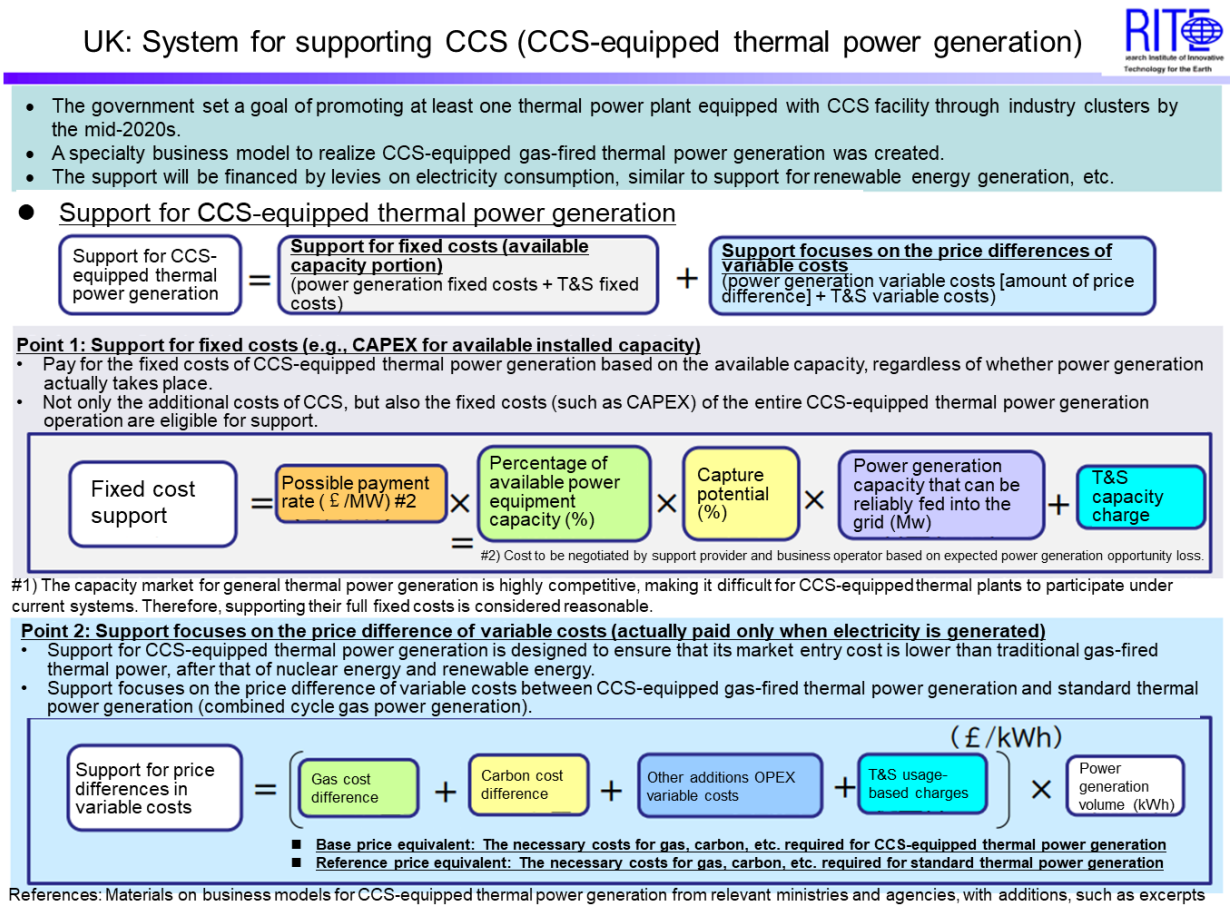
Second, it is only in the NS that there are electricity/heat-related carbon capture projects planned to become operational in the near future. Carbon prices under the EU ETS and the UK ETS, which include the electricity sector, are expected to increase in response to a tightening of the cap on emission allowances (Figure 19). At the same time, the UK is also implementing support measures for thermal power generation to promote the low-carbon transition of the power sector (Figure 20). A combination of these regulations and support policies is believed to be activating plans in the NS. In the US, on the other hand, while there is support through the IRA, emission regulations for thermal power plants are likely to be revised, and ETS programs have been adopted by only a handful of states, so there are few incentives to implement CCS. It is inferred that the deficiency of regulations promoting the introduction of CCS is the reason for the scarcity of planning in the US.

Figure 19: Outlook for carbon prices under the EU ETS and the UK ETS



Source: Compiled by MGSSI based on International Emissions Trading Association, GHG Market Sentiment Survey 2023, https://ieta.b-cdn.net/wp-content/uploads/2023/09/IETA_GHGSentimentSurvey_2023.pdf (accessed April 7, 2025)

Figure 20: Support for CCS-equipped thermal power plants in the UK



Source: Translated by MGSSI based on Research Institute of Innovative Technology for the Earth (RITE), CCUS Support Schemes in the UK and the Netherlands https://www.meti.go.jp/shingikai/enecho/shigen_nenryo/carbon_management/ccs_wg/pdf/001_08_00.pdf (accessed April 9, 2025)

2. Transport

As for the similarity of transport, the number of T&S projects is high in both regions. This suggests that more businesses will become engaged in CO2 transport and storage operations in both regions.

Differences are that in the US, transport is planned primarily by pipelines, while in the NS, transport is planned by a combination of pipelines and vessels. EOR facilities exist already in the US, and regulations are in place. Future expansion is expected to include the repurposing of those existing facilities and the extension of pipelines to new storage sites. In the NS, in contrast, since there are few existing facilities, in the short term, it is expected that short-distance pipelines will be constructed in areas with concentrations of high-emission industries, and this will be combined with transport by medium-sized vessels, which have already seen practical use.

3-3. Storage

In both regions, deep saline formations are selected as storage destinations in many projects. The fact that saline formations are distributed throughout the world and are the most technologically mature of all storage methods may be a driving force behind the plans (Figure 21). In the US in particular, many plans are assumed to focus on the use of saline formations because a large number of them are located within reach of onshore emission sources such as electricity, heat, hydrogen, and biofuels.

Figure 21: Technological maturity level of each storage method (TRL*Note)

Storage method	TRL		Achievements to date
Saline aquifer	9	Adoption expected in the near future	CO2 injection in saline aquifers has been successfully demonstrated over the past two decades with many operational large-scale first-of-a-kind projects around the world (e.g. Sleipner in Norway, Quest in Canada).
Depleted fields	7-8	Pilot projects	The first injection of CO2 within depleted fields has been completed in 2023 during the pilot phase of Project Greensand in the Danish North Sea.
Dissolved CO2 injections	5	Large-scale prototypes	Aqueous injections, where CO2 is dissolved in water and injected into mafic igneous rocks, have been demonstrated by Carbfix in Iceland. In Oman, two pilots have been conducted injecting CO2 dissolved in rainwater into peridotite formations for accelerated mineralisation and sequestration of CO2.

Note: TRL=Technology Readiness Level. A systematic quantitative measure that allows for the assessment of the maturity of a particular technology and comparison of the maturity of different types of technologies.

Source: Compiled by MGSSI based on EA, CCUS Policies and Business Models, https://iea.blob.core.windows.net/assets/d0cb5c89-3bd4-4efd-8ef5-57dc327a02d6/CCUSPoliciesandBusinessModels.pdf (accessed April 7, 2025)

One difference is that depleted oil and gas fields are widely utilized only in the NS. In the region, many oil and gas fields are scheduled for closure owing to a natural decline in oil and gas production and other factors. Oil and gas fields will likely be reutilized for carbon storage after depletion because geological surveys have been completed during the mining process, and that should reduce the cost of surveys and risks for repurposing for CCS use.

4. TRENDS TO WATCH GOING FORWARD

In the US, the Republican Party, which regained power in the November 2024 presidential election, takes a negative position on costly decarbonization policies and may reduce current policy support and revise regulations. Since many project plans are presumably designed based on current policy support, there is concern that if support is terminated, progress may stall, particularly for plans that have not yet reached a final investment decision.

In the NS, meanwhile, enabling storage in the UK, which has a large storage capacity, is necessary to secure storage capacity and lower costs for Europe-wide[10]. However, under the current rules of the EU ETS and UK ETS, CO2 stored outside the coverage areas is not eligible for emission reductions. Since CCS is essential to achieving the NS's decarbonization targets, a rule change to allow for Europe-wide storage is expected.

If the above moves become evident, the relative positions of the US and the NS could be reversed, especially in plans related to electricity and hydrogen. Future policy developments in both regions should be monitored closely.

[10] CCSA, Accelerating a Europe-wide CO_2 storage market, https://www.ccsassociation.org/resources/download?id=6091