Sub-seafloor Geologic Storage of Captured CO_2: At a Glance

Carbon dioxide can be permanently stored under the seabed in geologic reservoirs. This is achieved by injecting captured CO_2 into rock formations thousands of feet beneath the seabed, where it is trapped by a combination of mechanisms such as a caprock with low permeability, capillary or residual trapping, dissolution in brines naturally present in the storage rocks, or reactions that form solid minerals.[75] Stored carbon dioxide may come from carbon dioxide removal (CDR) methods like direct air capture, or possibly even direct ocean capture via electrochemical methods if fully developed (see related fact sheet on electrochemical-based CDR).[76] Carbon dioxide can also be collected using carbon capture and storage techniques, which trap carbon dioxide that would otherwise be emitted from industrial facilities before it enters the atmosphere.[77]

Potential Scale of Carbon Storage: The potential offshore capacity for sub-seabed CO_2 storage is immense. There is capacity for more than 36,000 gigatonnes of carbon dioxide ($GtCO_2$) to be stored offshore under the seabed of U.S. waters alone.[78] The Department of Energy's National Energy Technology Laboratory has estimated that the Gulf of Mexico and Atlantic coastal regions each have the capacity to store on the order of hundreds of billions of tons (many gigatonnes) of carbon dioxide.[79]

Cost: Carbon capture and offshore storage is limited primarily by cost. Transportation of CO_2 offshore is expensive—more costly than onshore geologic injection.[80]

Duration of Carbon Storage: With proper site selection and adequate monitoring for leaks, sub-seafloor geologic carbon dioxide storage has the potential to be extremely durable, offering the longest sequestration timescales of any ocean-based CO_2 storage method. According to the Intergovernmental Panel on Climate Change, injected CO_2 can be safely stored in saline formations for 10,000 years or more with overall leakage rates at less than 0.001 percent per year.[81] Further, in certain types of reservoirs, CO_2 storage is expected to slowly grow more secure over time, as the injected CO_2 dissolves in water or brine or some portion eventually mineralizes into solid form, thereby becoming immobile.[82]

Technical Readiness: Offshore geologic storage has been successfully demonstrated by a handful of small-scale projects, including the Sleipner and Snøhvit projects near Norway, the CarbFix2 project in Iceland, and the Tomakomai demonstration project in Japan.[83] Sleipner and Snøhvit projects stored 0.024 GtC between 1996 and 2019 with no demonstrated leakage.[84] Effective tools for monitoring injected carbon and detecting potential CO_2 leaks from storage have also been developed and demonstrated in the field.[85]

Potential Environmental Risks: Environmental harm could occur from CO_2 leakage during transport or after placement beneath the seabed. Transport and initial injection constitute two risky phases of any geological CO_2 storage projects; the risk is even greater for sub-seabed storage than for terrestrial storage since CO_2 must be transported over or through the ocean by ship or pipeline.[86] A large CO_2 spill or leak could cause temporary but significant ocean acidification, harming a large variety of organisms in the immediate vicinity.[87] Once CO_2 is injected under the seabed, leaks from the storage reservoir could disrupt microbial communities and deep-sea organisms, and these impacts could cascade to larger species and ecosystems.[88] In addition, CO_2 leaked at either stage of the process will ultimately return to the atmosphere, reducing the carbon sequestration benefit of the project.

Outstanding Questions: As mentioned above, sub-seafloor geologic storage of CO_2 has been successfully demonstrated through multiple field and pilot projects.[89] Still, outstanding questions remain around multiple aspects of the approach. Environmental risks associated with transporting and injecting CO_2 offshore require further study. Additionally, research and development is needed for pipeline and platform infrastructure suited to transport and inject CO_2.[90] Congress is supporting research to address these key questions, with recent large-scale investments in CDR and geologic carbon storage through the Infrastructure Investment and Jobs Act (Pub. L. 117-58, 2021) and the Inflation Reduction Act (Pub. L. 117-169, 2022). Further, there are outstanding questions about how the federal government will regulate sub-seafloor geologic storage. Although the Infrastructure Investment and Jobs Act directed the Bureau of Ocean Energy Management to release regulations for carbon sequestration leasing on the Outer Continental Shelf in fall 2022, the bureau has not yet released draft regulations, so the substance of these regulations remains unknown.

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