GLOBAL CCS INSTITUTE

TRANSPORT OF CO_2

Safely and reliably transporting carbon dioxide (CO_2) from where it is captured to a storage site is an important stage in the carbon capture and storage (CCS) process. Transport of CO_2 is already a reality, occurring daily in many parts of the world. However, the scale of transportation infrastructure and investment required to enable large-scale deployment of CCS should not be underestimated.

HOW IS CO_2 TRANSPORTED?

Pipelines are—and are likely to continue to be—the most common method of transporting the very large quantities of CO_2 involved in CCS. There are already millions of kilometres of pipelines around the world that transport various gases, including CO_2.

Transport of CO_2 by truck and rail is possible for small quantities. Trucks are used at some project sites, moving the CO_2 from where it is captured to a nearby storage location. Given the large quantities of CO_2 that would be captured via CCS in the long-term, it is unlikely that truck and rail transport will be significant.

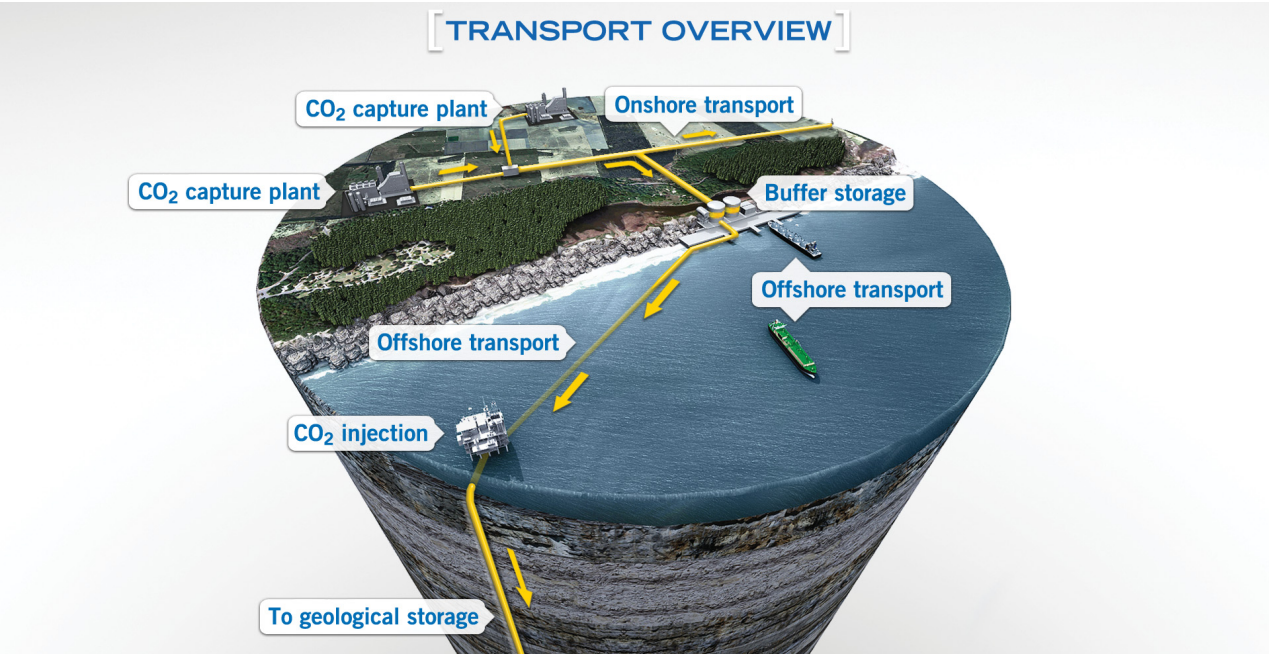
Ship transportation can be an alternative option for many regions of the world. Shipment of CO_2 already takes place on a small scale in Europe, where ships transport food-quality CO_2 (around 1000 tonnes) from large point sources to coastal distribution terminals.

Larger-scale shipment of CO_2, with capacities in the range of 10,000 to 40,000 cubic metres, is likely to have much in common with the shipment of liquefied petroleum gas (LPG). There is already a great deal of expertise in transporting LPG, which has developed into a worldwide industry over a period of 70 years.

IS TRANSPORT OF CO_2 SAFE?

There is significant experience with CO_2 pipeline development and operation on land and under the sea. There are 36 CO_2 pipelines currently operating in the US alone that transport 48–58 million tonnes of CO_2 each year.

CO_2 pipelines and ships pose no higher risk than that which is already safely managed for transporting hydrocarbons such as natural gas and oil. International standards are currently being developed to further promote safe and efficient operation of CO_2 infrastructure.



DOES THE INFRASTRUCTURE TO SUPPORT CO_2 TRANSPORT EXIST?

Extensive networks of pipelines already exist around the world, both on land and under the sea. In the United States alone, there are about 800,000 km of hazardous liquid and natural gas pipelines, in addition to 3.5 million km of natural gas distribution lines. Some 6,500 km of pipelines actively transport CO_2 today.

That said, the scale of pipeline infrastructure needed to support CCS deployment around the world is vast. In the United States, the length of pipeline required in the future will be between 8,000–21,000 km in 2030 and 35,000–58,000 km in 2050[1]. Given the rate of natural gas pipeline construction in the United States in recent years, the required CO_2 pipeline construction rates seem achievable.

The pipeline required to meet the existing plans for CCS development in the European Union and Norway—using both onshore and offshore storage—would be around 2,300 km by 2020 and 22,000 km by 2050[2] These estimates do not include the pipeline length required for linking individual projects to the main pipeline grid. As in the Unites States, this level of new infrastructure development is achievable.

CO_2 HUBS, CLUSTERS AND TRANSPORTATION NETWORKS

The initial demand for additional CO_2 transportation capacity will likely unfold in an incremental and geographically dispersed manner as new dedicated capture plants, storage and enhanced oil recovery (EOR) facilities are brought online.

Large-scale deployment of CCS is likely to result in the linking of proximate CO_2 sources, through a hub, to clusters of sinks, either by ship or so-called 'back bone' pipelines. While hubs, clusters, and networks are terms used somewhat interchangeably, in examining their use in describing projects some subtle differences become apparent.

A CO_2 **cluster** may refer to a grouping of individual CO_2 sources, or to storage sites such as multiple fields within a region. The Permian Basin in the United States has several clusters of oilfields undergoing CO_2 EOR fed by a network of pipelines.

A CO_2 **hub** collects CO_2 from various emitters and redistributes it to single or multiple storage locations. For example, the South West CO_2 Geosequestration Hub project in Western Australia seeks to collect CO_2 from various sources in the Kwinana and Collie industrial areas for storage in the Lesueur formation in the Southern Perth Basin.

A CO_2 **network** is an expandable collection and transportation infrastructure providing access for multiple emitters. For instance, the CO_2 Europipe project has developed a roadmap for a Europe-wide infrastructure network for the transport and storage of CO_2.

The incentives for CCS projects to be developed as part of a hub, cluster, or network include economies of scale (lower per unit costs for constructing and operating CO_2 pipelines). These costs are lower than can be achieved with stand-alone projects, where each CO_2 point source has its own independent and smaller scale transportation or storage requirement. A coordinated network approach can also lower the barriers of entry for all participating CCS projects, including for emitters, that do not need to develop their own separate transportation and storage solutions.

1 Dooley, J, Dahowski, R and Davidson, C, 2009. Comparing existing pipeline networks with the potential scale of future U.S. CO2 pipeline networks. 9th International Conference on Greenhouse Gas Control Technologies (GHGT-9), *Energy Procedia*, 1(1), pp.1595-1602.

2 Neele, F, Koenen, M, Seebregts, A, van Deurzen, J, Kerssemakers, K and Mastenbroek, M, 2010. *Development of a large-scale CO2 transport infrastructure in Europe: matching captured volumes and storage availability.*