Carbon Capture and Storage (CCS) schemes will involve the transport of pressurised liquid CO₂ to sites where it is permanently stored. Research is underway to identify the key challenges to be overcome to ensure that CO₂ can be safely and economically transported to potential storage sites. Potential storage sites include depleted oil wells, where it could be used for enhanced oil recovery (EOR)¹, empty gas wells, coal seams which cannot be mined or porous water-bearing rock formations known as saline aquifers.

Options for CO₂ transport include pipelines and shipping. Over 3000 km of CO₂ transport pipelines have been built, and are operational, mainly in the USA, but with one example also in Turkey. These have been used primarily to deliver CO₂ for EOR. Regulators in the USA have classified CO₂ pipelines as hazardous liquid pipelines when they operate a pressures over 73 atmospheres and have specified additional requirements such as increased depth of cover and surveillance when such pipes run close to population centres. Pipelines carrying petroleum and petroleum products are also classified as hazardous liquid pipelines. For CO₂ pipelines operating at pressures under 73 atmospheres, US regulators apply the same regulations as govern pipelines carrying natural gas.

The majority of US pipelines are laid in sparsely populated areas and there is little experience of pipelines in more densely populated areas. The researchers suggest that further work is needed to understand and regulate any risks associated with pressurised CO₂, particularly in relation to pipeline located onshore in densely populated areas. The also suggest further research into the level of toughness required for pipe materials to prevent fracture propagation in offshore pipelines (cracks that could ‘unzip’ a CO₂ pipeline over long distances). Calculating the level of toughness required is more complicated for offshore pipelines because the effect on the pipeline of interaction between escaping liquid CO₂ and water is not fully understood.

If water is present in the CO₂ stream, carbonic acid can form. Carbonic acid is corrosive to carbon steel pipes, which are the most economically viable material for pipeline construction. This well-known phenomenon can be avoided by drying the CO₂ (reducing water content to very low levels) before transportation. Drying adds only moderate additional costs to CCS.

To date, pipelines have attracted more attention than shipping as transport options. However, in some cases shipping may be more cost effective and/or allow lower-cost CO₂ sources and storage reservoirs to be used that cannot easily be accessed by pipelines or that may not be operational for long enough to justify the infrastructure investment. For offshore sites, ships transporting CO₂ as a pressurised, cryogenic liquid could compete economically with pipes for transport over distances greater than 700 km (assuming 6.2 Mt transported per year)². However, as volumes of CO₂ to be transported increase, ships become less economically competitive with pipelines.

¹ EOR is a process whereby CO₂ is pumped into oil fields to facilitate the extraction of oil that could not otherwise be accessed.


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Additional information: Other useful sources for information on transportation challenges for CCS are:

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