ZEP Report

The cost of subsurface storage of CO_2

ZEP memorandum, December 2019

CO_2 capture and storage: an essential greenhouse gas emission reduction technology

The new EU Commission has the goal to reach climate neutrality for Europe by 2050, the 'Green Deal' [EU, 2019a], which will support meeting the greenhouse gas (GHG) emission reduction targets defined in the Paris agreements. CO_2 capture and storage (CCS) is an essential element of the portfolio of technologies and measures that will be needed to meet this agreement: for an ambition to reach "net zero emissions" by mid-century, being adopted by several Member States, the role of CCS becomes not optional but essential (IPCC 2018, CCC 2019).

Projects of Common Interest

Following the opening of the Projects of Common Interest programme to CO_2 transport networks, five CO_2 PCIs are currently active in northwest Europe [EU, 2019b]. These are currently designing the first elements of large-scale CO_2 transport and storage infrastructure that will open up the vast storage capacity of the North Sea and Irish Sea to the countries bordering this offshore area, as well as to the countries in their hinterland. The PCIs are developing infrastructure that will be able to transport and store millions of tonnes of CO_2 on a yearly basis, delivering a significant contribution to industrial emission reduction.

Cost of storage

In 2011, the Zero Emission Platform (ZEP) published an analysis of the technical cost of CCS transport and storage [ZEP,2011]. The cost of storage was estimated to lie in the range of € 2-20 /tonne. Onshore storage sites have a cost that is typically at the lower end of this range, while generally more expensive offshore storage is at the higher end of the range. Using large-capacity storage sites will generally result in lower cost of storage. The ZEP cost estimates apply to a mature CO_2 storage industry. During the early phases of developing CO_2 storage industry, storage cost is expected to be higher.

Since 2011, the focus of large-scale transport and storage has shifted to offshore storage sites. The ZEP 2011 cost estimates for offshore storage were in the range of € 4 – 20 /tonne. Offshore transport by pipeline was estimated at € 3.4 – 9.3 /tonne, depending on flow rate, for a reference distance of 180 km. Please note, that these cost estimates exclude the cost of compression.

Updated cost estimates of transport and storage have been published recently. In the UK, a detailed analysis of five offshore sites resulted in reliable cost estimates [Pale Blue Dot, 2016]. The estimated (technical) unit costs for offshore transport and storage lie in the range of € 13 – 20 /tonne. Generally, higher costs were derived for saline aquifers, which require new wells and platforms, and for locations in deeper water. These cost levels were affirmed by subsequent detailed work in the UK, which also showed that transport and storage costs can be greatly reduced by re-using and sharing of pipelines and storage to serve geographic clusters of activities which produce CO_2 [ACT ACORN 2018].

In The Netherlands, a roadmap for the development of CCS from 2010 [EBN-Gasunie, 2010] was updated in 2017 [EBN-Gasunie, 2017], resulting in a high-level estimate of the cost of transport to and storage in offshore depleted fields in the Dutch sector of the North Sea. Estimated unit technical cost of storage are in the range of € 2-10 /tonne, which is in line with the cost estimates published in 2010 [EBN-Gasunie, 2010]. The cost of transport by pipeline are in the range of € 1-2 /tonne (with distances generally shorter than 180 km), while compression adds about € 9 /tonne. Again, all these cost estimates assume full-scale deployment of CO_2 capture, transport and storage by a mature industry.

Cost calculation based on immature accounting

There is a risk in costing early projects as examples of enduring steady-state costs. These projects typically build oversized transport pipes, with underfilled and small CO_2 flows during their operation and take responsibility and costs for the development of storage sites with a storage capacity much larger than required for just the early project. In addition, the resulting relatively high capital expenses are often loaded on a lifespan that is shorter than that of mature projects.

Conclusion

As large-scale CCS transport and storage infrastructure is being designed, with first injection planned in the mid-2020s, CCS remains one of the more cost-effective GHG emission reduction technologies, offering the possibility of deep and short-term emission cuts, not only for energy-intensive industries, but also for other sources of CO_2 emissions.

In a mature CCS industry, the technical cost of storing CO_2 in offshore storage reservoirs is expected to lie in the range € 2 – 20 /tonne; adding transport and compression cost will bring this in the range of € 12 – 30 /tonne.

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