Geological storage of CO_2: "Practicalities" - issues, risks and uncertainties associated with site selection.

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Abstract

Geological storage of carbon dioxide has been rapidly evolving over the last 15 years from a concept with some promise to provide large scale emissions reduction of CO_2, to become something that is considered technically viable. It still faces significant challenges, as do all major projects that deal with movement and assessment of subsurface fluids, but these are not insurmountable and will mostly be site specific issues. The volumes of CO_2 that are being emitted means that a future geological storage industry will be as big as the current world gas industry. Thus one of the challenges this new industry faces is that of meeting the scale of emissions and dealing with flow on effects associated with that scaling up of the effort. By 2050, over 500 power stations may be required with carbon dioxide capture and storage, and they may involve piping and injection of over 5Gt of CO_2 per year, equivalent to 100 TCF of gas processing per year (equivalent to worldwide gas processing of methane by the gas industry).

To deal with such volumes on an annual basis will mean that the rock sequences will need to be thoroughly understood in terms of geological heterogeneity of reservoirs and seals, fluid flow dynamics within the reservoirs, and pressure transmission effects. All of these factors will combine to impact on geomechanical processes in the subsurface. Time lapse seismic may be a valuable tool, but may not always be viable as a measurement and monitoring tool of the injected CO_2 plume, as its suitability depends on the age and depth of the rock sequences. New tools will be required to help meet the expectations of the regulators and the community to be able to verify and monitor that the CO_2 is behaving as predicted from modelling. Costs associated with the industry will need to be kept under control due to the lack of a commercial profit from such activities in the current economic regime. It is anticipated that some offsets will come from future emissions trading schemes, and possibly from the Clean Development Mechanisms. One of the important areas to reduce costs will be in reducing well numbers through smart engineering and completion of wells. Individual projects could require many 10s of wells, including injection and pressure relief wells.

Apart from development of technology and knowledge, there will be a required change in the mindset for geologists and engineers dealing with geological storage. The processes of assessing geological storage sites and engineering them is not a simple re-design of petroleum geology, petroleum systems analysis and petroleum production. New entrants to this technology will require exposure to training and a different way of thinking to what they

may be used to from classical petroleum exploration and production work. However their skills sets are transferable and will provide valuable experience in assessment of storage sites. From a site selection perspective, these skills and the knowledge base that continues to emerge needs to be built into ongoing assessment processes. Less academic and more practical approaches and outcomes are going to be required for the industry to progress. Whilst many government and research groups are attempting to become aware of many of the practical issues, industry is delaying in building both their experience and workforce to the appropriate level that would be required if CCS is deployed at the scale that is necessary. This delay is due to a lack of commerciality of large industrial scale projects and thus there is little financial incentive for industry to act decisively. For an effective and efficient industry to develop, this must change.

From the legal and regulatory viewpoint the challenges are not simple and could be the 'Achilles heel' of the business if not properly planned for and considered. Unlike petroleum and groundwater extraction activities, the CO_2 is injected back into the deep subsurface into porous and permeable reservoirs. Whilst the oil and gas industry commonly re-inject fluids to maintain pressure in declining fields, they have never dealt with the volumes that are involved with geological storage of CO_2 and the injection occurs into physical traps in the subsurface. A significant complication is that CO_2 is buoyant and less dense than water and oil. This means it will flow through the subsurface unless it is physically trapped in geological structures like occur for oil and gas accumulations. However, the most effective mechanism for large scale trapping of the CO_2 is through a process known as residual gas saturation (RGS). RGS is effective if the CO_2 migrates (slowly) through the porous reservoirs beneath an impermeable seal. This means to achieve large scale trapping of CO_2, then the CO_2 plume will have to be migratory over time, potentially crossing between tenement boundaries of competing licenses for other stakeholders and resources. Additional to the physical nature of the CO_2 plume movement is the pressure wave that emanates relatively instantly. The pressure build up from large scale injection potentially can lead to fracturing of the reservoir if not closely modelled and monitored by regulators. This in turn may lead to pressure build up in neighbouring stakeholders' licenses, either affecting their activities or even potentially preventing them injecting fluids themselves due to a regulatory control not to exceed a certain pressure in the regional aquifer system.