

WHAT ARE THE KEY PROCESSES OF CO₂ STORAGE TO REPRESENT IN ENERGY SYSTEMS MODELS? A DYNAMIC MODEL OF CO₂ STORAGE IN THE UK BUNTER SANDSTONE

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Carbon capture and storage (CCS) is expected to play a key role in meeting targets set by the Paris Agreement and for meeting legally binding greenhouse gas emissions targets set within the UK [1]. Energy systems models have been essential in identifying the importance of CCS but they neglect to impose constraints on the availability and use of geologic CO₂ storage reservoirs. In this work we analyze reservoir performance sensitivities to increasing average target injection rate, injection site location and varying CO₂ storage demand for three sets of injection scenarios designed to encompass the UK's future low carbon energy market. We use the ECLIPSE reservoir simulator and a model of the Southern North Sea Bunter Sandstone saline aquifer. We first find that increasing average target injection does not affect the ability to store CO₂, but will be limited by the increase in bottomhole pressure at each site. We find that deeper injection sites will be the least limiting for injection as the near-site lithostatic pressure will be higher [2]. From the first set of varying injection scenarios we find that fluctuating amplitude and frequency of injection has little effect on reservoir pressure response and plume migration. Injectivity varies with site location due to variations in depth and regional permeability. In a second set of injection scenarios, we show that with envisioned UK storage demand levels for a large coal fired power plant, it makes no difference to reservoir response whether all injection sites are deployed upfront or gradually as demand increases. Meanwhile, there may be an advantage to deploying infrastructure in deep sites first in order to meet higher demand later. However, deep-site deployment will incur higher upfront cost than shallow-site deployment. In a third set of injection scenarios, we show that starting injection at a high rate with ramping down, a low rate with ramping up or at a constant rate makes little difference to the overall injectivity of the reservoir. Therefore such variability is not essential to represent CO₂ storage in energy systems models resolving plume and pressure evolution over decadal timescales.

[1] *Future of Carbon Capture and Storage in the UK*, UK Parliament House of Commons, Energy and Climate Change Committee, London: The Stationary Office Limited.

[2] Agada S., J. S. (2017). The impact of energy systems demands in pressure limited CO₂ storage in the Bunter Sandstone. *International Journal of Greenhouse Gas Control*, (in press).