Considering the Potential for Sedimentary Basin Geothermal Power Generation When Screening for Prospective Geologic CO₂ Storage Sites

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Abstract

The Intergovernmental Panel on Climate Change (IPCC) suggests that limiting the global mean surface temperature to 1.5°C or 2°C could require injecting up to ~1,200 gigatonnes of CO₂ (GtCO₂) by 2100. In the United States specifically, the Princeton Net Zero America study suggests that deploying infrastructure to inject between 0.9 and 1.7 GtCO₂/yr is required to transition the country to a net-zero emission economy by 2050, which is 1.3 to 2.4 times larger than the country’s oil production on a volume equivalent basis and entails drilling thousands of CO₂ injection wells across the country.

While sequestering CO₂ across the United States and the world is necessary to address climate change, deciding where to inject the CO₂ is difficult. For one, the cost and capacity of CO₂ sequestration sites can vary substantially from one location to another because the geology of the subsurface is heterogeneous. Additionally, the geology is always uncertain and thus the injectivity, and thus cost and capacity, of any given site is largely unknown until at-scale CO₂ injection starts. Further, knowledge of the lowest-cost CO₂ sequestration sites is alone insufficient because the CO₂ sources, CO₂ transportation network, and existing energy infrastructure (e.g., transmission lines if the CO₂ source is a power plant) can all also influence the location of targeted sequestration locations. For example, it is possible that the lowest-cost CO₂ sequestration sites may not be the least-cost location to target when also considering the location of CO₂ sources and the transportation infrastructure required to connect them together.

In addition to these more well-known considerations, the location of CO₂ storage may also be influenced by the option of using the sequestered CO₂ to generate geothermal electricity. In sedimentary basin CO₂-geothermal power plants, geologically stored CO₂ is used as the subsurface heat extraction fluid: a portion of the sequestered CO₂ is intentionally produced back to the surface with a production well, expanded through a turbine to generate electricity, cooled and condensed, and then re-injected with an injection well so that none of the CO₂ is released back to the atmosphere. This potential could affect the location of CO₂ storage—for example, if one prospective site could generate less-expensive CO₂-geothermal electricity compared to another.

In this study, we estimate the cost of sedimentary basin CO₂-geothermal power across South Dakota, USA. We do this using the professional version of the Sequestration of CO₂ Tool (SCO₂T PRO). We originally developed SCO₂T PRO to estimate the operational CO₂ storage capacity and cost of prospective CO₂ storage sites and have now modified it to estimate the cost and capacity of sedimentary basin CO₂-geothermal power plants using data generated from the generalizable GEOthermal techno-economic simulator (genGEO). Our results suggest that there is potential to approximately triple the United States geothermal power capacity by using sedimentary basin CO₂-geothermal power plants in South Dakota (Figure 1). As South Dakota is not well-known for

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having geothermal resources that can support electricity generation, our results suggest that using geologically stored CO\textsubscript{2} in this way could expand the geothermal resource base in the country.

*Figure 1: Supply Curve for Sedimentary Basin Geothermal Power in South Dakota USA. For reference, total installed geothermal power capacity in USA is \textasciitilde3,800 MWe. The colors represent differences in net-to-gross ratios of reservoir thickness: 60\% (red); 20\% (black); and 10\% (blue).*

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