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Facilitating the deployment of CO_2 storage by exploiting synergies with geothermal energy

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Abstract

Geological CO_2 storage should play a crucial part in the net zero emissions by 2050 target, as suggested by recent reports from the IEA or the IPCC. It contributes first by decarbonising high-emission sector by storing CO_2 emitted during energy and industrial production. It is also a key aspect for achieving technological CDR (Carbon Dioxide Removal). Methods such as BECCS (BioEnergy with Carbon Capture and Storage) and DACCS (Direct Air Capture with Carbon Storage) rely on geological storage. Yet, the deployment of full-scale storage projects to date has not reached an adequate pace of change in order to contribute significantly to reach the net zero objective. Many factors can explain this observation: difficulty of a reliable business case (economic barrier), lack of political support and awareness (political barrier), concerns over public opposition (societal barrier), knowledge of favourable subsurface conditions (geological barriers), etc.

In some ways, CO2-EOR, which is a synergy between CO_2 storage and hydrocarbon production, has played a role in helping the deployment of CO_2 storage, by providing business case and demonstrating the viability for parts of the CCUS chain. However, CO2-EOR also often encounter negative appreciation for its direct connection to hydrocarbon production, and contribution to CO_2 emissions.

In this paper, we focus on the synergy between CO_2 storage and geothermal energy. Several authors have proposed such synergies. Tillner et al. (2013) envisage the coexistence of CO_2 injection and a geothermal doublet. Buscheck et al. (2016, 2017) propose to exploit the thermal (and physical) energy of brine produced when injecting CO_2. Kervévan et al. (2017) propose to dissolve CO_2 in the geothermal brine and to store the resulting fluid in saline aquifer by using a geothermal doublet. Pure CO_2 has also been proposed as a geothermal working fluid instead of water, notably due to favourable thermodynamic properties. CO_2 based geothermal systems encompass two concepts: i. CO_2-EGS (Enhanced or Engineered Geothermal Systems) first proposed by Brown (2000); ii. CO_2 Plume Geothermal (CPG) in hydrothermal reservoirs introduced by Randolph and Saar (2011).

This study aims to propose a structured approach to evaluate to which extent a combination of CO_2 storage and geothermal energy would facilitate the deployment of CO_2 storage. It will compare the global performance of the various options for combining CO_2 storage and geothermal energy with the expected performance of a conventional CO_2 storage project in saline aquifer.

The proposed approach is based on BRGM's new method for performance assessment of subsurface uses. The method defines "performance" as any required conditions that would contribute to meet the objectives of the project. For a CO_2 storage project, performance is primarily measured in terms of the quantity of CO_2 stored in the targeted reservoir

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over time, while respecting a list of constraints: no significant risk of harm to people or the environment (safety), an overall positive balance sheet (economic), as well as any additional criteria important to stakeholders.
The method relies on the quantification and comparison of Key Performance Indicators (KPI) for both conventional CO_2 storage project and all the above-mentioned combinations of CO_2 storage and geothermal energy. Such assessment will be based on synthetic but realistic models, applied on saline aquifer of the Paris Basin (France), considering at least three sets of KPIs, including:

- technical indicators related to the reservoir performance (e.g. amount of CO_2 stored over the lifetime of the storage site)
- environmental and safety indicators (e.g. risk of leakage and induced seismicity)
- economic indicators (e.g. Net Present Value, levelized cost of storage)

A state-of-the-art reviewing a list of factors addressing the main (economic, political, societal, technical and geological) barriers will help to construct complementary sets of KPIs. We will study how these KPIs may influence the legitimacy, credibility and governance of projects and potential consequences on the territorial integration of projects (de Sartre and Chailleux, 2021).

The main outcomes will be (i) the assessment of the conditions for which synergies between CO_2 storage and geothermal energy are desirable and (ii) the completion of a robust method compatible for assessing the global performance of synergies between various subsurface uses.

Thanks to the proposed development, we will be able to draw objective comparison between concepts for a given context and to answer the question: "which of these solutions is more desirable from different stakeholders' point of view"? The proposed method will be replicable for other contexts and more generally for other hybrid underground uses.

(728 words)

Keywords: CO2 storage, geothermal energy, performance, synergies, barriers

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