Techno-economic tradeoffs of CO₂ fluid in geothermal plant

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Introduction

- Geothermal power is considered one of the most consistent forms of renewable electricity.
- Traditionally, water is used as a circulating fluid for heat extraction and subsequent power production, but it has been proposed that CO₂ can be circulated through porous, permeable formations to produce geothermal power while storing CO₂, also known as CO₂ plume geothermal (CPG).
- In this study, we conduct a techno-economic analysis comparing the use of water and CO₂ as a circulating fluid in porous geothermal reservoirs.
- We include capital and operating costs for each fluid, as well as production tax credits for renewable electricity generation and CO₂ storage credits through the 45Q tax amendment.
- We conduct Monte Carlo simulations on all possible combinations of inputs, resulting in 3,072 cost outputs for each fluid. In the median 50% of outputs, the average rate of return is 20% for a CO₂ project and 22.9% for water, while the average NPV is 42.3% greater for water than for CO₂.

Methods

- In the following, an economic cashflow model was implemented for both conventional geothermal powerplant as well as CPG.
- Various variables were employed on both costs and revenue in the techno-economic analysis.
- We use MATLAB and Excel to compute project costs and conduct Monte Carlo simulations.

Results

- A case study was conducted that examines the proposed use of CPG geothermal powerplant in California as a supporting alternative to conventional geothermal powerplant.
- The study focuses on geothermal powerplants with depth ranging from (3-10km) that offers adequate reservoir temperatures.
- The case study has taken into consideration that CCO₂(U)S plants are located within 200 miles from the Geysers.

Conclusion

- These results suggest using CO₂ as a replacement fluid to water could be an economically viable and sustainable means of geothermal power production.
- Moreover, CPG has the potential of generating electricity from wasted CO₂ and can be used in regions where water is a limited resource.

Future work

- Extend this technology to aging oil and gas reservoirs.
- More detailed site studies on CO₂ capture technologies and availability in the region of geothermal reservoir.
- In addition, extend studies on transporting and optimizing CO₂ to increase the efficiency and harness maximum heat.

References


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Penn State College of Agricultural Sciences

Penn State College of Medicine

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