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Geothermal energy extraction from depleted oil and gas wells: Assessing British Columbia's potential

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ABSTRACT

Geothermal heat extraction from intermediate-depth systems (1–3 km) using closed-loop designs such as, U-tube and double-pipe systems, presents a promising solution, particularly for heating community and agricultural facilities in colder regions, even where the geothermal gradient is relatively low. Over the past two decades in British Columbia (BC), a significant number of horizontal unconventional gas wells have been developed. These wells have relatively short productive lifespans, leaving many now suspended or approaching the end of their operational use. Leakage from these wells poses significant environmental and financial risks, with existing solutions only potentially effective for 50–100 years. Current well abandonment practices involve cement seals to maintain well integrity, but these methods are costly, prone to failure due to cracking, and rely on untested long-term durability. Converting suspended or inactive wells into geothermal wells offers a dual advantage: deferring plug-and-abandonment costs and liabilities while generating renewable energy. Deep wells often have a favorable temperature gradient for geothermal energy extraction, which can be used for direct heating or electricity generation. In Northeast BC, the prevalence of pad-drilled wells (5–30 wells drilled from a single surface location) simplifies geothermal operations, even in areas with low geothermal gradients, enhancing economic feasibility. In this study, we evaluate geothermal potential in BC by creating a geothermal map and analyzing specific pad-drilled wells. Using mathematical modeling, the project focuses on the double-pipe extraction method, where the well casing serves as the outer pipe and tubing as the inner pipe. A working fluid circulates between these pipes to extract heat from the surrounding formation. The research also explores intermittent extraction to allow heat recovery in the subsurface, ensuring the longevity of the resource. By converting inactive wells into geothermal systems, this research supports sustainable energy solutions and positions geothermal energy as a viable alternative in the global transition to clean energy. With rising global energy demand and increasing commitments to reducing fossil fuel reliance, the need for clean, renewable energy sources is more critical than ever. This study showcases BC's potential to lead renewable energy development through innovative geothermal applications, offering a sustainable solution that reduces environmental impact and decreases reliance on fossil fuels.