Energy transition and reuse of oil and gas wells as deep enhanced closed loop geothermal heat exchangers

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Since the 1950s many sedimentary basins worldwide and in Italy were highly explored for oil and gas exploitation, CO_2 sequestration, geothermal and mining applications, providing an accessible deep underground database and a number of exhausted wells currently not used.
The production of heat and electricity from geothermal energy is an established practice since the early 1900's. However, many geothermal projects are plagued by high up-front exploration costs and can face financial difficulties due to the uncertainties related to geological risk, namely low permeability, and the possibility of failure in the exploration phase. A promising technical option to exploit deep geothermal resources is represented by closed loop systems, a technology commonly associated to ground source heat pumps and able to exchange heat with its surroundings by conduction. However, this technology applied at greatest depth (>1 km) faces challenges such as limited heat transfer conduction through rock and high drilling costs due to the use of multilateral wells, a valuable solution to implement the deep system performance for heating/cooling and energy production.
The research project aims to analyze the potential and feasibility of deep closed loop systems solutions for heat and power energy production in sedimentary basins. The employment of multilateral wells and horizontal wells to create a complete deep closed circuit will be taken into consideration, to assess the possible heat exchange implementation able to support the creation of local energy communities and to address the main issues related to drilling and heat transfer.
Numerical simulations will be run considering different site specific and in operation to assess the performance of this technological solution. Then, specific objectives of the research are to apply standard geological and geophysical workflows for oil and gas prospecting in closed loop geothermal application, devoted to (i) identify the local geothermal gradient, (ii) characterize the rock formation and their thermal properties (especially thermal conductivity) in representative test areas, (iii) define the best well planning in sedimentary basins.
Subsurface characterization will consist of a multidisciplinary approach based on stratigraphic correlation, structural mapping, seismic and geomechanical interpretation of pre-existing data, determination of heat gradient and rock petrophysics analysis. Finally, it is expected to compare the modelling results with real technological demonstration on-going worldwide, by establishing a collaboration with some leading international companies and research institutions in this sector. The research activities will include also pre-spud predictions of thermal conductivity using mineralogy as a tool to reduce thermal output risk. The candidate is expected to be proactive in collecting and re-interpreting already existing available data for sedimentary basin at national or international level, performing a sub-surface characterization for multi-later closed-loop systems, pointing out advantages and disadvantages compared to conventional geothermal production wells.

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