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Title

Geothermal resources exploitation from disused hydrocarbon wells: simplified tools for a reuse strategies analysis

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Abstract

The current world energy paradigm, strongly relying on fossil fuels, turns out not to be more sustainable. The limits of this type of energy system, in terms of air pollutant emissions and resources depletion, have taken on more and more evidence over the last few decades. Clean energy production using sustainable resources has become one of the significant challenges the world faces today and one of the central topics of European and National development policy visions. Medium-term objectives concerning the decarbonization of the European Energy Systems are corroborated in the 2020 Climate and Energy Package and the following 2030 climate and energy framework. Besides, the Italian Piano Nazionale Integrato per l'Energia e il Clima establishes the new national targets for 2030 on energy efficiency, renewable sources, and CO_2 emissions reduction. "Responsible production and consumption" and "Ensure access to affordable, reliable, sustainable and modern energy for all" are two of the 17 Global Goals that make up the 2030 Agenda for Sustainable Development. Achieving increased energy efficiency is required to urgently change the way they produce, consume goods, and manage energy resources. Therefore, energy companies' primary aim has to provide new, more sustainable energy solutions, unlike those based on fossil fuels, and guarantee access to low-cost energy through technological development and environmental protection.

Recognized as equitably and environmentally sustainable, geothermal energy resources can ensure a renewable potentiality, establishing its importance for a new production model for the forthcoming future. Consequently, the need for developing new geothermal energy-related solutions has assumed increasing importance to cope with the energy demands at a global rate. In the described process, energy production based on the exploitation of deep geothermal energy resources derived from disused hydrocarbon wells in oilfields represents a considerable environmental solution. The hydrocarbon wells' technological reconversion can solve problems associated with suspended wells near municipalities, allowing to hypothesize long-term scenarios for the exploitation, even at the end of the production cycle of hydrocarbon wells to the benefit of end-users in the industrial, civil, and agriculture districts.

Since 1985, more than 8000 wells have been drilled for hydrocarbon extraction activities in Italy. In mature Italian oilfields, deep wells represent suitable candidate structures for geothermal heat exploitation, thus providing access to subsurface energy resources. Available geological and geophysical exploration data into the deepest regions of such contexts have ascertained the coexistence of hydrocarbons and the low- to medium-temperature geothermal energy resources.

Currently, closed-loop geothermal technologies represent a more effective technological solution to harness deep geothermal energy resources in oilfields. Open-loop systems are found to be subject to some technical problems, including groundwater recession, corrosion, and scaling problems. The re-injection of fluids represented a further non-negligible issue. Due to their proven advantages, in the proposed research work, the attention was centered on two different geothermal closed-loop-type technologies (U-tube and Coaxial Wellbore Heat Exchangers). Two simplified heat exchange models have been implemented in Python and MATLAB software. The main aim is developing simplified investigation tools, potentially applicable to each analyzed site (Italy and foreign countries) that would allow defining the most advantageous hypotheses of geothermal exploitation linked to a hydrocarbon well, currently no longer exploited. Using the proposed tools, it turns out to be possible to comprehend the energy feasibility of converting a hydrocarbon well into a geothermal one, through closed-loop-type geothermal technologies. The differences in the extracted thermal energy amounts and the benefits resulting from the repurposing of existing hydrocarbon wells were emphasized. The specific Italian geological and depositional contexts, the selected closed-loop WBHE technologies, the local energy demand affect the possibility of realizing an energy conversion project.