Tracing the evolution and charting the future of geothermal energy research and development

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ABSTRACT

The gamut of geothermal energy research encompasses the studies aimed at harnessing the abundant and inexhaustible thermal energy within the Earth, and it ranges from heat transfer to the activity of thermophilic microorganisms, 3D printing, and additive manufacturing and impacts the NET ZERO endeavour of humanity. In this paper, computational social network analysis has been employed to discover the subfield clusters of geothermal energy research and further trace the key evolutionary routes from the research corpus. The development, limitations, and opportunities of each cluster are examined, and it becomes evident that the focus of research ranges from geothermal evaluation, long-term effects of borehole heat exchangers, shallow systems that employ urbanisation's ground heating, enhanced geothermal systems (EGS) for district heating, combined and hybridised geothermal power generating models, including multi-generation and poly-generation, geothermal fluids, reinjection and their dual nature, environmental effects in geothermal water and mineral scaling, enhanced geothermal systems aiming to increase permeability without causing seismicity, and finally to social acceptability. We address significant questions, such as whether the waste heat is compatible with the idea of green geothermal heat and the elimination of pollutants and find that further R&D and technological advancements are required for this ubiquitous clean energy to get wider acceptance and employment. The future of this energy depends on the rational and scientifically sound exploration and use of the resources, just as in the case of fossil fuels, and thus precludes geothermal energy as a win-all solution to the energy needs of the whole world.

KEYWORDS

Geothermal energy; Heat exchanger; Heat extraction; Renewable energy; Space heating; Urban heating

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