

Innovation in geothermal potential assessment: the InGEO Project

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Geothermal potential is often cited as immense. According to IEA (2024), geothermal potential is second only to solar PV in terms of electricity generation among renewable energy technologies. It is also significant for heat and cooling production, especially in countries with high heating and cooling demand, and, generally, “more than enough to meet all electricity and heat demand in Africa, China, Europe, Southeast Asia and the United States”.

Assessing geothermal potential identifies ideal sites and ensures geothermal project viability; this is the goal of the InGEO project. (“Innovation in GEOthermal resources and reserves potential assessment for the decarbonisation of power/thermal sectors”; www.ingeo.cnr.it). The project’s novelty lies in producing an open-source tool for calculating geothermal potential, including thermodynamic simulation and economic analysis of operating plants. InGEO challenges include: (i) developing an innovative exploration workflow that integrates geological, geophysical, thermophysical, and other datasets to enhance geothermal reservoir characterisation; (ii) computing geothermal potential based on resource characteristics and operational solutions for heat extraction and power generation in conventional and non-conventional systems (fluid extraction-reinjection, closed-loop exchangers, thermal storage); and (iii) validating the regional scale approach with site-specific information where geothermal projects are in operation.

The exploration workflow is being established by evaluating geothermal conditions in the Northern Apennines’ buried fold and thrust belt, including the Romagna and Ferrara Folds. Over 200 seismic surveys, 700 deep boreholes (over 1500 m), and 160 borehole logs across about 22.500 km² have enabled a detailed 3D geological model. This model shows the variation in thickness of main lithological units to roughly 10 km, identified through seismic reflection interpretations guided by well stratigraphy. 3D seismic tomography and surface gravity data models are compared to spot inconsistencies in geophysical parameter datasets and produce a more robust 3D model. This model and petrophysical analyses will form the basis for developing the thermal model and dynamically assessing the area’s thermal regime. The open-source code in development, titled GEOTHERMOS, integrates the temporal variations of underground conditions with the production metrics of the plant. It utilises the volumetric method, considering vertical and lateral variations in temperature, static reservoir pressure, and rock permeability distributions. The code can currently simulate thermodynamic cycles for electricity generation and calculate the Levelized Cost of Energy (LCOE) and the Net Present Value (NPV) for the techno-economic evaluation.

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IEA (2024) - The future of geothermal energy, International Energy Agency, <https://www.iea.org/reports/the-future-of-geothermal-energy>.