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Innovation in geothermal potential assessment: the InGEO Project

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Innovation in GEOthermal resources and
reserves potential assessment for the
decarbonization of power/thermal sectors



Le Geoscienze e le sfide del XXI secolo

Padova, 16-18 settembre 2025



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The vast geothermal potential

Second only to PV potential, among RES for electricity, according to IEA (2024), the geothermal potential is “more than enough to meet all electricity and heat demand in Africa, China, Europe, Southeast Asia and the United States”.



Energy system ▾ Topics ▾ Countries ▾ Data ▾ Reports ▾ 🔍 👤

Technology breakthroughs are unlocking geothermal energy's vast potential in countries across the globe

News
13 December 2024



Largely untapped underground energy source can help meet world's rapidly growing demand for electricity, but cost reductions are needed to drive new generation of projects

With global electricity demand set to grow strongly, new technologies are opening up the massive potential of geothermal energy to provide around-the-clock clean power in almost all countries around the world, according to a new [IEA report](#).

The Future of
Geothermal Energy

[Explore report](#)

International Energy Agency, (2024)

<https://www.iea.org/reports/the-future-of-geothermal-energy>

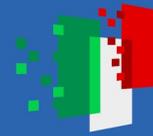




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Geothermal energy resource estimate at the regional level

Why: it plays a crucial role in the decision-making, financing, development, and operation of geothermal projects (business decision, government and public reporting, project finance,...)

Why: it requires a deep understanding of geological processes, and provides an opportunity for integrating geological, geophysical, geochemical data

Why: it is the most asked question from journalists when talking about geothermal energy, to underline the importance of developing geothermal projects (energy source to solve our huge energy demand, economic driver, a piece of solution for climate change issues, ...)



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Geothermal energy resource estimate

What is a geothermal resource?

How to estimate its potential?

There is still a need for a comprehensive and common assessment and comparison framework serving as a foundation for a comprehensive overview of current and future energy sustainability **scenarios** at project, company, national, regional and/or global levels to be used by investors, regulators, governments and consumers





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Geothermal potential assessment

Why: Resource assessment and reserve estimation are essential in decision-making, financing, development, and operation of geothermal projects.

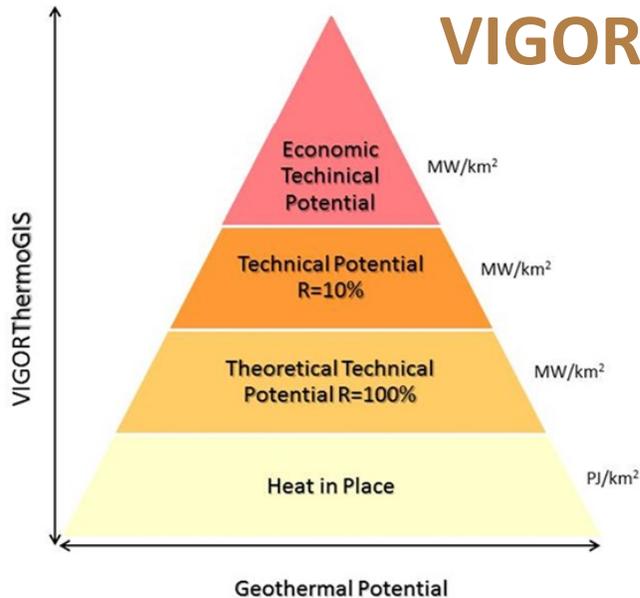
What: Quantifying the power potential (MWe) of geothermal fields in their early stages of development, where there is limited information about the resource.

How: Several methods exist, each with different levels of accuracy in evaluating output potential. The Volume Method is the most commonly used approach.

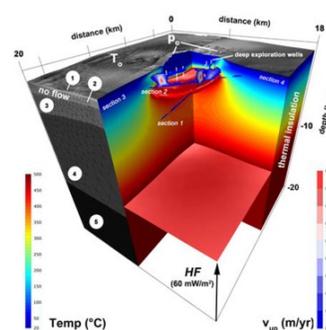




VIGOR THERMOGIS, based on the volume method



Input data:
3D geological and
3D thermal models



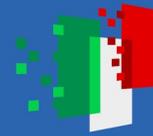
- The code employs 3D subsurface models and temperature distribution.
- The volume element (VOXET) has specific dimensions, and during the pre-processing phase, the input data must be sampled using the same grid.
- The geological units are characterized by average petrophysical values (density, specific heat) considered uniform throughout the entire volume, without accounting for the variation of thermal properties with temperature.
- Considered technology is based on the geothermal doublet (1 production well and 1 injection well), a binary plant for power production (with a constant average cycle relative efficiency value), or a DH plant.



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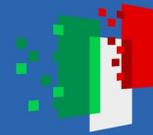


Goal and novelty of InGEO

Goal: Improve the knowledge of geothermal resources and assess the energy they contain (geothermal potential) for various uses, to identify ideal sites and ensure geothermal project viability

Novelty: Develop an open-source tool for calculating geothermal potential, including thermodynamic simulation and economic analysis of operating plants





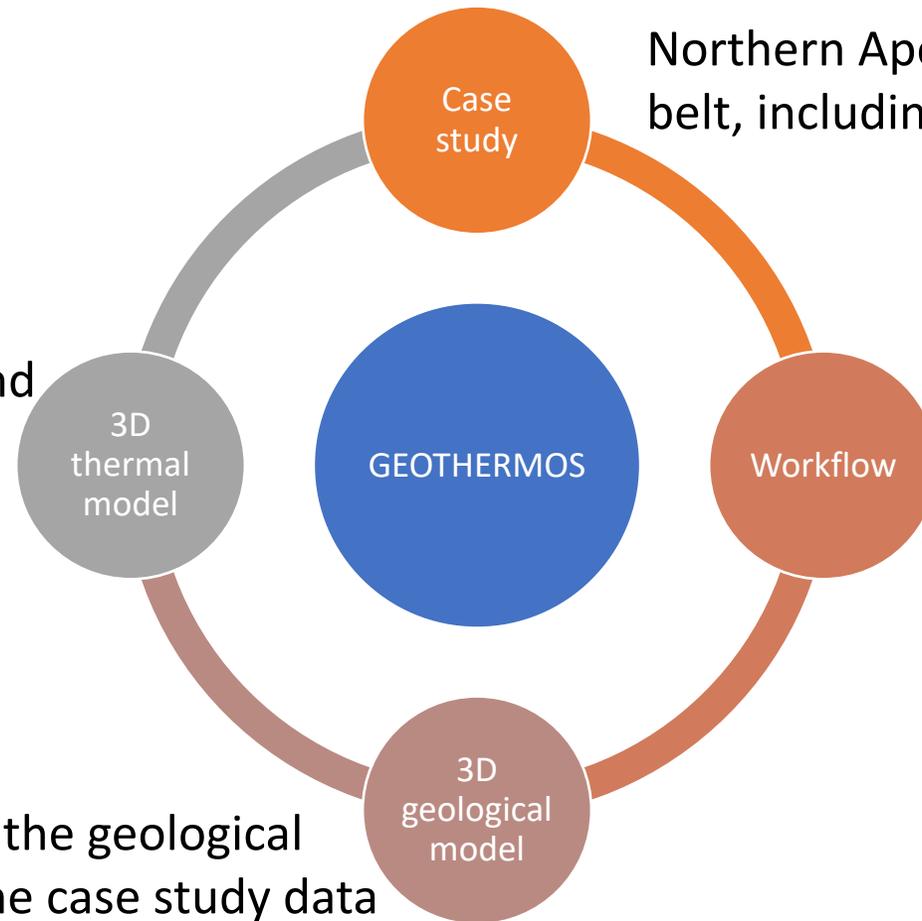
Challenges of InGEO

1. **Developing an innovative exploration workflow** that integrates geological, geophysical, thermophysical, and other datasets to improve geothermal reservoir characterization;
2. **Calculating geothermal potential** based on resource characteristics and operational solutions for heat extraction and power generation in both conventional and non-conventional systems (fluid extraction-reinjection, closed-loop exchangers, thermal storage);
3. **Validating** the regional scale approach with site-specific information where geothermal projects are active.



Based on 3D geological model and petrophysical analyses, dynamically assessing the area's thermal regime

Application of the geological workflow to the case study data



Northern Apennines' buried fold and thrust belt, including the Romagna and Ferrara Folds

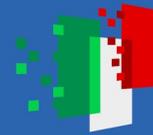
- Geological workflow: Integration of geological (boreholes) and geophysical data
- Potential assessment workflow



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This open-source code integrates the temporal variations of underground conditions with the production metrics of the plant

GEOTHERMOS

It utilises the volumetric method, considering vertical and lateral variations in temperature, static reservoir pressure, and rock permeability distributions





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For further details

This Session, 21-23 16.10 - 16.20

Nanni T.*, Gola G., Cortassa V., Galgaro A., Slupski P., Tesauro M., Basant R. & Manzella A. : Investigation of deep thermal state in buried Romagna and Ferrara fold sector

This Session, 21-31 16.50 - 17.00

Cortassa V., Tesauro M.*, Basant R., Gola G., Nanni T., Galgaro A. & Manzella A. : Analyses, interpretation, and integration of boreholes data and seismic reflection profiles into a 3D Geological Model of the Romagna and Ferrara Folds, (Eastern Po Plain) for the evaluation of geothermal resources

21-28 Booth 90 (Poster area 1)

Basant R.*, Tesauro M., Cortassa V., Gola G., Nanni T., Slupski P.M., Galgaro A. & Manzella A. : Joint geophysical modelling constrained by geological and petrophysical data for assessing the geothermal energy potential of the Romagna and Ferrara folds (RFF), Eastern Po-plain

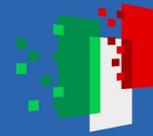




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