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The Geological Service for Europe's Strategic Initiatives on Sustainable GeoEnergy Capacities

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ABSTRACT

Geological Service for Europe (GSEU) project is initialling efforts to enhance the accessibility of subsurface information in Europe. The project is run by the EuroGeoSurveys (EGS) - a non-profit organisation encompassing 37 European geological surveys. EGS as a whole aims at proving data and expertise to European policy makers, including the European Commission, to the industry, and also to the citizens.

The GSEU project involves, among other things, creating an Online Platform for centralised access to the European geoenergy datasets, and a creation of an extensive Knowledge and Competence Hub to explain and display current research outcomes and to foster collaboration between European geological surveys and stakeholders. This development builds upon the existing European Geological Data Infrastructure (EGDI), and includes several components:

1. Creation of the pan-European database of geoenergy datasets to consolidate and standardize existing datasets from previous national and international projects. Information on > 200 datasets has been collected so far.

2. Improved findability of the datasets, including improvement of the search interface, new search system and significant expansion of its keyword thesaurus.

3. Development of new guidelines for FAIR data and for data harmonisation.

4. Design of the knowledge hub, its structure and content, including catalogue of tools that can be used on geothermal datasets.

The geothermal datasets will be accessible through the EGDI Search, with some also directly through the EGDI map viewer. By fostering enhanced collaboration and knowledge sharing, GSEU's initiatives are poised to support Europe's transition towards a more sustainable and integrated energy future.

INTRODUCTION

EuroGeoSurveys (EGS) is a non-profit organisation, encompassing 37 European geological survey organisations. EGS aims to provide data and expertise on the earth’s subsurface to the European policy makers, including the European Commission, to the industry, and also to the citizens in general. One of the key themes of EGS is geothermal energy. To effectively build a European regulatory framework and expand the utilisation of geothermal energy all stakeholders need information and data.

While there already is a large volume of valuable geoenergy data in the public domain, it is fragmented across numerous web pages of individual geological surveys, research institutes, governmental organizations and national and/or international projects. The data can thus be easily missed when initiating new projects, inhibiting efficient progress in developing solutions for the sustainable energy transition. In addition, relevant data on project web pages can and often is lost when the web page maintenance is stopped.

The EuroGeoSurveys' portal European Geological Data Infrastructure (EGDI - https://www.europe-geology.eu/) provides an online platform for remediating this by facilitating sharing, integration, and accessibility of geological information and FAIR data (Findable, Accessible, Interoperable, Reusable) across Europe.

EGDI provides access to data in two main ways.

- The Data Search allows searching through the database of spatial datasets, documents etc. The user can then find detail information on the datasets, and the links to the portal where the data can be found (even if outside of EGDI). The search is based on freetext search, utilising semantic modelling, on spatial search and also on several filters.
- The Map Viewer (https://maps.europe-geology.eu/) allows direct visualisation of the spatial datasets. It links to datasets stored within EGDI itself, but also to many external datasets using the Geospatial Web Services.

The currently running project Geological Service for Europe (GSEU) a 4-year project, running from 2023 to August 2027, aims at improving EGDI concerning sustainable geoenergy in several different ways. This includes:

- Creation of a pan-European database of sustainable geoenergy datasets to consolidate and standardise relevant datasets from national portals and previous national and international projects, as well as newly within GSEU created pan-European datasets.
- Improved findability of the datasets, including improvement of the search interface, new search system and significant expansion of its keyword thesaurus.
- Development of new guidelines for FAIR data and for data harmonisation.
- Development of a Knowledge and Competence Hub for sustainable geoenergy, which has the goal to foster knowledge exchange, inform about the different topics of sustainable geoenergy, provide access to the data and provide additional information about the data, including tools for data creation and accompanying reports for data description.

This abstract focuses on the pan-European database and the Knowledge and Competence Hub for sustainable geoenergy.

1 PROVIDING ACCESS TO PAN-EUROPEAN AND NATIONAL / INTERNATIONAL DATASETS

Improving the findability of existing pan-European, national as well as international datasets comprises several key tasks:

- Collecting information on the datasets
- Integrating the collected information into EGDI by turning it into metadata
- Ensuring the metadata quality and compliance with the FAIR principles
- Amending the keyword thesaurus, which provides basis for the freetext search

The details of this work as of mid-2025 can be found in Janku et al. (2025).

1.1 Creating the dataset inventory

The original dataset inventory has been created based on surveys between GSEU partners, with the GSEU core team providing guidance and quality control. The GSEU partners identified relevant data sets and provided the data sets descriptions within two large data collection campaigns. Additional information was collected in between them. The horizon SAPHEA project (https://gogeothermal.eu/projects/saphea/) also provided information about datasets. In the end, 221 datasets were identified that shall be (197) and potentially shall be (24) integrated into the EGDI. Majority of them are related to geothermal energy (see Figure 1 below). This included >40 of third-party datasets from data custodians such as GFZ Postdam. Datasets were associated with

one or more of four scientific themes: deep geothermal energy, shallow geothermal energy, carbon capture and storage (CCS) and energy storage. A separate category, "other" was used to describe more general datasets that are considered relevant for geoenergy application, but could not be clearly associated with individual themes.

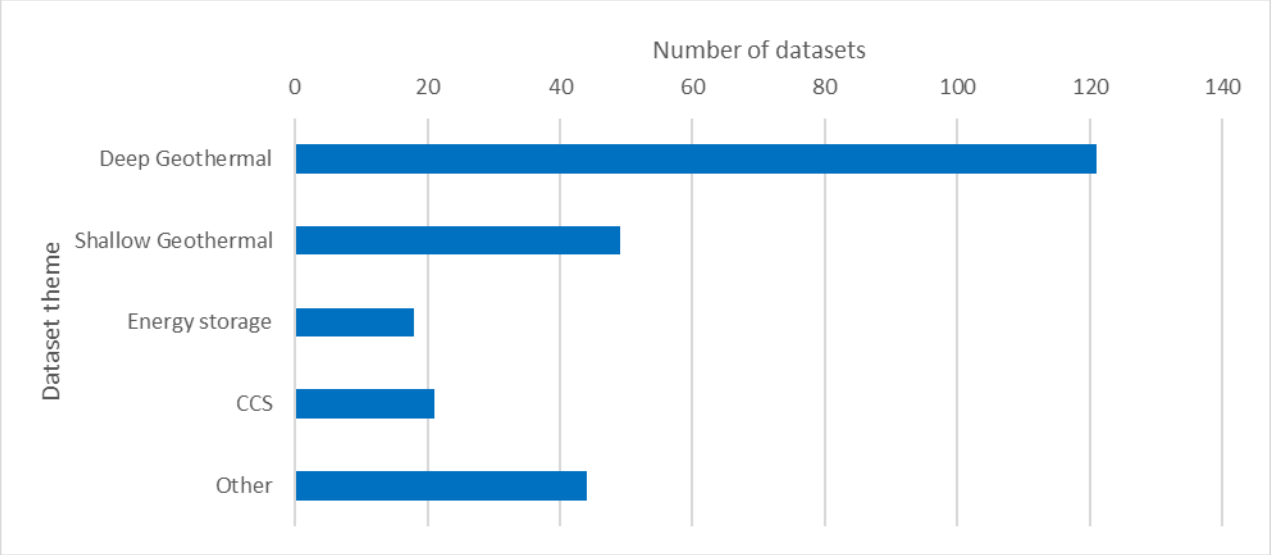


Figure 1. The number of datasets in the inventory per scientific theme. Adopted from Janku et al. (2025). Note that a single dataset can belong to multiple categories.

The collected information included the majority of essential metadata, as presented in the EGDI Metadata profile. However, additional information was collected as well in order to allow for a more refined search and more reliable editorial work on datasets.

The collected datasets include the pan-European Geoenergy Atlas, also developed during GSEU project (see the extended abstract by Herms et al., presented also on WGC 2026).

1.2 Integration of the Inventory into EGDI

For the sake of convenience, the dataset inventory was initially set up as a spreadsheet. The information in the spreadsheet does, however, need to be converted into metadata, which have to be integrated into the EGDI database structure. In general, sustainable geoenergy metadata is stored in two separate parts of the EGDI database.

1. The EGDI Metadata Catalogue (MiCKA). The catalogue includes metadata for all the datasets included in EGDI. MiCKA includes support for harvesting, when the metadata are primarily stored in other (typically national) metadata catalogues and are regularly downloaded into MiCKA, where they are then used for search.

2. The sustainable Geoenergy Inventory database. This database schema includes additional metadata attributes, which are deemed important specifically for geoenergy (incl. geothermal) datasets. It includes information such as dataset theme, the number of layers in the dataset and some information specific to the third-party datasets.

In the last quarter of 2025, a metadata creation campaign has started by the GSEU sustainable geoenergy group in order to create the metadata based on the original inventory spreadsheet. The campaign included creating metadata in national catalogues in cases where the records were to be harvested into EGDI. It involved geoenergy experts and metadata coordinators (experts tasked with ensuring the metadata quality) from the members organizations of the GSEU project.

In accordance with the best practices, as well as relevant legislations (such as the EU Data Act), the data in EGDI have to be FAIR. In addition, GSEU developed additional guideline in order to increase the consistent quality of the metadata (Cipolloni et al., 2025). The guideline includes rules apply to data, services, metadata, project vocabularies etc. In addition to these rules, the guidelines include an index to measure the FAIRness of the data / metadata, and includes tools to calculate them.

At the time of writing of this abstract, the campaign is still in progress.

1.3 Finding the datasets in EGDI

Both the EGDI Data Search and EGDI Map Viewer include freetext search as one of the main ways to find the data. When user types in a search term, the backend system then searches through the keywords in metadata, but also through the dataset names, abstracts etc. This system utilises semantic modelling to allow for search in national languages and also to enable the use of synonyms, acronyms etc. The semantic modelling is supported by the Keyword Thesaurus - an RDF database of terms, with their synonyms, translations and relationships. During GSEU, the current EGDI Keyword thesaurus was reviewed and found insufficient. Over 140 terms were subsequently added. The terms include a whole terminology focused on consenting, permitting and project lifecycle, terms describing thermal energy storage methods (ATES, BTEs, MTES) etc.

2 THE SUSTAINABLE GEOENERGY KNOWLEDGE AND COMPETENCE HUB

The knowledge and competence hub will provide the central open access point to information about sustainable geoenergy. It is being designed to accommodate the highly variable needs of the EGS stakeholders, from general public (preferring clear understandability of the presented information) to researchers (ability to find data and related literature, networking possibilities) and policy makers (clear but detailed high-level picture).

The knowledge hub will include:

- Series of information pages on the various topics of sustainable geoenergy (geothermal energy, carbon storage, energy storage) featuring pan-European data sets in the form of storymaps.
- Dashboard to presented updated information on geothermal potential and installed capacities (and corresponding information for CO2 Storage and Energy Storage).
- Gateway to the aforementioned data search and visualisation.
- Tools to create spatial data sets, either links to external homepages or downloadable tools.
- Glossary, explaining geoenergy terms to the general public.
- Dedicated searchable databases of the Geoenergy projects, EGS member organisations and experts, all interlinked. Information about the EGS member organisations and experts will only be available via log-in to prevent data miss-use.

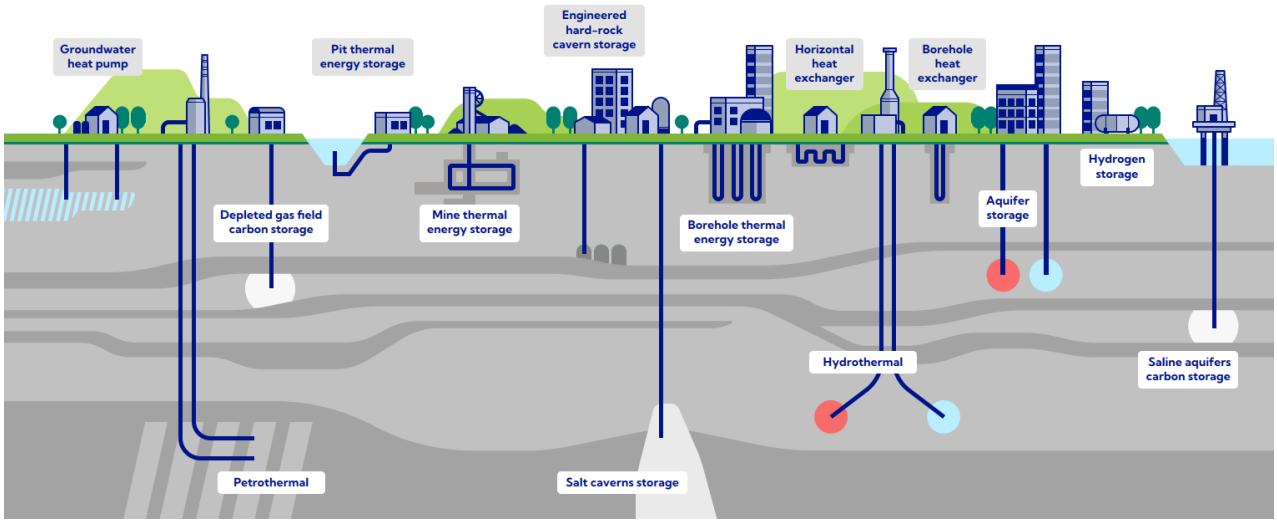


Figure 2. Scheme that will be used to guide users to various subthemes of sustainable geoenergy.

The hub will be a result of collaborative work between several groups: more than 50 members of the GSEU Geoenergy group, GSEU Networking group, EGDI Operations Group and EGS Geoenergy Expert group (GEEG). The details on the Hub as of end of 2024 can be found in Steiner et al., 2025.

3 CONCLUSION

With less than two years of the project remaining, the GSEU Geoenergy group has collected information on more than 200 national and project datasets in the field of geoenergy. Majority of them is related to deep or shallow geothermal energy. The datasets will be made searchable through the EGDI search, and some will be also directly accessible through the EGDI map viewer.

An extensive Knowledge and Competence hub is being built to serve as the single access point to all geoenergy related information collected by the consortium of European geological surveys. It will inform on various sustainable geoenergy fields, present updated statistics on the available and utilised geothermal potential, and include database of European Sustainable Geoenergy projects.

Through this, GSEU will foster enhanced collaboration and knowledge sharing to support Europe's transition towards a more sustainable and integrated energy future.

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