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GeotIS – a Unique Comprehensive Geothermal Information System

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INTRODUCTION

GeotIS is a free, interactive web-based geothermal atlas and information system, developed, maintained and operated by the LIAG Institute for Applied Geophysics in Hannover, Germany (Agemar et al. 2014). It provides geological, geophysical and geothermal data on deep and medium-depth geothermal reservoirs and increasingly information relevant to shallow systems across Germany (and parts of Upper Austria) via maps, interactive cross-sections, catalogs of installations, and other tools. It is used by planners, researchers, students, authorities, project developers for preliminary assessment of geothermal potential and for decision-support. By making subsurface data publicly available, GeotIS helps to reduce the exploration risk for geothermal projects. Furthermore, GeotIS also provides annual heat and power production statistics of deep geothermal installations as well as a catalog of deep geothermal plants with key operation parameters.

One of the most popular features is the interactive cross-section: On the main map, users can draw a line between two points to define the profile of interest. The system automatically generates a vertical cross-section through the subsurface along the user's line, based on the underlying 3D geological and temperature model. The cross-section view shows isotherms (temperature contours) and geothermal horizons such as stratigraphic units with one or more deep reservoirs. The viewer provides multiple customization options:

- Vertical exaggeration – to emphasize structural features or temperature gradients
- Colour scales – users can switch between predefined palettes or select individual colours
- Maximum depth – can be set interactively to focus on the desired depth range

By hovering the mouse pointer over the cross-section, users can read depths, subsurface temperatures, and uncertainty at any point along the profile. Cross-sections and maps can be exported as images (PDF).

This functionality makes GeotIS not just a static atlas, but a dynamic exploration and planning tool supporting geothermal site assessment, research, and education.

GeotIS was initiated in 2006 and went online in 2007, allowing the public to get an idea of what the first German geothermal web atlas looked like. Later projects such as GeotIS II, GeoFaces and StörTief expanded data coverage, added fault data and even more structural models, updated temperature data, included e-learning modules and improved the user interface.

More recently, under the ArtemIS project the system is being enhanced to incorporate medium-depth geothermal resources. In the course of the ArtemIS project, the profile feature was introduced for giving an overview on geothermal information for selected locations. The profile feature also includes the Geothermal Score – a simple measure for assessing the suitability of a site for five generic use cases. The profile feature was specifically designed to give a brief summary on the geologic setting and the geothermal prospects, comprehensible even for non-experts.

Currently, fluid data of geothermal brines are added under the project THC-Prognos. Fluid properties have implications on the technical design of geothermal facilities. The knowledge about fluid properties helps to mitigate scaling and corrosion.

The project WärmeGut focusses on shallow geothermal systems. First results of WärmeGut include maps on the general permissibility of borehole heat exchangers and horizontal geothermal collectors (Fig. 1).

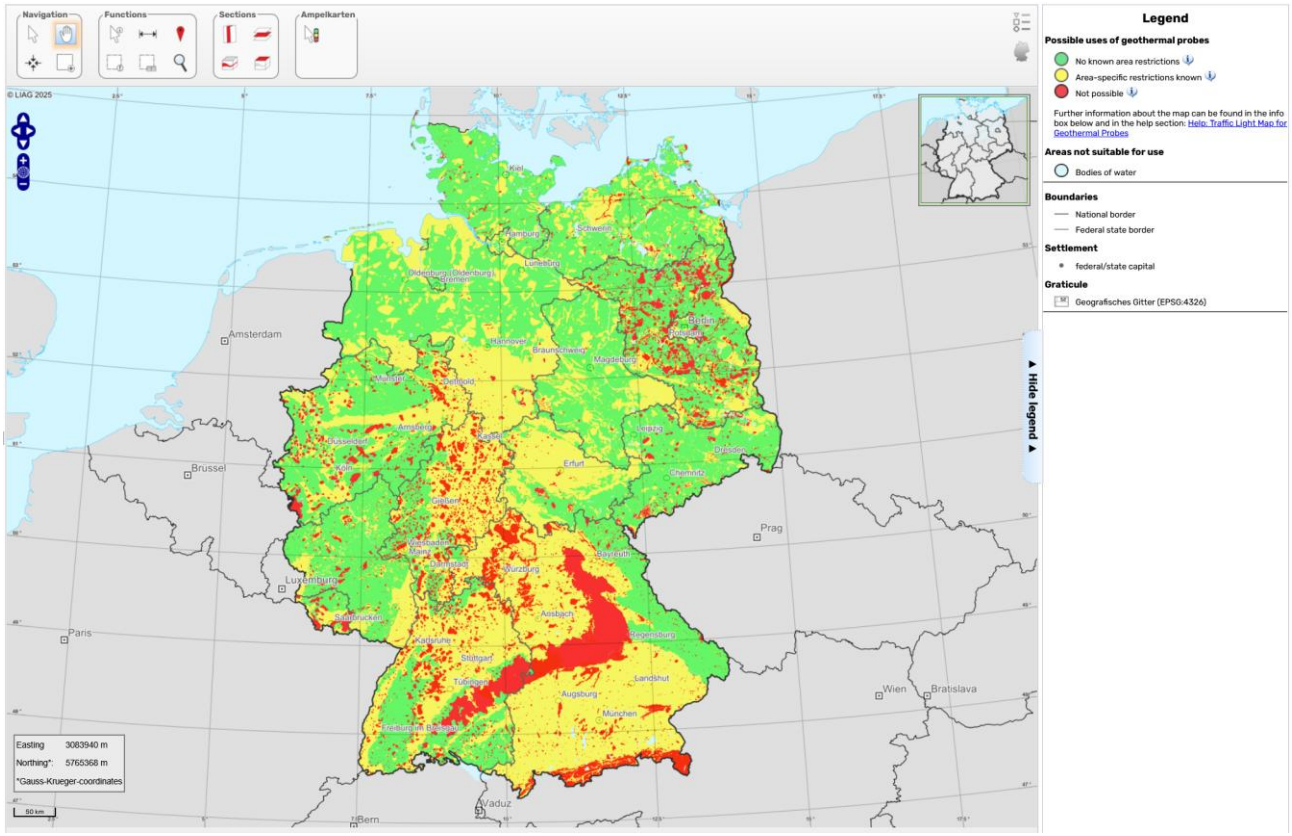


Figure 1. Screenshot of GeotIS with permissibility "traffic light" map for borehole heat exchangers.

1 NEW FEATURES

1.1 Potential of Shallow Geothermal Systems

A prominent part of the project WärmeGut deals with estimating the geothermal potential of geothermal borehole heat exchangers (BHEs) and collectors throughout Germany. To calculate the potential of shallow geothermal energy, the Institute for Building and Energy Systems (IGE) at Biberach University of Applied Sciences developed a customized version of their software GEO-HAND^{light} which has been integrated into GeotIS for fast calculation of borehole heat exchanger fields (Hochschule Biberach 2025). This provides a tool to users to assess the local shallow geothermal energy potential.

The estimates can be matched with the energy demand for heating in the corresponding region in order to assess the potential share of ground source heat pumps to the overall energy consumption for heating. The heat demand can be visualized as maps with a 50 m x 50 m grid. The data were compiled by the DBI Gastechnologisches Institut gGmbH Freiberg and categorised into four domains:

- Residential buildings
- Municipal buildings
- Industrial buildings
- Other commercial buildings

The current implementation of GEO-HAND^{light} in GeotIS currently assumes that a certain percentage of the selected area is available for borehole heat exchangers. The default values for seasonal coefficient of performance (SCOP=4.0) and for the coefficient of performance (COP=4.2) can be adjusted by the user. Other parameters, like temperature and thermal conductivity are retrieved from the database (Fig. 2).

Current development aims at an advanced methodology which is based on a three-step process for determining the technical potential of shallow geothermal energy:

1. Identify available areas using GIS data while excluding restricted zones.
2. Distribute geothermal heat exchangers (e.g., borehole heat exchangers) within these areas.
3. Determine the extractable geothermal potential based on a defined specific heat extraction rate or fluid temperature limits.

The third step requires detailed analysis because mutual thermal interference between heat exchangers or nearby systems reduces the potential. This is efficiently modeled using dimensionless thermal response functions (g-functions), which take into account factors such as borehole depth and spacing (Miocic et al. 2024).

It is also important to consider operation modes and load profiles. Thermal recharge of the subsurface by cooling operations would also have a large impact on potential estimates. It is planned to include these aspects in GeotIS in the future.

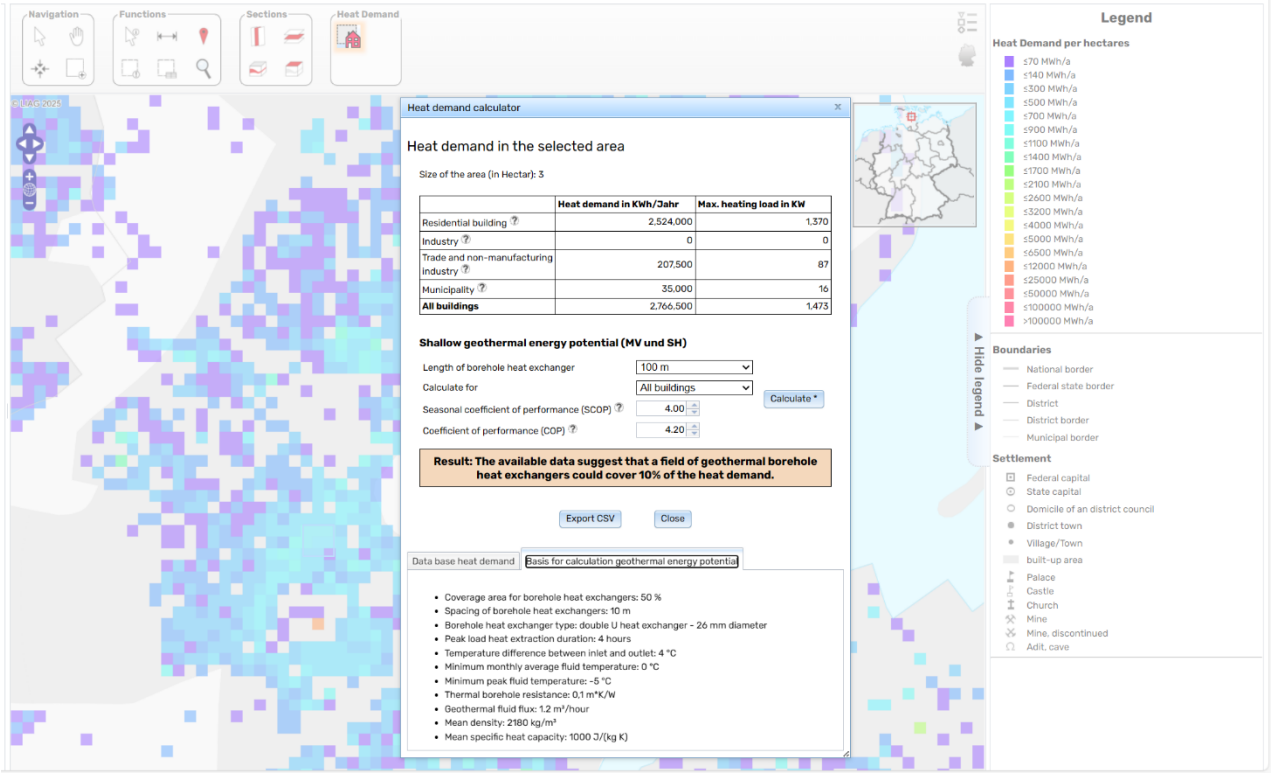


Figure 2. Screenshot of GeotIS showing local heat demand and potential share of virtual borehole heat exchangers in the selected area. The calculation of the result is accomplished by the integrated GEO-HAND^{light} software.

1.2 Geothermal Score and Profile Feature (Deep Geothermal)

Despite the growing complexity due to additional data and functions, GeotIS should be as easy and intuitive to use as possible. Against this background, Profile Feature was developed (Fig. 3). Upon one mouse click on a location on the map the user is able to explore manifold information: PlayType, geothermal gradient, geothermal horizons, and well locations near-by. It will also serve as starting point for simulations in the future. The Profile Feature also provides an easy-to-understand summary of the geological and geophysical subsurface conditions and a clear overview of a site's suitability for five generic geothermal use cases:

- Balneology / Space Heating
- Greenhouses
- Food Industry
- District Heating
- Power Production

The integrated Geothermal Score is based on typical threshold values for temperature, transmissivity/productivity, and reservoir thickness. Its scale ranges from 1, not suitable, to 5, very suitable. Level 2 states that minimum requirements are fulfilled. Level 3 indicates that energy output could be 3 times the minimum output. Level 4 states that energy output could be more than 4.5 times the minimum output and level 5 means that energy output could be more than 6 times the minimum output.

The Profile Feature also includes a sophisticated spatial analysis tool that displays existing wells and geothermal installations within a configurable radius around the selected location. The system supports multiple buffer rings that can be adjusted using an interactive control panel. Users can select the number of buffer rings

(typically 5 Rings) and set the maximum distance parameter, with options extending up to 25-50 km from the point of interest.

One of the most valuable features of the Profile Feature is the comprehensive database of existing boreholes and geothermal plants within a 10 km radius of the selected location. The system automatically queries and displays detailed information about nearby installations.

The plot on the upper right displays the relationship between subsurface depth and temperature. This visualization enables users to quickly assess the thermal conditions at various depths. The temperature curve provides critical information for preliminary feasibility assessments, allowing project developers to estimate the expected fluid temperatures at specific drilling depths.

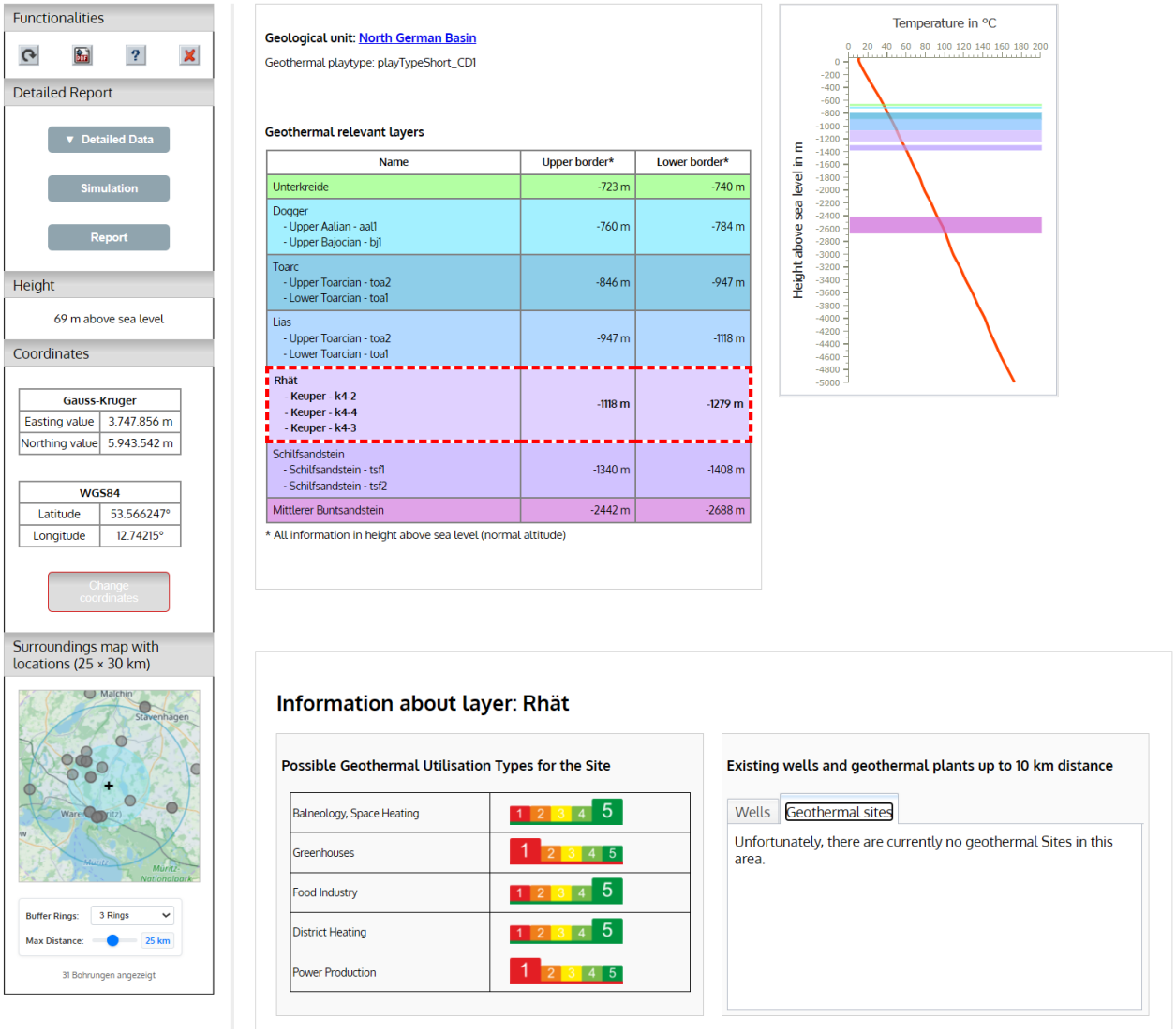


Figure 3. Screenshot of GeotIS Profile Feature. The link at the top provides information about the geologic setting. The table lists stratigraphic units of interest according to the user's selection. The plot on the top right shows the temperature increase over depth and the depths ranges of the stratigraphic units. The Geothermal Score is displayed at center bottom whereas an overview map with drilling locations is presented at the bottom left.

2 CONCLUSION

GeotIS is a nationwide digital infrastructure for geothermal information and resource assessment in Germany (and parts of Upper Austria). With its broad dataset, map tools and continuous updates, it is a key enabler for accelerating geothermal project planning, improving risk transparency and supporting the energy transition. The LIAG Institute for Applied Geophysics in Hannover continuously maintains, updates, and expands GeotIS. In short:

- One of the world's most comprehensive geothermal atlases freely available online.
- Strong integration of subsurface geological / geophysical data with geothermal system data and interactive visualization tools.
- A tool that bridges science, industry, planning, and education in one platform.
- Supports Germany's heating-transition and geothermal expansion through data-driven decision-making.

URL: https://www.geotis.de

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