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Deep Geothermal Utilization in Bavaria: Insights from the Geothermal Alliance Bavaria Project

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1 ABSTRACT

Deep geothermal utilization in Bavaria has a history of almost 30 years. During this time, numerous research questions have emerged from operating plants that tap into the Upper Jurassic Malm carbonate within the Molasse Basin in southern Bavaria, Germany. As of 2025, there are 26 plants in operation in the region, seven under construction, and 34 in early development. Since 2016, the Geothermal Alliance Bavaria joint research project has been providing scientific support and addressing issues that could delay project development. The uniqueness of the project lies in its regional-scale living-lab approach, where real geological and operational data from multiple projects are systematically integrated to optimize reservoir performance and minimize the interaction between neighboring projects and wells. Temperatures and stress alteration in the reservoir are monitored and analyzed to predict long-term risks of thermal decline and induced seismicity. The research serves as a basis for a decision support model for licensing authorities in future project development, enabling an increased contribution of deep geothermal energy to district heating systems. The urgent demand for renewable heating in other regions, where the Malm reservoir is not present, highlights the need to explore alternative targets. Therefore, EGS concepts for the crystalline basement, as well as the potential of medium-depth sandstones, are evaluated in combination with large-scale heat pumps or used as ATES. On the surface, new prototypes of more efficient heat pumps, including reversible systems, are being developed to further improve the efficiency of geothermal energy use.

2 INTRODUCTION

70 % of the energy demand of private households in Germany is for heating purposes. Only 18 % of it is sourced from renewables, mainly from biomass (Umweltbundesamt, 2025). Deep geothermal with district heating systems could be one of the main pillars in transforming into a sustainable heating system, especially for densely populated areas. The hot sedimentary Molasse Basin extends from Switzerland to Upper Austria. The first geothermal well in its Bavarian part was drilled in 1998, targeting hydrocarbons, but encountered thermal water instead. Following this success, geothermal development started in the early 2000s. To date, all 26 deep geothermal applications in Bavaria produce from the Upper Jurassic Malm carbonate (Figure 1). The Malm is affected by dolomitization, recrystallization, and compaction. It has a thickness of 300-650 m and dips towards the south, to the Alps, resulting in strongly different conditions depending on the location (Bohnsack et al., 2019). The total installed capacity is 400 MWth and 40 MWel, typically developed in doublet systems, consisting of a production and injection well. Local peak production rates reach up to 160 kg/s. However, geothermal development wasn't a straight success story. As reservoir temperature strongly correlates with depth, some investors aimed for power generation with binary systems in the southernmost part of the Molasse basin, which is still subsidized by the German feed-in tariff. This led to the first unsuccessful dry wells, resulting in the stagnation of project development due to uncertainty and the drawback of the risk mitigation insurance. In addition, the occurrence of unexplained induced seismic events and scaling-caused operational failures further increased public skepticism towards geothermal energy.

To understand geological processes that lead to low reservoir productivity, drilling problems, induced seismicity, and to optimize future plant configuration, the Geothermal Alliance Bavaria (GAB) interdisciplinary research project was initiated in 2016. This work is a review of the research highlights by its members, the Technical University of Munich, Friedrich-Alexander-University Erlangen-Nuremberg, Bayreuth University, Ludwig-Maximilians-University Munich, and the Hochschule München University of Applied Sciences in the second project phase (2020-2024). Furthermore, it gives insight into the ongoing research topics until 2028. Thanks to the support of local geothermal operators, who have provided abundant geological and even some specific operational data, the regional-scale living-lab approach of the project makes this research environment unique. The interdisciplinary team addresses real-life challenges of the local geothermal industry to provide regionally applicable solutions.

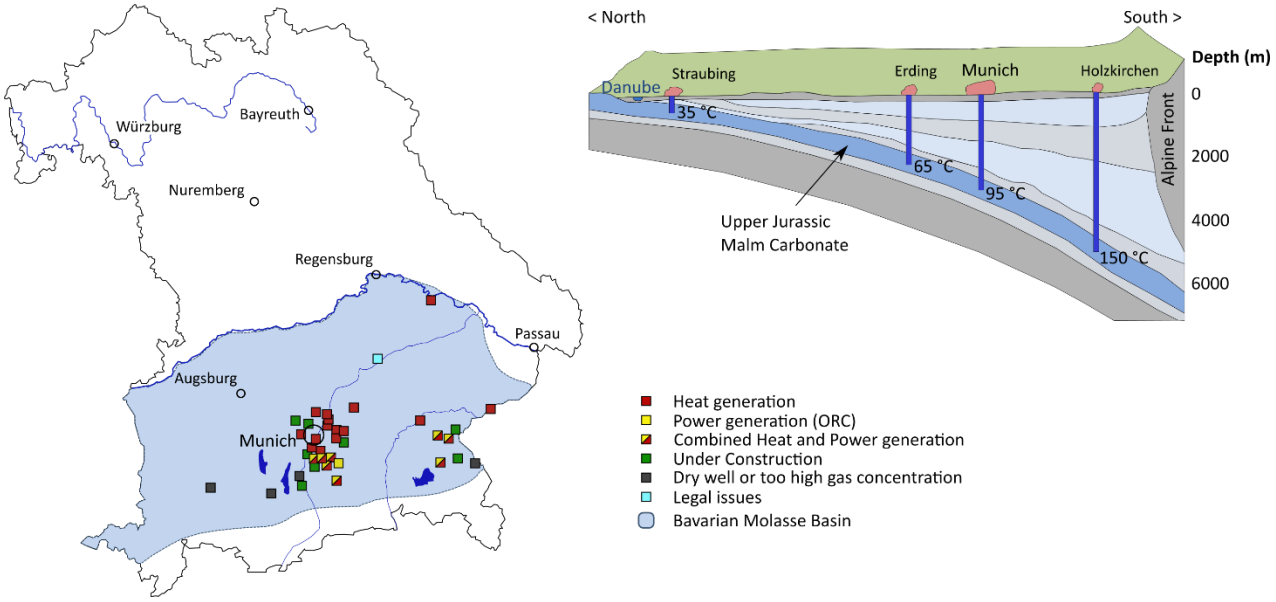


Figure 1: Location of deep geothermal applications in the Free State of Bavaria, Germany (left) and schematic North-South cross-section of the Bavarian Molasse Basin (right)

3 THMC-RESERVOIR MODELING

To predict reliable production rates and revenues for future projects from the heterogeneous Malm carbonate, a scale-dependent, holistic understanding of the formation's thermo-hydro-mechanical-chemical (THMC) properties is crucial. Zosseder et al. (2022) compiled temperature and hydraulic data from existing wells and interpolated the temperature distribution for the top Malm. Schölderle et al. (2025) identified productivity zones for the Malm based on multivariate methods. They derived permeability from porosity, acoustic, and electric resistivity logs from hydrocarbon wells, and correlated these with pump test data and production rates from geothermal wells. Drews et al. (2025) combined these findings with economic calculations to estimate the local levelized cost of heat (LCOH). Their probabilistic analysis enables a ranking of project locations from most promising to least promising (Figure 2).

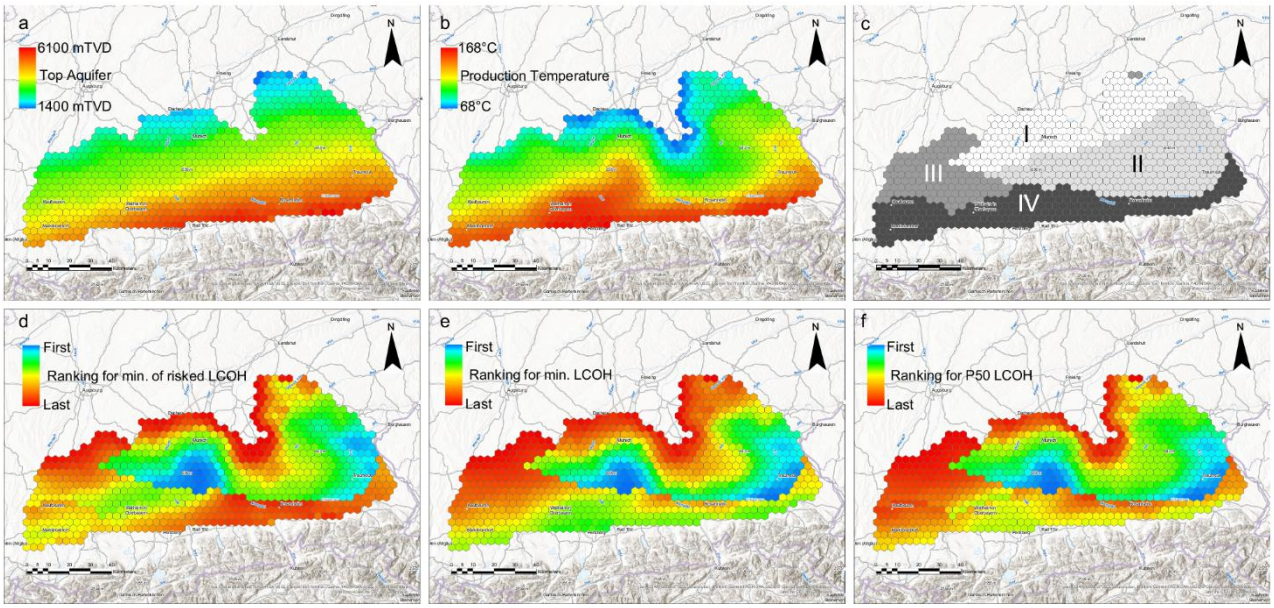


Figure 2: a) TVDm top Malm, b) Production temperature in °C, c) Zones of equal production rates in kg/s (zone I: 20-110-150-180, zone II: 5-80-150-180, zone III: 0-10-50-70 and zone IV: 0-0.1-30-70), d) Spatial distribution of the minimum of risk-adjusted levelized cost of heat $LCOH_{risked, min.}$, e) Spatial distribution of the minimum levelized cost of heat $LCOH_{min.}$, f) Spatial distribution of the median levelized cost of heat $LCOH_{P50}$. Color-coding of portfolio criteria indicates their position in the ranking, with blue indicating the first (best and therefore lowest LCOH) ranks and red indicating the last (worst and therefore highest LCOH) ranks. From Drews et al. (2025).

Continuous data acquisition was possible in a multilateral well in Munich, where fiber-optic cables were installed in both an injector and a producer. This setup enables high-temporal-resolution numerical modeling of the productive zones within a thick reservoir section (Andy, A., 2025; Moursy, M., 2025). Their work reveals a highly dynamic system and pressure communication between the multilateral wells.

Mechanical model parameters were defined on the basin scale using borehole data. Shatyrbayeva et al. (2024) created pore pressure maps based on logs and mud-weight data from hundreds of wells, which were also integrated into the World Stress Map and are available as borehole fact sheets at the State Office for the Environment in Bavaria. Such datasets are crucial for reducing drilling-related risks, delays, and economic losses. Almost three-quarters of geothermal wells in Bavaria experienced drilling-related delays and cost increases during construction (Drews et al., 2022). On the lab scale, Drexl et al. (2024) evaluated the fracture mechanism of limestone samples, providing insights into borehole stability in the open-hole reservoir section. Their fracture toughness experiments were conducted for both shear and tensile modes until sample failure.

To raise overall efficiency, many geothermal operators aim to lower injection temperatures. However, in the heterogeneous Malm reservoir, which contains water with a high concentration of dissolved carbonates, this trend can have adverse effects on the reservoir itself and the technical components. Dissolution along preferred flow paths could lead to premature thermal breakthrough, while scaling can damage the electrical submersible pump and lower the efficiency of the heat exchanger. Dietmaier et al. (2025) developed a method for quickly assessing alterations along fractures in limestones due to the injection of undersaturated geothermal fluids, while Dietmaier & Baumann (2023) developed a method for detecting significant chemical changes in the inflow regime of wells. They were able to detect the effects of remote pumping and injection tests on the local flow system; however, not sufficiently sensitive for cases without inflow from neighboring layers and without hydrochemical contrast in the aquifer. This limitation revealed an unfavorable practice at the plants: discontinuous data acquisition (yearly), which overlooked early warning signs for thermal breakthrough in the annual fluctuations of geochemical data.

To quantify the formation kinetics of the critical first deposition layer in degassing processes, a test setup was used to reproducibly generate deposits by stripping the CO2 in the water and to quantify the effects on parameters that can be measured continuously during operation. The hydrogeochemical model was extended by a kinetically exchanging gas phase in PhreeqC (Zacherl & Baumann, 2023). This represents a digital twin that can be used to predict hydrochemical behavior and to control the system based on the hydrochemical conditions. The kinetics of calcium carbonate precipitation was experimentally quantified under different flow conditions, in multiphase systems, using a quartz crystal microbalance combined with Raman spectroscopy (Zacherl & Baumann, 2024). Omidi & Baumann (2025) coupled fluid dynamics and hydrogeochemistry, explicitly integrating flow and mass transfer in multiphase systems (Figure 3). This serves as an early warning system for thermal breakthrough, as a slight increase in the concentration of calcium ions indicates an increased proportion of water from the injection well.

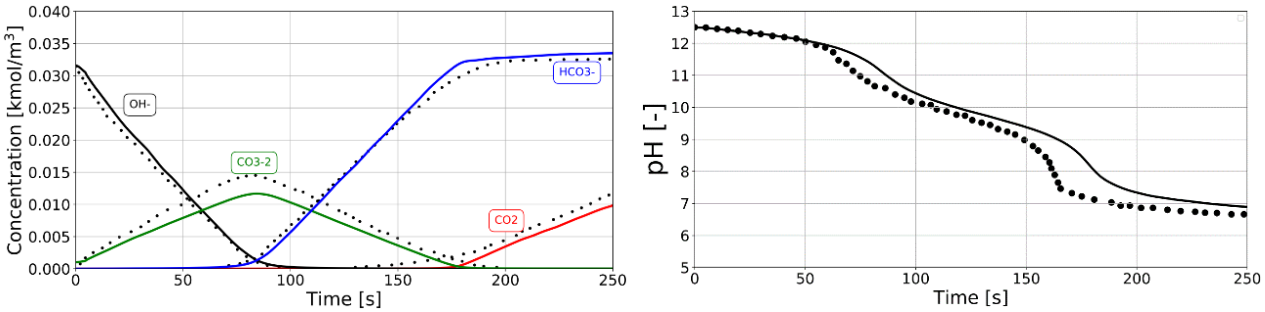


Figure 3: Development of the concentrations of the primary species in the lime-carbonic acid equilibrium (left), time course of the simulated pH value (line) compared to the experimental data (dots; right). From Omidi & Baumann (2025).

The current research focus is on achieving a holistic understanding of the Bavarian subsurface and modeling its reservoir properties. The models should couple THMC effects and be able to mirror the reservoir across scales. This is essential because Bavaria's geology is characterized by pronounced anisotropies, which would otherwise be lost when transferring laboratory results to the field scale. The final goal is to integrate these results into a toolkit for permitting authorities to identify risks from interactions between license fields and issue permits only for sustainable exploitation strategies.

4 EFFICIENT AND FLEXIBLE PLANT OPERATION

The average temperature and flow rates of the Malm reservoir in the Munich region range between 75-100 °C and 90-110 kg/s, providing ideal conditions for district heating. However, the residential heat demand fluctuates strongly due to the continental climate. This leads to an excess availability of heat in the summer months, and to the need for a secondary heat source to cover peak demand of the heating network during the winter. Uhrmann et al. (2025) performed life cycle assessments for hydrogeothermal plants in the region and identified the peak load supply as the primary emission source, alongside the electricity consumption of the production pump. However, by increasing the share of renewables in the electricity mix, the global warming potential of a representative heating plant south of Munich could be reduced by up to 40 %. To improve the year-round system efficiency and operation, Schifflechner et al. (2023) evaluated different plant configurations for geothermal trigeneration systems with Organic Rankine Cycles (ORC). These systems can simultaneously supply peak load in winter as a large-scale heat pump, or as an ORC or an absorption chiller in the summer, thereby reducing overall system emissions and raising system efficiency with only one additional component.

Two test rigs were developed to prove the concept. First, a novel reversible HTHP-ORC optimized for geothermal applications was built and tested. It operates as an ORC during summer to convert excess heat for power production, while providing additional heat in winter in heat pump mode. With this configuration, a higher utilization rate can be achieved, while investment costs remain lower than those of acquiring two devices (Kaufmann et al., 2025b). For the experimental characterization of the system, Kaufmann et al. (2025a) studied typical temperature levels in the Malm for both HTHP and ORC operation. The experimental results demonstrate that both the COP of the HTHP and the efficiency of the ORC are comparable to stand-alone systems, proving that the reversibility in one system can be implemented without any significant performance degradation in one operational mode. For the reversible absorption chiller, Irrgang et al. (2025) compared pure absorption system concepts with hybrid and cascading concepts. The results show that single-stage systems alongside hybrid cycles have the greatest cooling potential for the selected reference projects. The novel test rig enables very efficient operation in chiller mode with 80 kW cooling capacity, but also has individual adaptations for reversible operation. The design consists of parallel cooling of the condenser and absorber, while maximizing heat transfer in the tube bundles and minimizing pinch points in all heat exchangers. The optimal combination of an ORC with an absorption chiller for district cooling and its environmental impact was also assessed for climate conditions in South-East Asia in a joint study with researchers from Singapore (Chidire et al., 2025).

Molar-Cruz et al. (2022) demonstrated that reaching higher peak load hours in individual heating plants is key to achieving the lowest possible levelized cost of heat. They analyzed the benefits of heat transport networks (HTN) between geothermal regions and consumers to reach this goal. These pipelines bring thermal energy from geologically favorable locations to areas with the highest heat demand density. Since HTNs require lower upfront investment costs and no economic risk compared to geothermal wells, they could lower the overall cost for heat supply on a regional scale. Figure 4 highlights an example from their model for the city of Munich, where better geologic conditions are expected south of the city borders.

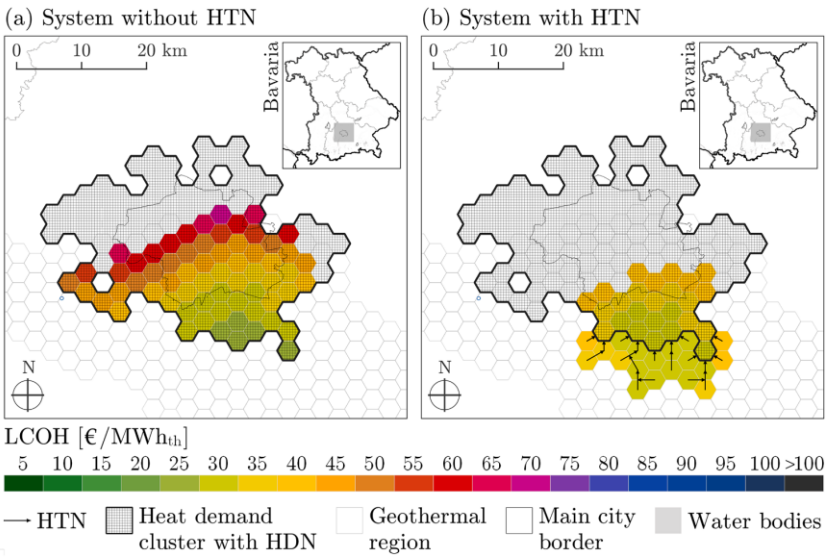


Figure 4: Achievable LCOH in the city of Munich, using heat transport networks (HTN) from better geologic conditions (right), compared to a system with local geothermal production (left). Both systems provide the same thermal output. From Molar-Cruz et al. (2022).

As described in Section 3, scaling frequently damages the technical components of plants in the Molasse Basin. Irl et al. (2023) set up a real-time operation monitoring algorithm to identify critical losses and optimize in-situ cleaning intervals for scaled components. In addition, to prevent electrical submersible pump failures, Rossmann (2024) designed a prototype for a reluctance synchronous motor, which proved not only more robust under local reservoir conditions but also achieved a 5 % improvement in efficiency over conventional designs.

Reservoir conditions of the Malm match the operating requirements of district heating networks quite well in and around Munich and at the eastern border to Austria. In regions north and west of Munich, the reservoir is shallower, resulting in lower temperatures, which necessitate a secondary heat source to supplement the operating heating networks. To replace fossil-powered auxiliary heat sources, the integration of large-scale heat pumps is a current focus area of the project. To understand the system behavior of medium-depth geothermal systems (defined here as reservoir depths less than 2500 m or temperatures less than 80 °C), Jeßberger et al. (2025) conducted sensitivity analyses for a range of realistic reservoir conditions. For example, the reduction of the electricity price from 192 €/MWh to 150 €/MWh leads to a decrease of 17 % in the LCOH. By increasing the COP up to 55 % of the Carnot-COP, the LCOH can be reduced by up to 13 %. By varying the drilling depth and the mass flow rate, the LCOH can be calculated for every possible combination occurring in the investigated region. The minimum LCOH of 77 €/MWh can be achieved at a depth of 2500 m with a flow rate of 200 kg/s, while the maximum LCOH of 150 €/MWh can be achieved at the same depth with a flow rate of 30 kg/s. Figure 5 shows the LCOH as a function of the drilling depth and thermal water mass flow.

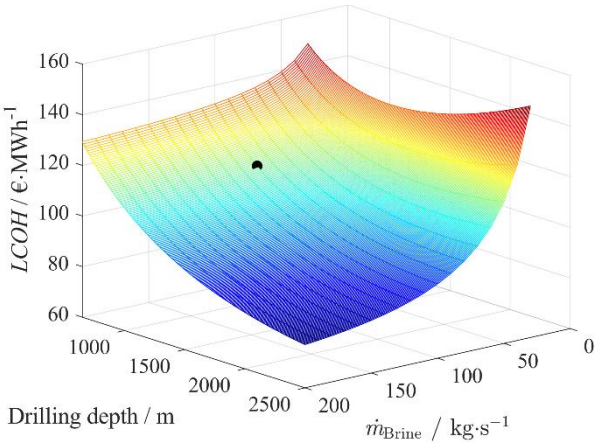


Figure 5: LCOH for medium-depth geothermal combined with large scale heat pump as function of the drilling depth and thermal water mass flow, based on the modal values. From Jeßberger et al. (2025).

Gawlick (2025) integrated deep geothermal from the Malm into her energy system model to assess its role in a future renewable energy system. Scenario analyses show the competitiveness of geothermal plants in the Bavarian Molasse Basin. Decisive factors for its successful implementation are the attainable CAPEX costs by mid-century, the utilization factor (full load hours), and the market price for electricity. For example, with an electricity price of 0,05 €/kWh in 2050, the LCOH of deep geothermal is lower than that of large-scale heat pumps above 5000 full load hours. With an electricity price of 0,15 €/kWh, parity is reached with 2000 full load hours.

In the next steps, technical approaches and methods will be developed that can be optimally applied to the geological conditions of the respective subsurface. These include a condition monitoring system for electrical submersible pump motors, which detects thermal overload at an early stage and thus minimizes pump failures. The use of new working media, such as mixtures, and multi-stage process control, is being investigated to ensure reliable and cost-efficient operation of HTHPs. The testing of innovative components and the optimization of system control in reversible ORC processes contribute to more flexible system operation. Additionally, a technical solution for a hybrid absorption chiller is being developed to utilize excess heat for cooling in the summer. Furthermore, a broader field of application and optimal system designs for geothermal energy is analyzed. The current focus is on optimizing technological approaches for supplying industrial processes with heat, steam, and cooling. The potential of medium-depth geothermal energy for industrial customers is evaluated and optimized by focusing on increasing the temperature lift with heat pumps. Innovative approaches to increasing the flexibility of geothermal energy will be investigated to address the growing demand for flexible technologies that facilitate sector coupling. This can be optimized, particularly through the future integration of heat storage and reversible ORC systems. Additionally, the research will facilitate the better integration of geothermal energy into regional and urban energy planning. These developments are rounded up by detailed life cycle analyses for the applications described.

5 SEISMIC RISK MINIMIZATION

The lack of a scientific explanation following the Poing M2.1 seismic event led to public skepticism regarding deep geothermal development and even a referendum against a project in a nearby town. Consequently, this research area aims to quantify the impacts of induced seismicity on buildings and to establish a fast evaluation of potential shaking.

Figure 6 explains the workflow for the seismic risk-hazard evaluation. The input soil dynamic parameters, including shear- and P-wave velocities in the research area, were determined using downhole, cross-hole, and passive seismological in-situ methods, complemented by resonance column measurements. To assess the possible impact of induced seismicity, the vulnerability of characteristic building categories was analyzed. Kumawat et al. (2024) created a building model using the finite element method (FEM) and modeled the soil-

structure interaction (SSI) using impedance models or lumped parameter models (LPM). The variability of the soil parameters in Munich has only a minimal effect on the overall response of the buildings due to the high stiffness of the local soil. For stiff soils, both frequency-dependent and frequency-independent foundation models yield comparable results regarding the building transfer functions. To lower computational effort, the SSI model was reduced to 1D. Csuka et al. (2022) confirmed the correctness of the simplifying assumption of one-dimensional wave propagation for tectonic earthquakes.

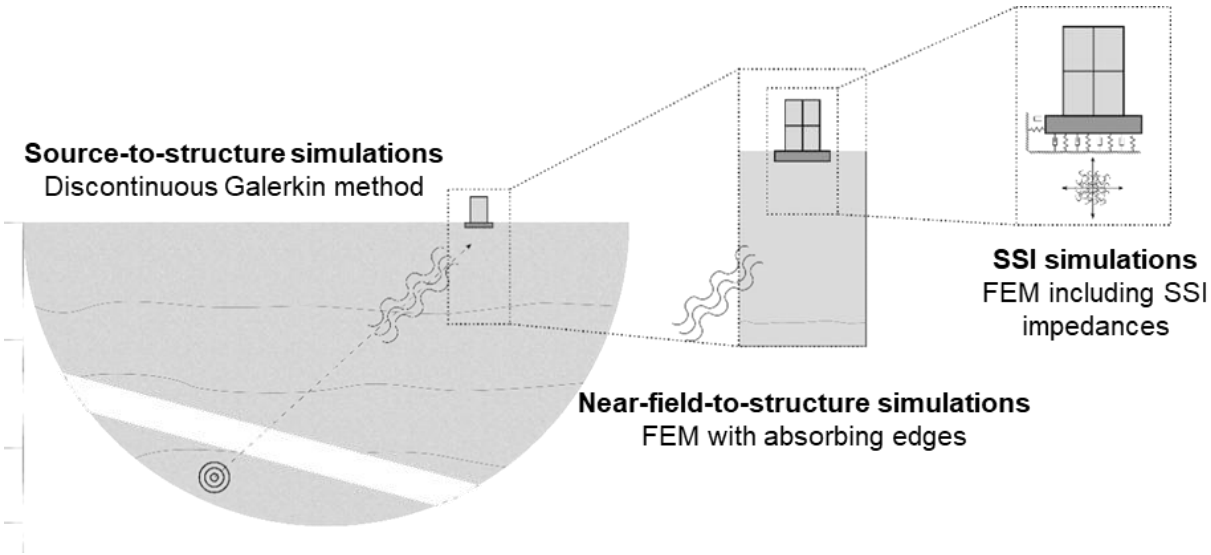


Figure 6: Procedure for validating the three-step simulation approach with different scales and degrees of resolution

To evaluate possible upper limit effects, Keil et al. (2022) generated physics-based simulations of ground movement for several scenarios in the Munich area. As a first step towards hazard reduction, a TIGER-MOOSE approach was adapted, which solves the problems of thermal-hydraulic transport of solutes in the geothermal reservoir. This allows for a systematic comparison of the overstress area with numerical estimates of the critical area required to trigger sustained earthquake ruptures. Once the defined criterion is reached, the stresses from the reservoir simulation are transferred to SeisSol, and the spontaneous earthquake rupture is modeled in 3D. Depending on the assumptions made, both confined and runaway ruptures are modeled. Finally, theoretical estimates of the maximum magnitude of self-arresting earthquakes were refined by using coupled complex models. These, together with the database of seismic records in the greater Munich and Insheim area (Taddei et al., 2022 & 2024), build the basis for ground movement models.

Physics-based simulations of earthquakes pose a challenge for various earthquake scenarios, due to the high computational costs of numerical simulations. To enable fast physics-based solutions and react quickly to significant shocks, the approach by Rekoske et al. (2023) was adapted for the Munich area. The method of reduced order models (ROM), based on interpolated Proper Orthogonal Decomposition (POD), is used to predict the peak ground velocity at the surface (PGV). For the case study, the Schäftlarnstrasse geothermal project of Stadtwerke München was used for a test case scenario. The earthquake sources are implemented with varying depths and different focal mechanisms. A total of 1,000 earthquake scenarios were calculated and then scaled by magnitude to obtain a dataset of 30,000 PGV maps. The trained ROM reproduced the simulated PGV map well. However, there are some limitations that require further research. The PGV maps were not calculated for varying locations of the epicenter, which would span a larger parameter space and thus require a more extensive data set. The targeted frequency of 10 Hz was not achieved, as the computational effort for a large training data set is too high. Currently, only PGV maps are generated, while seismograms or response spectra are missing.

To address the challenges in predicting seismicity, Lienen & Günnemann (2022) developed the Finite Element Networks (FEN) method. FENs combine the advantages of traditional FEM methods with the strengths of modern neural networks, thereby enabling the effective integration of prior physical knowledge into a machine learning process. Additionally, the physical interpretability of FENs enables a deeper analysis of the results. Individual components of the model could actually represent the expected physical processes, such as convection and swelling/sinking. This is a crucial step toward increasing confidence in the model predictions and enabling the establishment of an early warning system.

Research on seismic risk & hazard remains central in the project, regarding expected EGS applications in Northern Bavaria. Three pillars are in focus: causes and control options of induced seismicity; possible effects of occurring seismicity and their countermeasures for buildings; use of modern data sources for the areal estimation of the effects of occurring seismicity. Since EGS projects are usually associated with higher microquake rates, it is crucial to monitor seismicity accordingly and to take measures to avoid seismicity causing damage. For this, an adaptive tracking traffic light or, more broadly, a reservoir management system is being developed. This allows for the quantitative investigation of stress conditions at the target depth. Possible effects of seismicity on buildings directly influence public acceptance. New approaches to SSI and the influence of soil properties are being investigated. Finally, the area-wide seismic measurement system, known as Distributed Acoustic Sensing, will be implemented. This system, which is based on the use of unused fiber optic cables ("dark fiber"), will enable the precise measurement of peak velocities over large areas and support the delineation of an impact area in the event of damage.

6 GEOLOGICAL EXPLORATION OF NEW HORIZONS

The Malm reservoir is situated only between the Alpine Front and the Danube River (Figure 1), providing optimal conditions for the Munich metropolitan area. However, around seven million inhabitants of the state lack access to the Malm reservoir and require an alternative sustainable heat source to meet climate goals. The integration of large-scale heat pumps into medium-depth geothermal systems, described in section 4, can also be applied to medium-depth sandstone formations in the Molasse Basin and Northern Bavaria. These sandstones are subsequently characterized for direct use and ATES applications (Tzoufka, 2025).

Developing deep geothermal systems in northern Bavaria, where the sedimentary cover is thin, requires EGS or AGS technology. The project focus was to characterize the Haßberge heat anomaly, located in the triangle of the cities Bamberg, Coburg and Haßfurt in northwest Bavaria, geologically. Only a few wells have been drilled in this area, and only well Eltmann reached the pre-Permian basement rocks. However, they indicate an elevated geothermal gradient and heat flux density (Kämmlein et al., 2020). This, combined with a negative gravimetric anomaly, may suggest the presence of a radiogenic heat-producing granite body (de Wall et al., 2019). To delineate this structure, a large-scale subsurface model was created, based on existing 2D seismic data and large-scale gravimetric and magnetic data. Furthermore, high-density gravimetry was conducted and interpreted, revealing a larger size for the assumed granite body (Fazlikhani et al., 2024). Soil gas measurements for radon were taken in the areas where faults were assumed, and their presence was confirmed.

Field experiments were conducted in 15 shallow boreholes in a near granite quarry to estimate the hydro-mechanical properties of analogous granites. Hähnel et al. (2023) revealed a tight system. Double packer tests on selected fractures or fracture zones showed fracture transmissivities in the range of 10-8 and 10-9 m^2/s. The fracture transmissivity correlates with dip, azimuth, the number of fractures per fracture zone, and the depth of the test interval. High-pressure double packer tests with interval pressures of up to 100 bar did not result in mechanical opening of the fractures; flow into the fracture network was only achieved in two fractures. In the surrounding boreholes, clear pressure reactions could only be observed during the high-pressure tests. The pressure reaction times and amplitudes, together with the position of the reaction wells in relation to the test wells and the results of the hydraulic tests, lead to the following conclusion: A partial closure of the fractures by fracture mineralization is suspected, which hinders the flow and leads to a high complexity of the flow paths in the fracture network. The flow in the test field is therefore interpreted as discrete along individual, open fractures in an otherwise low-permeability and poorly interconnected fracture network. To combine the results of geophysical investigations with the fault network map, which is based on the well and seismic reflection data, the fault network and Bouguer gravity map should be integrated into a geologic model of northern Bavaria. This is especially important for the Haßberge region (Figure 7).

In the next steps, geophysical measurements are to be used to refine the research at the assumed Haßberge granite in terms of geometry, depth, and structure. Meanwhile, EGS concepts in northern Bavarian population centers are to be evaluated for heat supply. The overarching aim is to further develop the EGS technology in northern Bavaria, enabling the drilling of a research well with subsequent energy extraction into the bedrock.

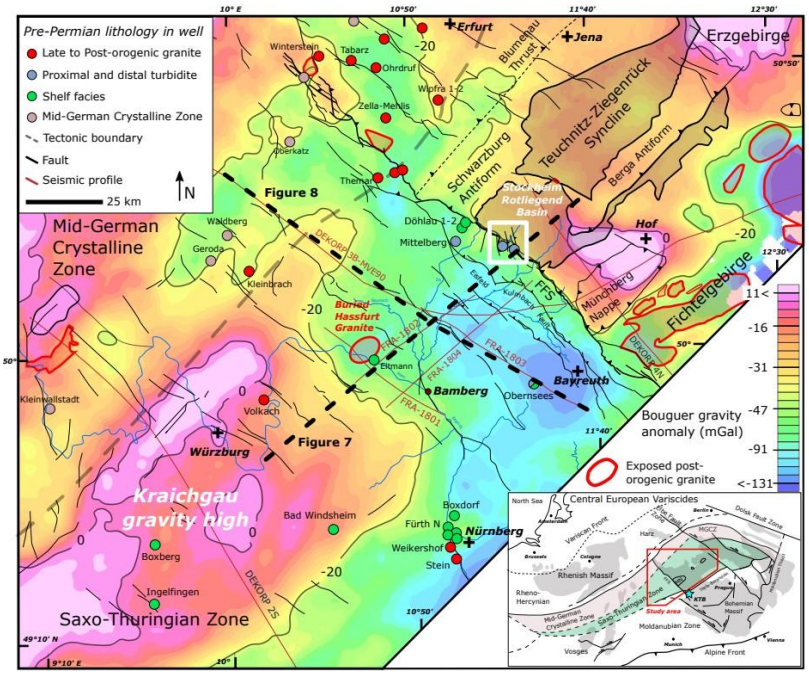


Figure 7: Bouguer gravity anomaly map of the study area and basement wells. Lower Carboniferous turbidites tend to correlate with a medium gravity anomaly while the Variscan granites (red polygon) are characterized by a negative Bouguer gravity signature. Elevated gravity values (>-20 mGal) in the SE reflect the Kraichgau gravity high, which is bounded to the NW by a regional gravity low. The regional negative gravity belt has been shown to be an area of granitic intrusion as indicated by several wells and exposed granites known as "Thuringian Hauptgranite". Modelled Hassfurt granite is shown in the center of the study area. From Fazlikhani et al. (2025).

7 CONCLUSIONS

The Geothermal Alliance Bavaria project represents a unique collaboration among its member universities and partners: geothermal operators and public authorities. With all the presented scientific achievements, technological improvements, and a new federal funding scheme for renewable-powered district heating networks, deep geothermal development in Bavaria is accelerating quickly. For 25 plants in operation, eight are under construction, and feasibility studies or exploration are ongoing in 34 new license areas. A doubling of the installed capacity is expected by the early 2030s.

Our interdisciplinary research team has effectively addressed uncertainties that previously slowed project development over the past decade. The second project phase brought us closer to a holistic THMC understanding of the Malm reservoir. We were able to predict the impact of induced PGVs on buildings and improve the efficiency of technical components on a lab scale. In addition, we delineated and characterized, on an analogous outcrop, an assumed heat-producing granite body in northern Bavaria.

The described fast development in the Malm formation raises concerns about the interaction between neighboring wells. Therefore, the current GAB project phase aims to provide decision-support models for licensing authorities to assess temperature and stress alterations in the Malm reservoir, thereby predicting long-term risks for thermal decline and induced seismicity. Even with a rising number of licenses in Bavaria, deep geothermal use is still concentrated only in the southern (deeper) parts of the Malm. The urgent need for renewable heating alternatives shifts the project's focus to alternative reservoirs throughout Bavaria. Besides EGS concepts for the crystalline basement, the use of medium-depth sandstones, combined with large-scale heat pumps or as aquifer storage, will be evaluated. The subprojects are organized methodically and applied subsequently to these three geothermal technologies.

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