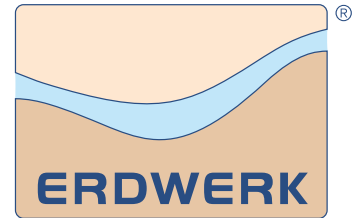


ERDWERK GMBH
Experts in Geothermal Energy Since 2002





DEAR CUSTOMERS, PARTNERS AND FRIENDS OF ERDWERK

Renewable energy and thus geothermal energy are now undisputedly considered part of the energy mix – not just in Germany but also internationally. The ecological and economic performance of geothermal energy today puts it at a competitive level with other renewables. This keeps us motivated to take on new projects, breathe life into projects at a standstill and venture into new realms internationally.

Looking back at the company's success and development since 2002, we have learned to be flexible whilst offering the upmost reliability in a dynamic market. We have established ourselves as a strong industry player in an environment that is defined by different parameters such as, the fluctuating price for oil and natural gas as well as the EEG (Renewable Energy Law). We are a reliable and technically competent partner, specializing in collaboration with municipalities and government authorities. We assist our customers in understanding the advantages of geothermal energy as a local, decentralized and sustainable energy supply, thereby ensuring an environmentally friendly and regional resource that will ultimately strengthen the energy policy situation.

As a geological and well engineering consultancy, we pride ourselves in being the one-stop source for all underground activities from conception through to completion of a geothermal project. Today, our ERDWERK team is able to provide the full range of services and draw on extensive experience from many projects.

We look forward to continue to offer these services and wish you a sincere „Glück auf!“

Achim Schubert and his ERDWERK team

OUR EXPERIENCE COUNTS!

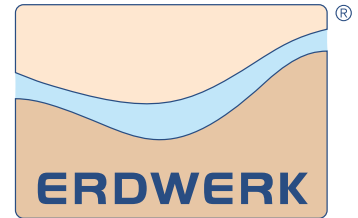
Since the founding of the company in 2002, ERDWERK has planned and supervised deep geothermal energy activities for more than 100,000 drilled meters. To date, we can boast a total thermal output of more than 200 MW (status: end of 2016). In the last few years, we have tendered drilling services for our clients with a value of over 350 million euros. In addition, we have supported and planned numerous other projects at home and abroad.

OUR PROJECTS: FROM PLANNING TO EXECUTION

Our clients are municipalities, industry and private companies. Typically, the life of a project begins with the application of the mining law followed by a feasibility study. We then support the reprocessing of existing data or the design of a new seismic campaign, undertake the detailed planning, tender the drilling services and obtain the official permits. We provide geological, well engineering and administrative support during the drilling and testing phase until completion. Through our extensive experience in project management, cost planning, cost optimization and cost control and our highly skilled and well-established ERDWERK team we have earned respect across the sector and are considered a reliable and very experienced planner.

Our core competencies in deep geothermal energy

- Geology & Geophysics
- Reservoir Engineering
- Drilling Engineering
- Production Engineering
- Project Management



THE ERDWERK TEAM: MOTIVATION AND COMPREHENSIVE GEOTHERMAL COMPETENCE UNDER ONE ROOF

Over the last few years the ERDWERK has developed into a planning office that provides the complete range of services required for a geothermal project. We can therefore offer our customers extensive know-how and all services from one source. At the same time the size of our company allows our customers to take advantage of short and efficient communication channels. This allows, not only for a flat hierarchy with an interdisciplinary interconnectedness across eight specialist areas, but also for project teams to enjoy a continuous flow of information and knowledge within ERDWERK. Specialist teams are responsible for the integration and transfer of technical and scientific know-how by, for example introducing innovations or by acquiring and processing technical scientific solutions. Parallel to this the project team handles the daily project tasks with the project manager as the central point of contact .

This clear organizational structure allows us to ensure our quality. Task sharing is a motivating factor for the entire team and allows us to undertake diverse tasks which meet the clients demands. This is also a reason why we have established ourselves as a leader in the industry.



OUR RANGE OF SERVICES AT ONE GLANCE

Special fields:

- Drilling technology & production technology
- Geology & stratigraphy
- Seismology
- Reservoir Engineering
- Law & approval procedure
- Hydrochemistry & isotope geochemistry
- Research & development
- OFN geothermal energy & hydrogeology

Project experience:

- Deep geothermal energy for heat generation and power supply
- Hydrogeology for the exploitation of drinking water and mineral water
- Balneology
- Groundwater protection and groundwater monitoring
- Visual representation for the public display of drilling projects
- Quality control
- Execution of geological due-diligence assessments
- Near-surface geothermal energy for the heating and cooling of buildings such as heat pump concepts and design of the heat source

Software expertise:

We use the following software solutions to support and design your project:

- ArcGIS (ESRI)
- Petrel (Schlumberger)
- @RISK (Palisade)
- StressCheck (Halliburton)
- WELLCAT (Halliburton)
- WELLPLAN (Halliburton)
- FEFLOW (DHI-Wasy)
- Saphir (Kappa)/ AQUATESOLVE
- MATLAB (Mathwork)
- Eclipse (Schlumberger)
- Precisiontree (Palisade)

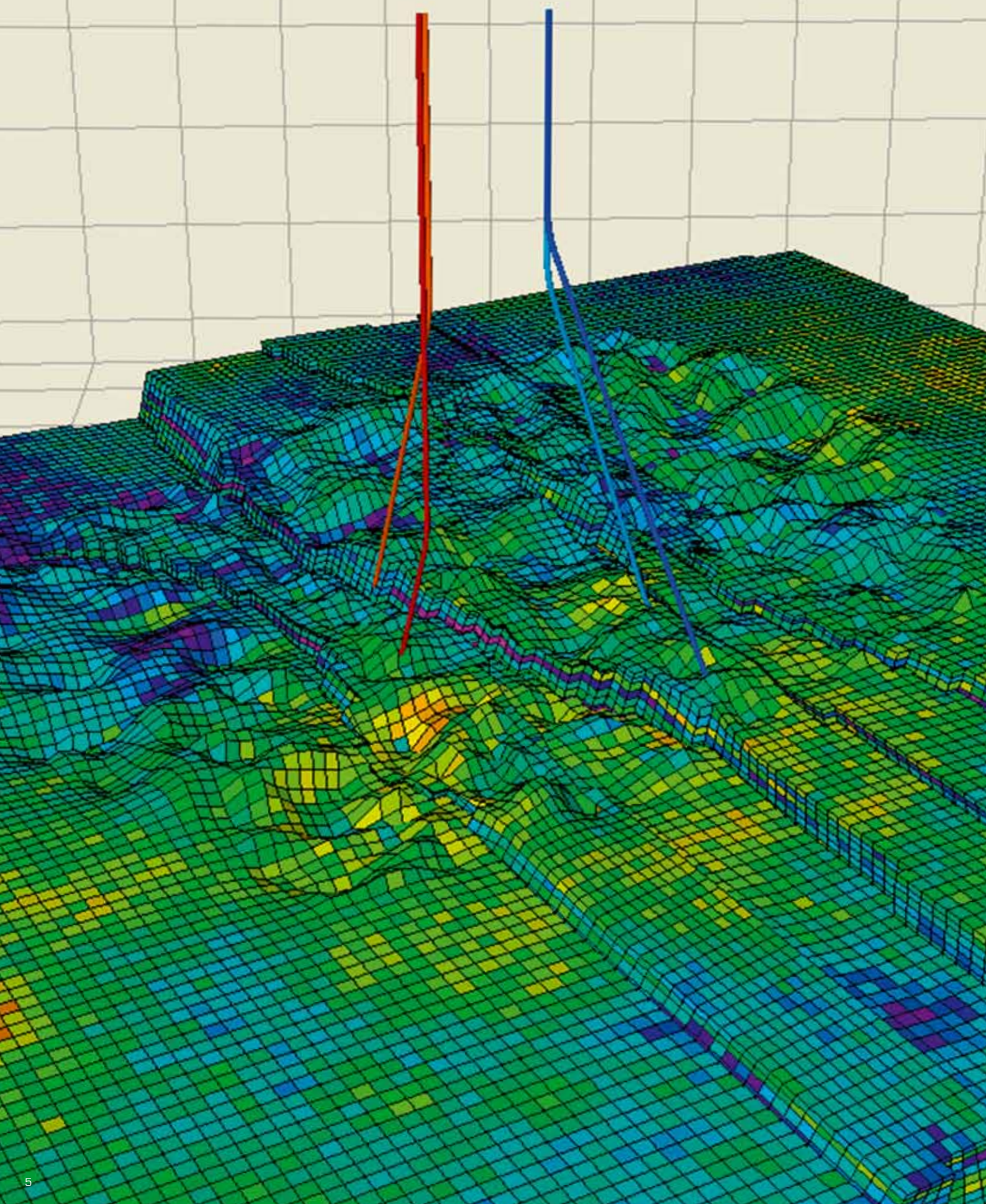
5302000

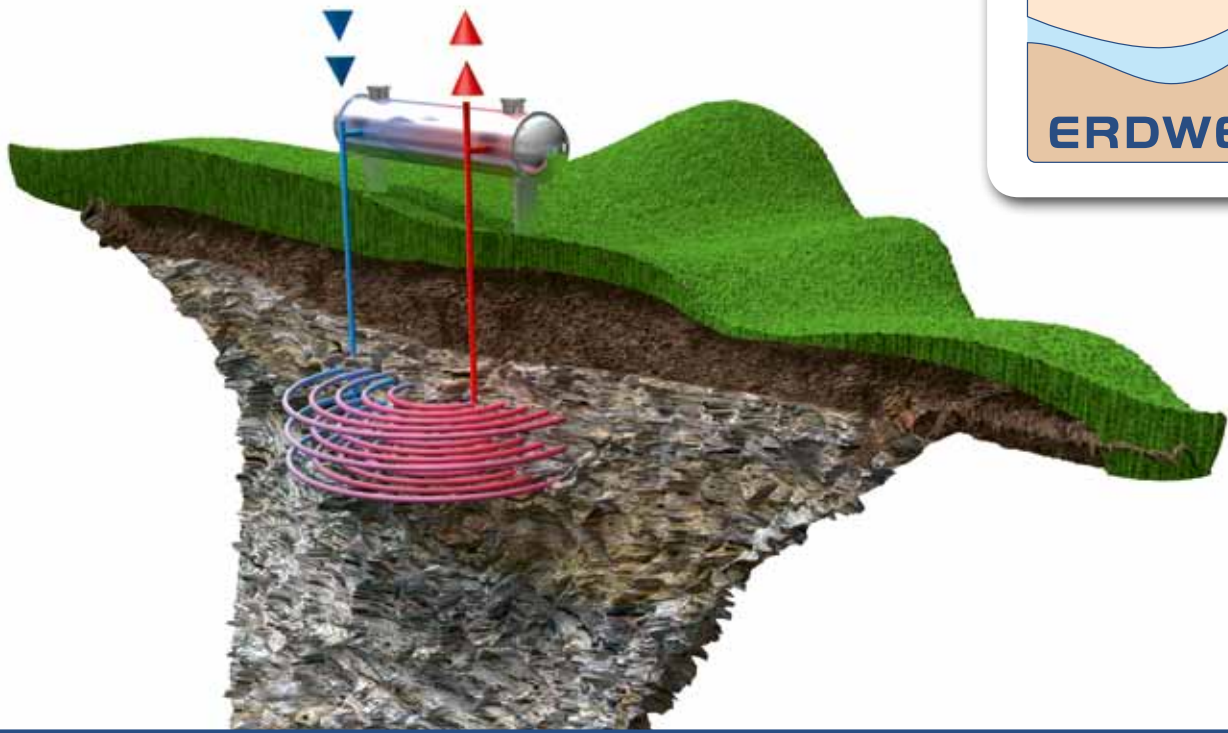
5304000

5306000

5308000

5310000





STRONG PARTNER FOR MUNICIPALITIES: HEIZWERK MANAGEMENT GMBH

Heizwerk Management GmbH was founded in 2015 by ERDWERK in order to develop and advance concepts for geothermal projects. As a 100% ERDWERK subsidiary, HEIZWERK goes one step further, building on 15 years of experience in planning and consulting for geothermal projects producing more than 200 MW.

Based on our extensive municipal project experience, we see our relationship and cooperation with municipalities and local partners as a great strength. HEIZWERK does not only offer turnkey subsurface geothermal solutions but also clears the way for financing. We plan, evaluate, finance and drill for you – all from one source.

With our commitment we do not only help to carry the risk of exploration but our name creates confidence with investors in the municipal geothermal heat supply market. Thanks to this confidence, we can advance and realize promising municipal geothermal projects with the help of investor funds – an important service for the young geothermal market where we are assisting in closing a crucial gap.

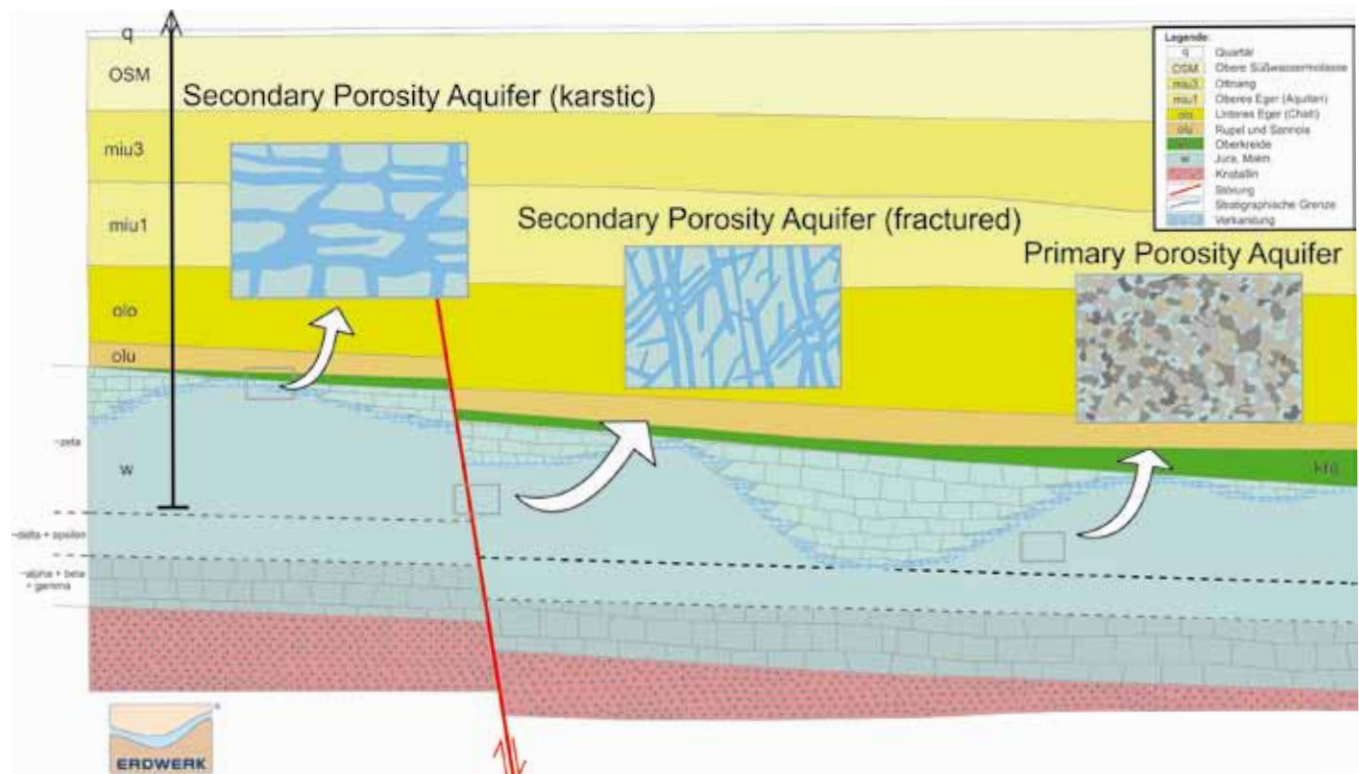
NEAR-SURFACE GEOTHERMAL ENERGY

The success of any near-surface geothermal project relies on the professional development and design of the heat source, which is usually based on the evaluation of the corresponding groundwater flow system, the soils and the rocks. Only those who attach importance to careful and thorough planning of the heat source system will achieve optimum efficiency, as well as sustainable and profitable operational reliability. In order to achieve complete success of your project, we have closely cooperated with leading manufacturers of heat pumps as well as companies experienced in the area of drilling wells for a long time.

For the realization of your project, we offer the following services – please note that they may be customized and weighed differently depending on your project requirements:

- General preliminary investigation - basic evaluation
- Geological, hydrogeological and geotechnical survey
- Preliminary clarification of regulatory approvals
- Efficiency analysis
- Cost estimation
- Detailed investigation, detailed planning, call for tenders
- Supervision and evaluation test drilling / pump test or reference ground loop
- Hydrogeological, thermal and numerical modeling
- Proposals for details of completion (well or ground loop field geometry, heat source design) and plant design
- Preparation of the tender documents
- Technical supervision of bidder meetings
- Project implementation - construction phase
- Construction supervision, construction monitoring
- Cost control
- Approval procedures
- Water law procedures





HYDROGEOLOGY AND BALNEOLOGY

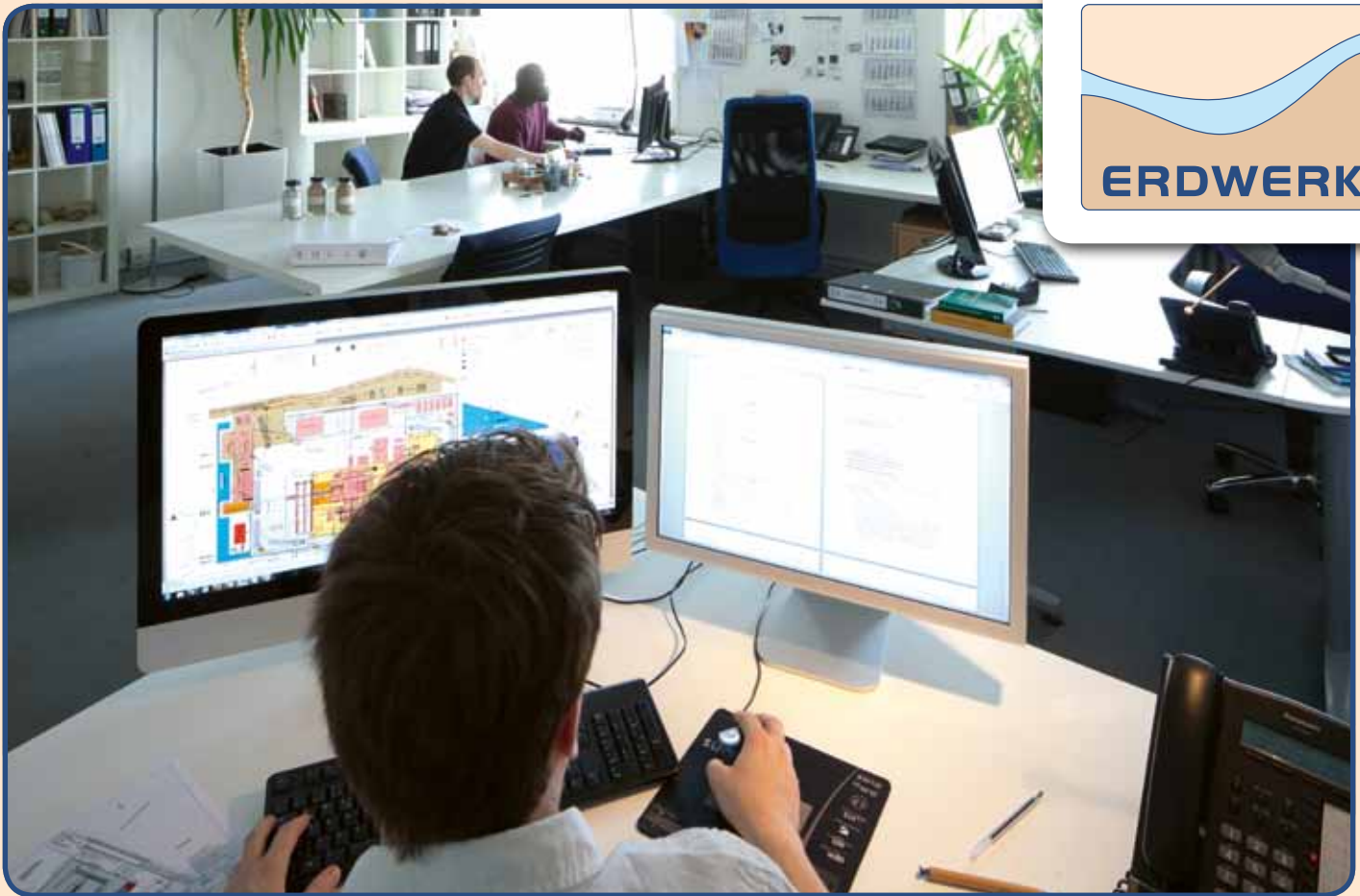
Geothermal energy systems exploit the groundwater for heating purposes –hydrogeology deals with the exploitation, utilization and protection of groundwater. Specific areas are, among others, the exploration of potential groundwater reservoirs, qualitative as well as quantitative protection and groundwater management including the zoning and monitoring of drinking water conservation areas.

Balneology utilizes water as a natural remedy in health resorts. This includes healing water, brines, thermal water and remedial gases. Our range of services includes balneology technology and balneochemistry (analytics) as well as the study of geological conditions as part of hydrogeology.



In order to realize your project, we offer the following services – please note that they may be customized and weighed differently depending on your project requirements:

- Basic evaluation and preliminary investigation
- Location analysis: Data acquisition and hydrogeological investigation
- Planning and hydrogeological-technical supervision of the exploratory borehole
- Feasibility study on the development of drinking, mineral and process water and/or healing water, brine, thermal bath water
- Hydrogeological expertise and statements
- Development of a hydrogeological model; numerical modeling
- Groundwater monitoring, reference data measurements
- Analysis and evaluation of the well output during operation
- Detailed planning, call for tenders
- Technical planning of exploratory drilling and well design
- Cost estimation
- Call for tender
- Site management, construction monitoring
- Planning, supervision and evaluation of hydraulic tests (e.g. pump tests)
- Quality management and acceptance
- Approval procedure
- Dimensioning and zoning of drinking water conservation areas
- In case of deeper developments: Assistance of the client through the mining law approval procedures



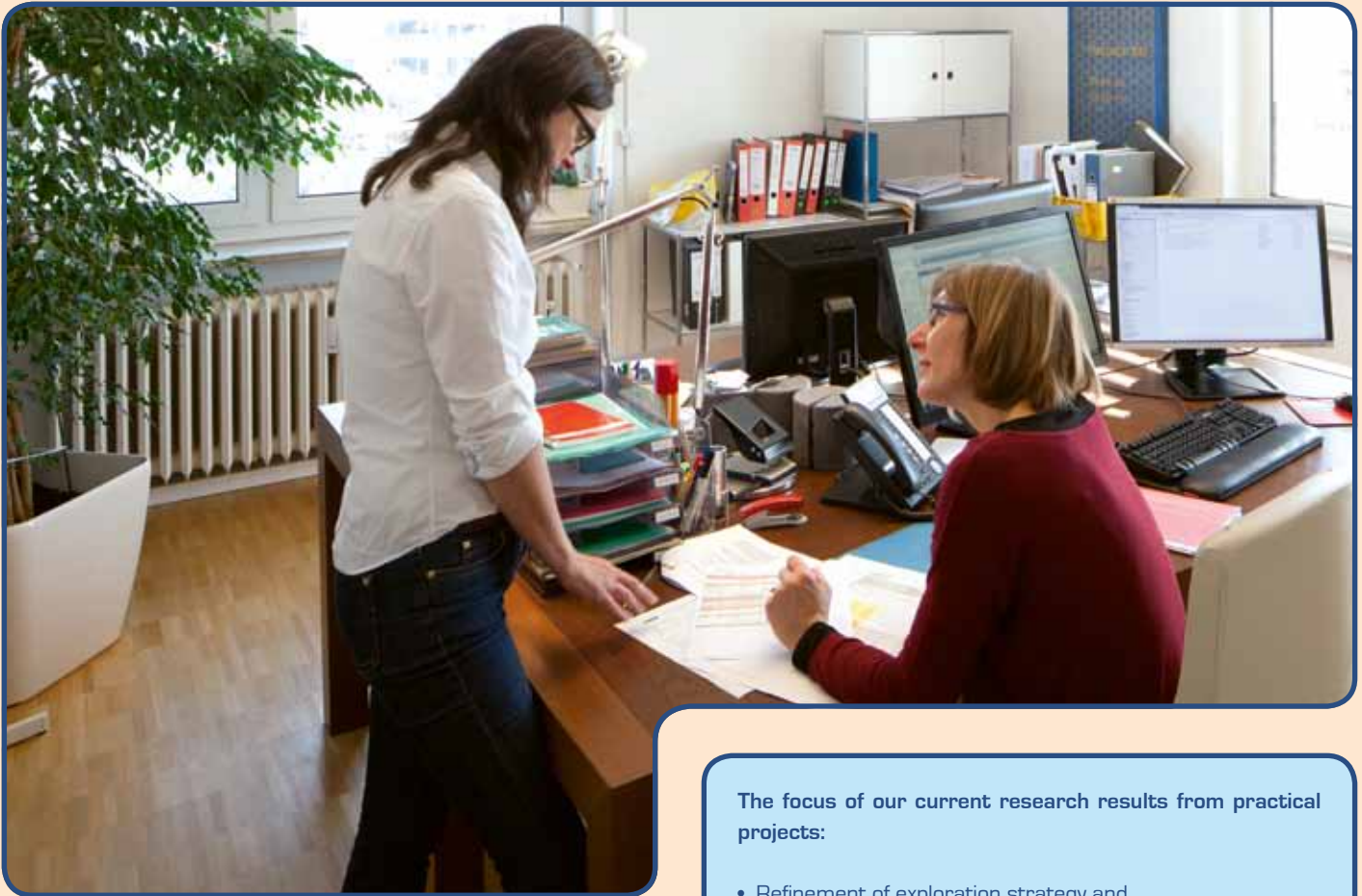
SCIENCE AND ENGINEERING RESEARCH IN COOPERATION WITH UNIVERSITIES AND OTHER R&D PARTNERS

Experience shows that there are no standard solutions for exploiting deep geothermal energy. Innovations and new technologies form the basis for strong company development and are also important for the further development of the industry.

ERDWERK, as a future-oriented company, depends on constant scientific and technical exchange. In cooperation with research and development (R&D) partners, we are able to consistently exceed the

expectations of customers and expand our potential. We actively participate in geothermal research and training together with universities, colleges and research institutes, who are important partners for our company strategy and our business development network. Our research projects are also funded by the federal government and the state of Bavaria. ERDWERK is also part of the Geothermie Allianz Bayern.





PERMANENT RESEARCH COOPERATIONS SINCE 2008

Since 2008 we have been regularly involved in research cooperations as an affiliated partner or via subcontracts. We are also involved in the supervision of master and bachelor theses or lectureships in education and teachings.

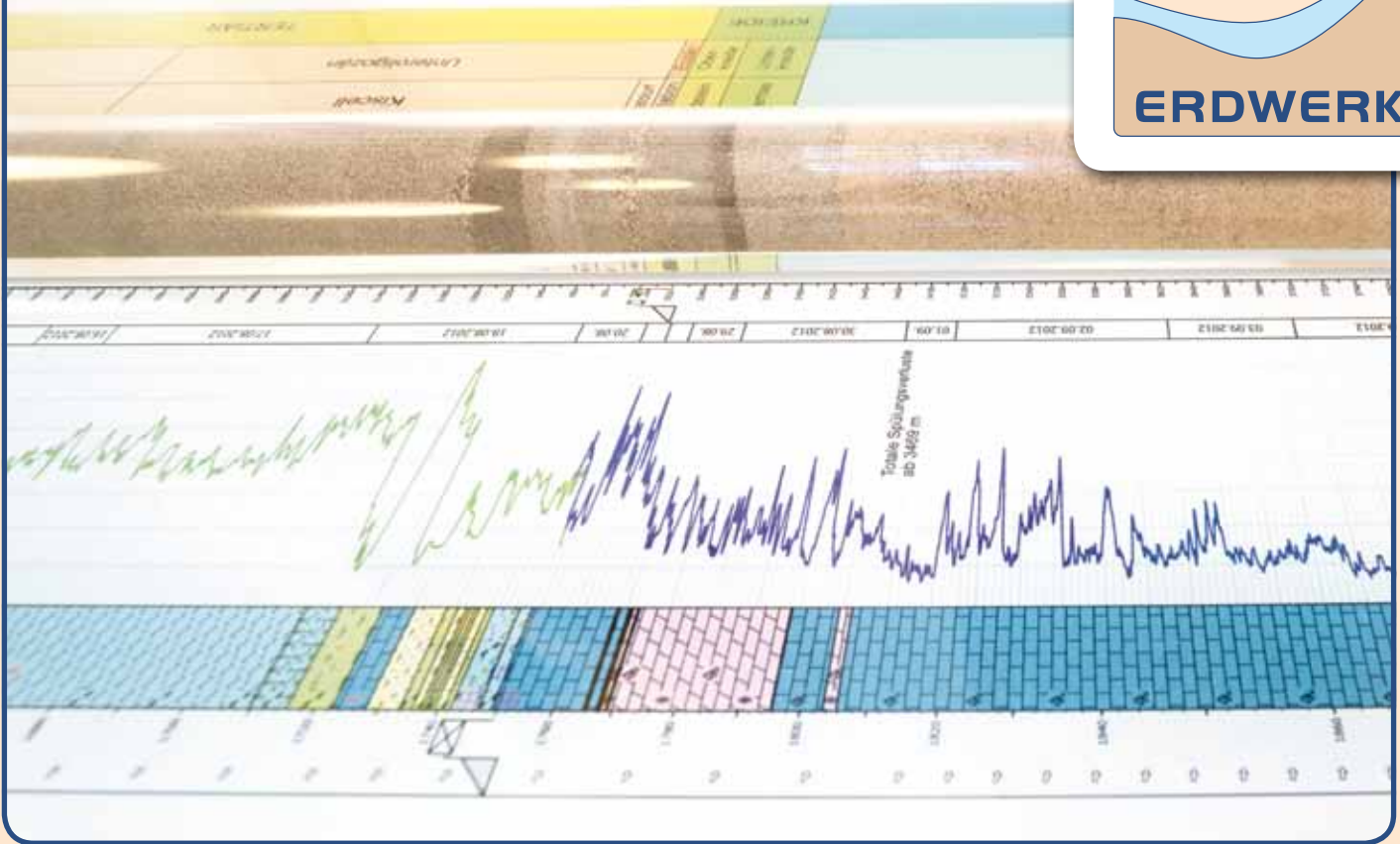


The focus of our current research results from practical projects:

- Refinement of exploration strategy and reservoir characterization
- Development of uncertainty evaluations and management tools for decision-makers in the geothermal energy sector
- Development and standardization methods for the reservoir evaluation of deep groundwater aquifers
- Providing optimization options during operation
- Early warning mechanisms and risk minimization during operation
- Expansion of the geothermal application using high-temperature heat storage
- Adaptation of the geophysical data analysis to the geological conditions and integration
- Large-scale reservoir management and sustainable exploitation
- Detailing of the technical parameter analyses to improve the basis for planning

Thanks to our continuous investment in research and development, ERDWERK has establish itself as the geothermal market leader, especially in the following areas:

- Expanded exploration strategy by integrating sequence stratigraphic and lithofacies approaches, geomechanical reservoir modeling
- Development of the „seismic to production workflow“ using Petrel/Eclipse TM for geothermal energy with prognosis methods for investors and insurance companies
- Economic and ecological benchmarking of geothermal heat production plants in Greater Munich
- Best Historic Performance Drilling in the South Bavarian Molasse Basin



FURTHER THOUGHTS ON GEOTHERMAL ENERGY

In addition to consortium led R&D projects, we also initiate in house research projects. Our staff members are encouraged to expand their knowledge through training at renowned companies and institutes. This expanded knowledge further enhances the company development, meaning that customer requirements and expectations are met and exceeded. Also thanks to this commitment, ERDWERK has consistently grown its prominent position in the market and sets the standard. In the following, you will find three examples for projects that we consider to be trendsetting in the development of geothermal energy.

WASTE HEAT FROM CHP IN THE UNDERGROUND

A completely new aspect regarding the utilization of geothermal energy, namely the heat storage, was first highlighted by a project initiated by BMW and funded since 2013 by the Bavarian Ministry for the Economic Affairs. The question to be answered was whether the storage of waste heat in the underground from combined heat and power (CHP) would allow geothermal energy to play a greater role in the regional energy discussion. Together with several project partners, such as the TUM amongst others, we examined the characteristics of the late Jurassic and the above lying layers for a high-temperature storage. In 2014 an exploratory borehole was sunk and an extensive research program testing heat storage was carried out.

SUPPORT OF THE GRAME RESEARCH PROJECT

In 2012 the visionary research project GRAME was developed for the SWM and the city of Munich with our support. The research project was a response to the demand in the geothermal industry following the expansion of projects, especially power projects. In the years up to the project approval in 2015, the focus of the research funding changed toward heat projects, however the question of the „high scalability“ of classic doublets in the Munich region remained. A reliable data basis in the form of a 3D seismic model, evaluated in accordance with the current state of knowledge was required. The overall potential and the sustainability of the reservoir in the urban area of Munich, the optimization of the interface for the above ground and underground planning in terms of the supply point into the network and the space requirements of a drilling rig in a metropolis like Munich was to be studied. The applicability of decision-making tools for the complex interplay of many economical and technical factors was also examined.

STRESS FIELD ANALYSIS AND SEQUENCE STRATIGRAPHY

In 2017 the Geothermie Allianz Bayern will start at the TUM; a research and innovation initiative funded across disciplines by the Free State of Bavaria. Here ERDWERK is also involved with studies on drilling technology and reservoir characterization. The stress field analysis and the sequence stratigraphy of the deep Late Jurassic are the focus of the studies that are to be carried out in close cooperation with the geological institutes of the universities in Erlangen, Tübingen and Karlsruhe.





OUR PROJECTS

ERDWERK has built a reputation in Germany but also internationally in countries such as Denmark, Belgium, England, Switzerland, Tanzania and Turkey. We have successfully supported many projects, especially in Greater Munich. In particular, we have a strong reputation for undertaking geothermal energy projects at the municipal level. In addition to the public-sector, our customers also include energy companies as well as reputable companies and corporations.

The following are some of our recent clients:

References

- AFK Geothermie GmbH
- Axpo AG Neue Energien
- Bayerische Landesbank
- BE Geothermal GmbH
- BMW AG
- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) Research
- E.ON Bayern Wärme GmbH
- GDF Suez E&P Deutschland GmbH
- GEOVOL Unterföhring GmbH
- Municipality of Grasbrunn
- Municipality of Vaterstetten
- Gemeindewerke Holzkirchen GmbH
- Innovative Energy for Pullach GmbH
- MVV Energie AG
- RENERCO Renewable Energy Concepts AG
- RWE Innogy GmbH
- ÜwGeo and Stadtwerke Mainz
- SachsenFonds GmbH
- Stadtwerke Bad Wörishofen
- Stadtwerke München Services GmbH
- Süddeutsche Geothermie-Projekte GmbH & Co. KG

For complete and constantly updated project overviews, please go to www.ERDWERK.com/projekte/.

For downloadable information on our projects, please go to www.ERDWERK.com/download/projektpraesentationen/.





GEOHERMAL PROJECT FREIHAM

With the completion of the geothermal heating plant in Freiam, the Stadtwerke Munich have realized their third district heating project together with ERDWERK. The project is part of the vision of the city of Munich to be the first major city in Germany to supply its residents exclusively with renewable energy by 2040.

The project in Freiam consists of a so-called doublet system comprising two wells which results in a closed thermal water cycle: The thermal water is brought to the surface via a production well. From there the thermal energy of the thermal water will be transferred in a heat exchanger to the district heating water for further use. The cooled water will be returned via the injection well. Therefore, no water will be taken from the underground – only the heat of the thermal water is used for heating.

In order to fully exploit this, a special low-temperature network will be installed in Freiam for the housing development that meets the most recent energy standards. For the energy use the district heating water will be cooled down significantly whereby more heat energy is also extracted from the same amount of thermal water. This takes full advantage of the temperature difference.

ERDWERK supported the project from the geological preliminary planning through the approval procedure to the execution of the seismic campaign which included the interpretation of the collected data and the drill path concept design.

Further ERDWERK carried out the implementation planning of the drilling and acted as the site management for the drilling of the wells.

Project parameters:

- Two diverted geothermal wells from two locations
- Final diameter of the holes 8.1/2", with 7" perforated lining
- Production wells Unterföhring Th1: 3.132 m MD, 2.518 m TVD (drilled)
- Injection wells Unterföhring Th2 3.113 m MD, 2.557 m TVD (planned)
- Production temperatures approx. 90°C
- Production rate Th1 approx. 95 l/s

Services:

- Project management
- Geothermal preliminary planning
- Application mining law
- Project management 3D Seismics
- Interpretation of seismic data (2D and 3D)
- Approval procedures
- Implementation planning wells
- Site management
- Cost control





GEOHERMAL PROJECT UNTERFÖHRING

The goal of this project was to supply Unterföhring, a community north of Munich, with heat from renewable resources. A geothermal double doublet was installed for this purpose consisting of two production and two reinjection wells. ERDWERK provided support for the geothermal project, with activities including; permit application for the exploration of geothermal heat, site management of the drilling and mining law and water law procedures concerning the development of geothermal energy. During the heating season 2009/2010 the first phase of the project was able to supply approx. 1,200 households with thermal energy and the district heating network is growing constantly.

Due to the rapid expansion of the network, the geothermal project Unterföhring was expanded by two more geothermal wells. The drilling for the expansion wells Th3 (3,050 m MD) & Th4 (3,897 m MD) started in February 2014 and was completed in June 2014. Thanks to the new doublet, the heat output more than doubled to approx. 23 MW(th).

Project parameters:

- Four diverted geothermal wells from one location
- Final diameter of the wells 6 1/8", with 5" perforated lining
- Production wells Unterföhring Th2: 2,578 m MD, 2,124 m TVD; Th4: 3,897.0 m MD, 2,340.62 m TVD
- Injection wells Unterföhring Th1 3,042 m MD, 2,512 m TVD; Th3: 3,050.0 m MD
- Production temperatures 86°C (Th2) and approx. 93°C (Th4)
- Production rate/injection rate doublet 1: approx. 85 l/s; doublet 2: > 90 l/s
- Thermal output doublet 1: approx. 10 MW(th), doublet 2: a. 13 MW(Th)

Services:

- Project management
- Feasibility study
- Application mining law
- Project management seismology
- Interpretation of seismic data
- Drilling planning
- Casing design
- Call for tender (EU)
- Site management
- Cost control
- Processing of legal processes
- Expansion of the existing doublet





GEOHERMAL PROJECT PULLACH

The community of Pullach im Isartal south of Munich has been providing local customers with district heat from a geothermal doublet since the winter 2005. The increasing acceptance of district heat by private and public customers resulted in an increased demand for geothermal energy. Consequently, the community expanded its geothermal heat production in 2011 with the Pullach Th3 well.

The annual CO₂ savings are approx. 6.000 t, based on about 16,000 MWh. The Pullach district heating network is about 25 km in length and reaches about 1000 households. The most important consumers are a public swimming pool, several schools and preschools, a residential area (560 units), the administrative building, a fire station, a church center, the youth hostel and the city hall.

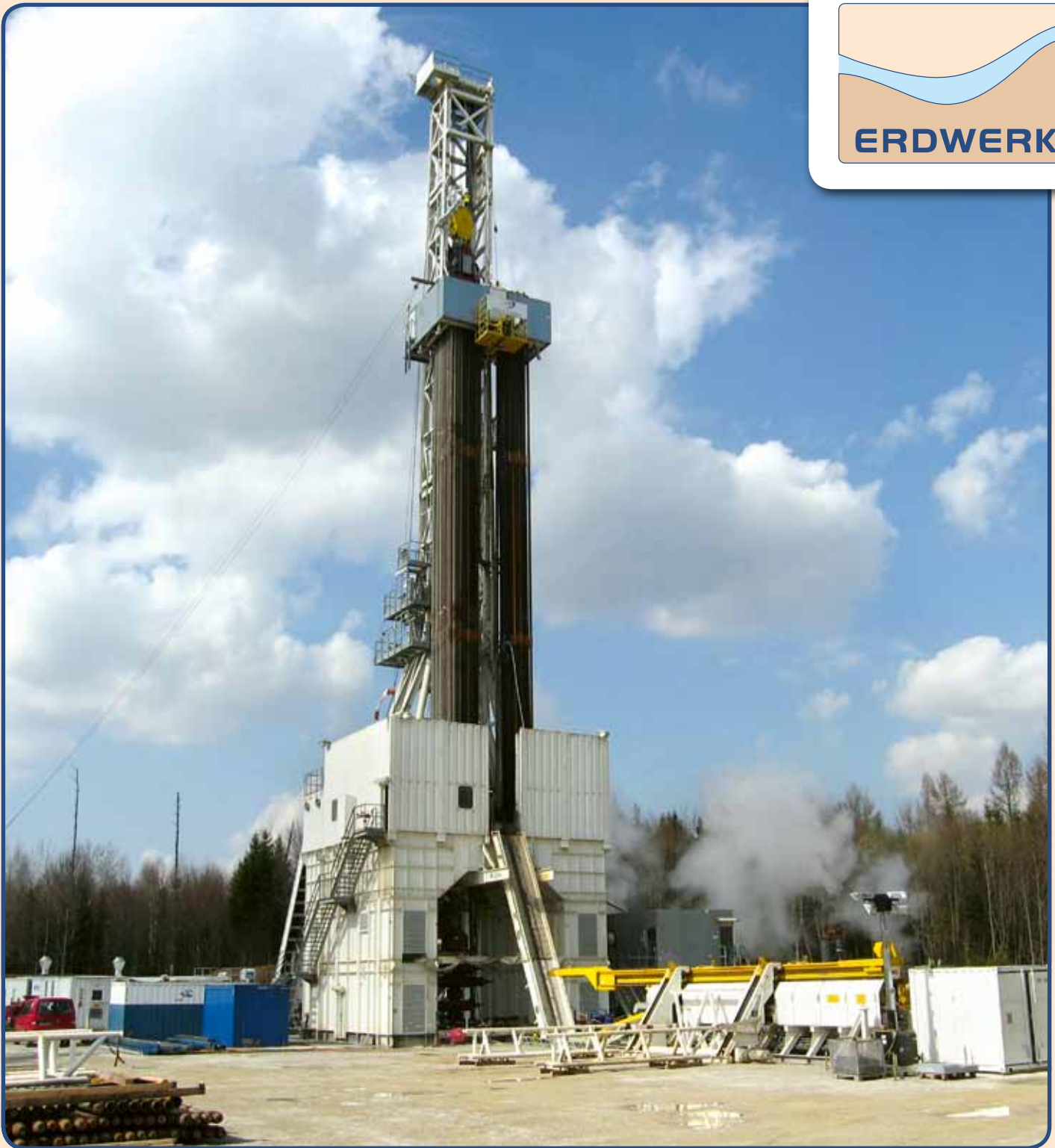
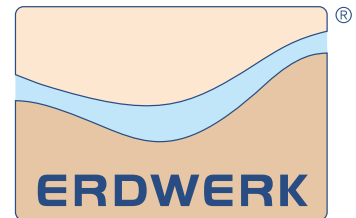
Project parameters:

- Pullach Th1: 3,550 m MD, 3,389 m TVD
- Pullach Th2: 4,120 m MD, 3,445 m TVD
- Pullach Th3: 3,984 m MD; 3,505 m TVD (expansion)
- Water temperature 102/ 107°C
- Maximum production rate 50 l/s (prior to expansion)
- Maximum energy: 10.4 MW(Th)
- Maximum extracted energy: 5.9 MW(Th)
- Maximum supplied output: 11.5 MW(th)
(peak consumption in winter ,09/'10)
- Cumulative extracted energy: 89,000 MWh
(Dec. ,05 to Jan. ,10)

Services:

- Geological-hydrogeological study
- Geothermal study
- Support reprocessing seismic
- Interpretation of seismic data
- Drilling planning
- Planning of IPS measures
- Casing design
- Call for tender (EU)
- Processing of legal processes
- Drilling supervision
- Geology and stratigraphy
- Cost control
- Development of geological models
- Development of reservoir model





ERDWERK GmbH
hydrogeology geothermal energy
Bonner Platz 1
D-80803 München

Phone: +49 (0)89 961 600 300
Fax: +49 (0)89 961 600 369
Mail: office@ERDWERK.com

www.ERDWERK.com

The ERDWERK GmbH is a member of
the following organizations:

- BWP - Bundesverband Wärmepumpe e. V.
- DGMK - Deutsche Wissenschaftliche Gesellschaft für Erdöl, Erdgas und Kohle e. V.
- Dt. Mittelstandsbund
- EGEK - European Geothermal Energy Council
- FH - DGG - Professional division hydrogeology in the Dt. Gesellschaft für Geowissenschaften
- GRC - Geothermal Resources Council
- GTV - Bundesverband Geothermie e. V.