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Feasibility Study for the Pilot Region Weinviertel (Vienna Basin)

TRANSGEO

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FEASIBILITY STUDY FOR THE PILOT REGION WEINVIERTEL (VIENNA BASIN)

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This report reflects the views of the authors.

The TRANSGEO project (https://www.interreg-central.eu/projects/transgeo/) is co-funded by the European Regional Development Fund through the Interreg Central Europe program. The overall objective of TRANSGEO is to investigate the potential to transform abandoned hydrocarbon wells into new sources of green geothermal energy. To reach this goal, the TRANSGEO team is providing new tools and knowledge to support communities and industries in the energy transition and to break down economic and technical barriers to well reuse.

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1. Introduction

This feasibility study investigates the potential to repurpose depleted hydrocarbon wells in the Weinviertel (Vienna Basin) as a Deep Borehole Heat Exchanger (DBHE) to produce low-temperature petrothermal energy. The study evaluates the geological conditions of the Vienna Basin, the engineering requirements of converting an existing wellbore into a closed-loop geothermal system, the availability of nearby heat demand, and the broader economic, environmental, and regulatory framework relevant to such an undertaking.

The report reflects the views of the authors and is prepared within the context of the TRANSGEO project, a cross-border initiative co-funded by the European Regional Development Fund through the Interreg Central Europe programme. TRANSGEO's overall objective is to investigate the potential to transform abandoned hydrocarbon wells into new sources of green geothermal energy. To achieve this goal, the TRANSGEO team is developing new tools, methodologies, and knowledge resources that support communities, municipalities, energy operators, and industries in advancing the energy transition. The project aims to identify and help overcome the technical, regulatory, and economic barriers that currently impede the reuse of existing wells for geothermal purposes.

The Weinviertel region of North-Eastern Austria and the broader Vienna Basin provide a favourable setting for such an assessment due to their extensive history of oil and gas production, resulting in many wells that have reached the end of economic hydrocarbon production but retain structural value for geothermal transformation. Repurposing these wells represents an opportunity to convert a decommissioning liability into a small-scale renewable heat asset with minimal environmental footprint and low operational requirements.

Given the moderate temperature regime of the basin (typically 25–120°C at the relevant depths), the focus is on direct-use petrothermal heat supply for local consumers located near the well. The viability of such systems depends heavily on the presence of suitable year-round heat demand within a short distance from the wellhead.

This report provides a structured evaluation of the technical feasibility, economic performance, regulatory considerations, and environmental implications associated with implementing a DBHE system in the Weinviertel (Vienna Basin). It offers a basis for decision-making by project developers, regional stakeholders, and policymakers interested in new pathways for sustainable energy production and innovative end-of-life solutions for the region's hydrocarbon infrastructure.

2. Vienna Basin

2.1. Overview

The Vienna Basin is a sedimentary basin between the Eastern Alps and the western Carpathians. Its southern and central part lies in Austria, the northern part of the basin in the Czech Republic and Slovakia. The long axis of the surface's elliptical outline is 200 km long and 60 km wide, covering an area in Austria of around 7,500 km². The federal states covered are Lower Austria, Vienna and Burgenland (Figure 1).

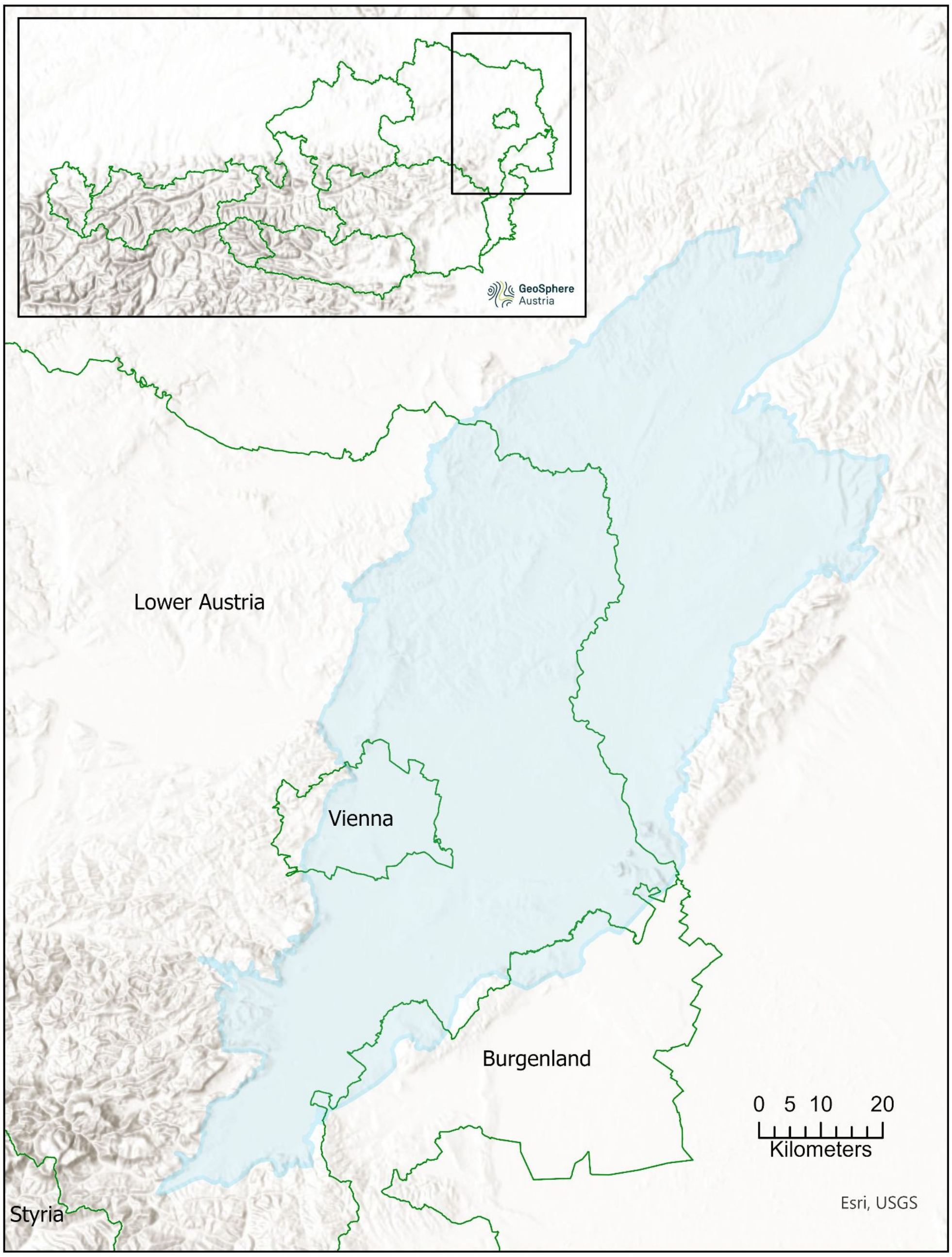

Figure 1: Position and surface outline (light blue) of the Vienna Basin.
Green lines mark the border to Czech Republic and Slovakia and show the federal states Vienna, Lower Austria and Burgenland.

2.2. Geology and history of hydrocarbon production in the Vienna Basin

Geologically, the basin started to evolve approximately 20 million years ago (Ma) and was accumulating up to 6,000 m of sedimentary rocks. They are remnants of river material and marine sediments from ancient seas, as well as lake and deltaic sediments. These rocks are cut by several major fault surfaces, creating compartments, so that the same rocks can occur at different depth levels across the basin. In the basement, carbonatic rocks are stacked into nappes and show complex structures, mostly with fractured porosity. For detailed stratigraphy and description of the basin evolution, see e.g. Sachsenhofer et al. 2024 and references cited herein. For a simplified succession of lithological units from the surface to depth, Table 1 gives an overview of the expected depth intervals, porosity, permeability, temperature and thermal conductivity.

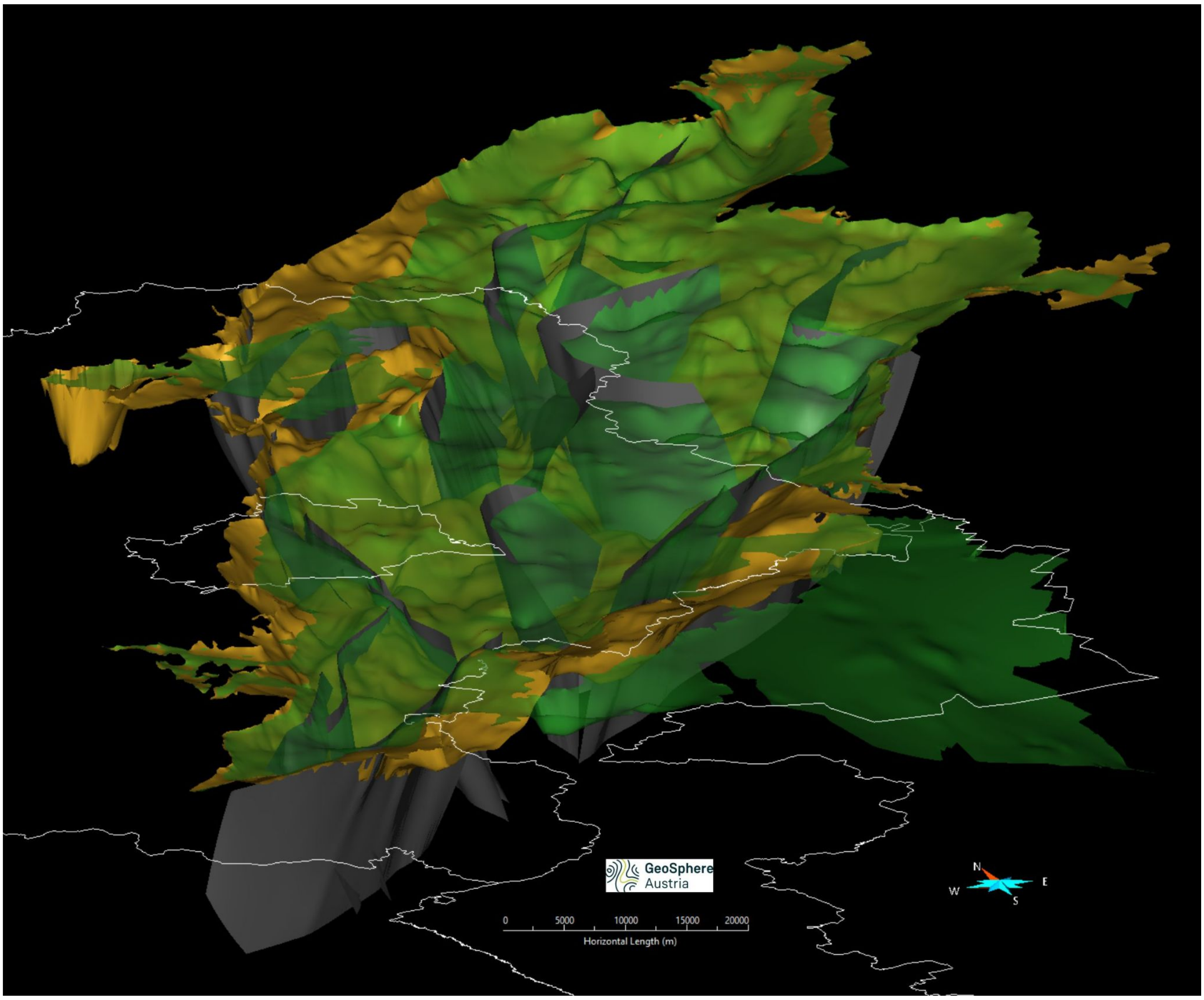

Figure 2: Structural model of the Vienna Basin with the basin floor (orange), main fault surfaces (grey) and one Pannonian layer at the top of the sedimentary basin fill (transparent green).
The white lines represent the state borders. Surfaces are compiled from project Transenergy, 2012.

Vienna Basin	Depth	Porosity	Permeability	Temperature	Thermal conductivity
Simplified Units	m	%	mD	°C	W/mK
Pannonian	0 - 730	14 - 22	9.3 - 246	—	2.93
Sarmatian	650 - 1500	21 - 29	3.9 - 3530	40 - 60	3.17
Badenian	1300 - 3020	18 - 28	0.1 - 3500	40 - 100	3.40 - 4
Karpatian	1650 - 3150	0 - 25	0.02 - 135	40 - 120	3.66
Basin floor carbonates	500 - 6000	0 - 3	0.04 - 800	40 - 150	3.8 - 4.6

Table 1: Average reservoir properties for the sedimentary fill and the carbonate units below. Parameters are important for geothermal applications of open and closed systems in the Vienna Basin. Data compiled from Bottig, 2025; Dürnegger, 2009; Götzl et al., 2012 and Kulich et al., 2023.

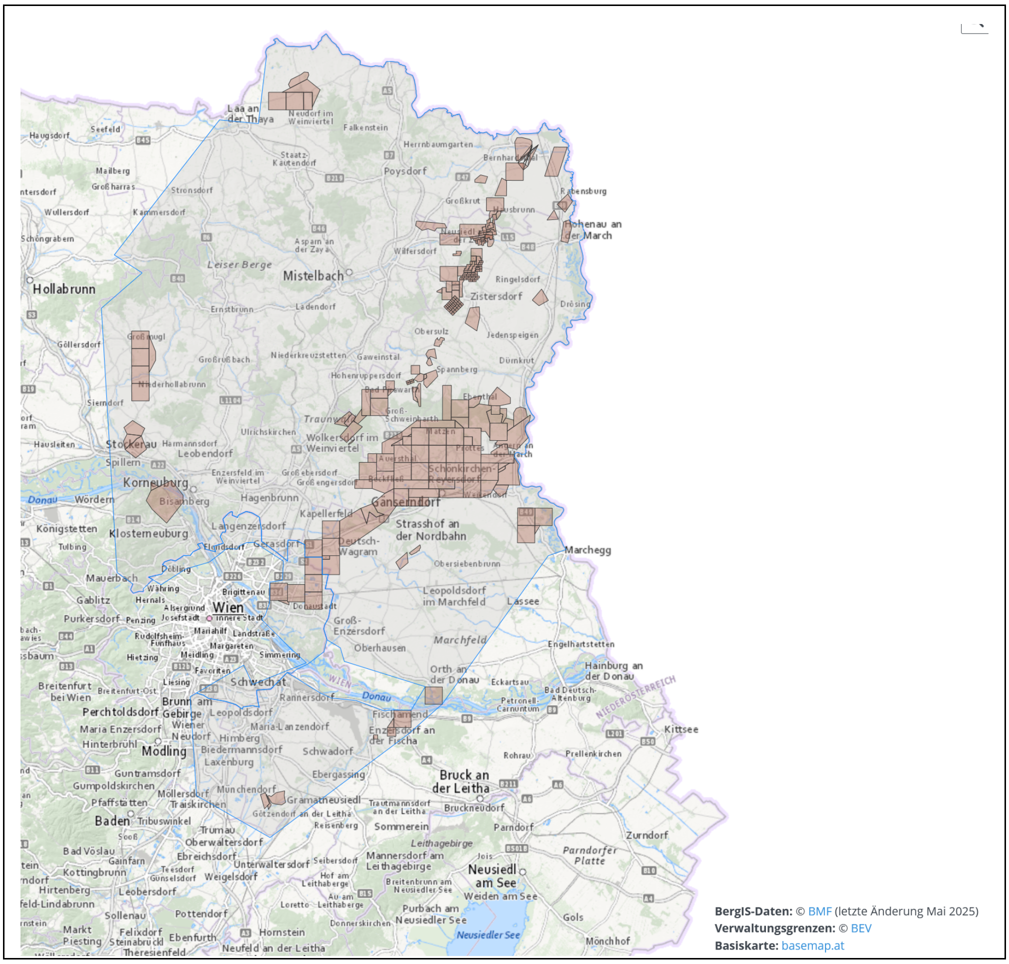

Figure 3: Production (red) and exploration (blue) licences for hydrocarbons (oil and gas; Federal Mineral Resources) in the Austrian part of the Vienna Basin. Map from BERGIS (Bundesministerium für Finanzen, 2025).

Oil and gas reservoirs are present in all tectonostratigraphic units and in a wide array of stratigraphic horizons and different depth ranges. The total depth of wells ranges from 500 to 8,000 m.

Oil production in the Vienna Basin began in the mid-19th century when the first near-surface deposits were discovered. Industrial oil drilling developed at the beginning of the 20th century and increased significantly during and after World War II. Austria was one of the most important European oil-producing countries during this period.

OMV, the major hydrocarbon producer in Austria, founded in 1956, played a key role in the further development of extraction technologies and the opening up of new fields. The most important production areas include, amongst others, the fields Aderklaa, Matzen, Prottes, Reyersdorf, Tallesbrunn and Zwerndorf. In total, in the Austrian part of the Vienna Basin, 3,500 wells with a greater depth than 300 m were drilled in the last 100 years. Currently, approximately 500 wells are active for gas and oil production or for underground gas storage (Bundesministerium für Finanzen, 2025). Most of these wells are operated by OMV Austria, a minor number of 24 by ADX VIE GmbH.

Even though there is no licensing system for geothermal applications established in Austria, there are recent projects and evaluations for different geothermal usage, for hydrothermal heat production or Aquifer Thermal Energy Storage in the Vienna Basin are currently being made (Sachsenhofer, 2024). One project of well reuse as a Deep Borehole Heat Exchanger was realised in 2010 with the project Prottes T11, where a gym was heated (Bräuer, 2012; Dürnegger, 2009).

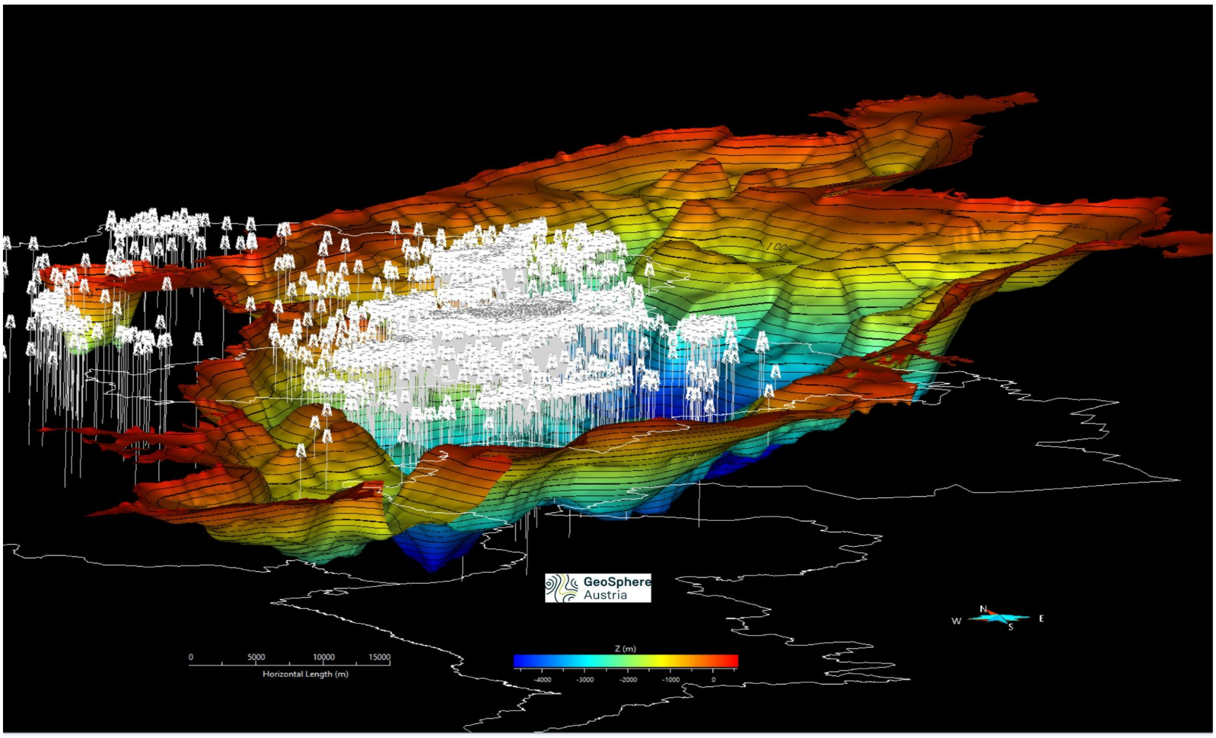

Figure 4: Structural model of the Vienna Basin with the basin floor and wells drilled for hydrocarbon exploration and production.
The white lines represent the state borders. Surfaces are compiled from project Transenergy, 2012.

2.3. Land Use in the Vienna Basin

To quantify the economic and land-use characteristics in the Vienna Basin, the CORINE Land Cover (CLC) dataset was extracted (EU Copernicus Land Monitoring Service, 2018). This dataset is also used as the basis for the Well Assessment Tool in the TRANSGEO database (TRANSGEO D.1.4.3). For industrial areas, the category CLC 121, for residential areas the categories CLC 111, 112 and 142 and for agriculture the categories CLC 211, 212, 221, 222, 242 and 243 were extracted and quantified for the Vienna Basin (Figure 5). As spatial selection, the algorithm: “all areas with centre within” was used. This selection is based on the TRANSGEO report D.1.2, where it was found that the primary “customer” groups for heat energy supply from reused abandoned wells are represented by industry, agriculture, and municipalities (the service and private sectors). These three sectors represent 60-70% of the energy demand in all of the TRANSGEO partner countries. With coverage of 3,000 km² (40.5 %) agricultural land use dominates the selection (Figure 6). Residential areas use 830 km² (11.1%; Figure 7) and industry (Figure 8) only 130 km² (1.8 %).

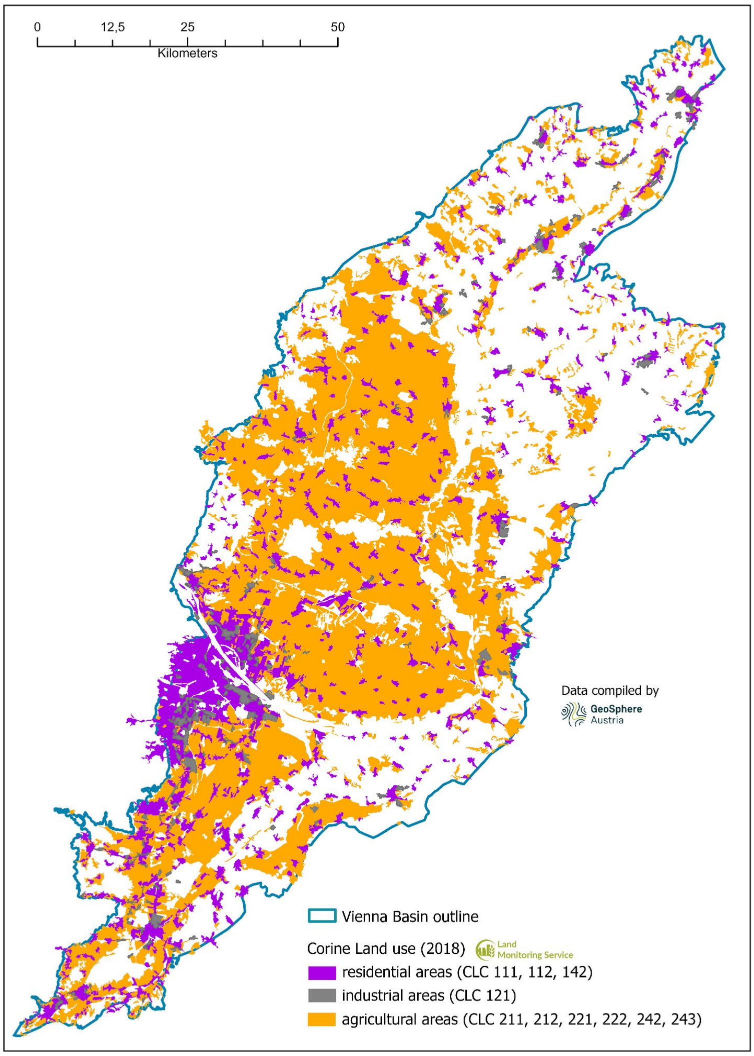

Figure 5: Extraction of land use data polygons covering residential, industrial and agricultural areas of the Vienna Basin.

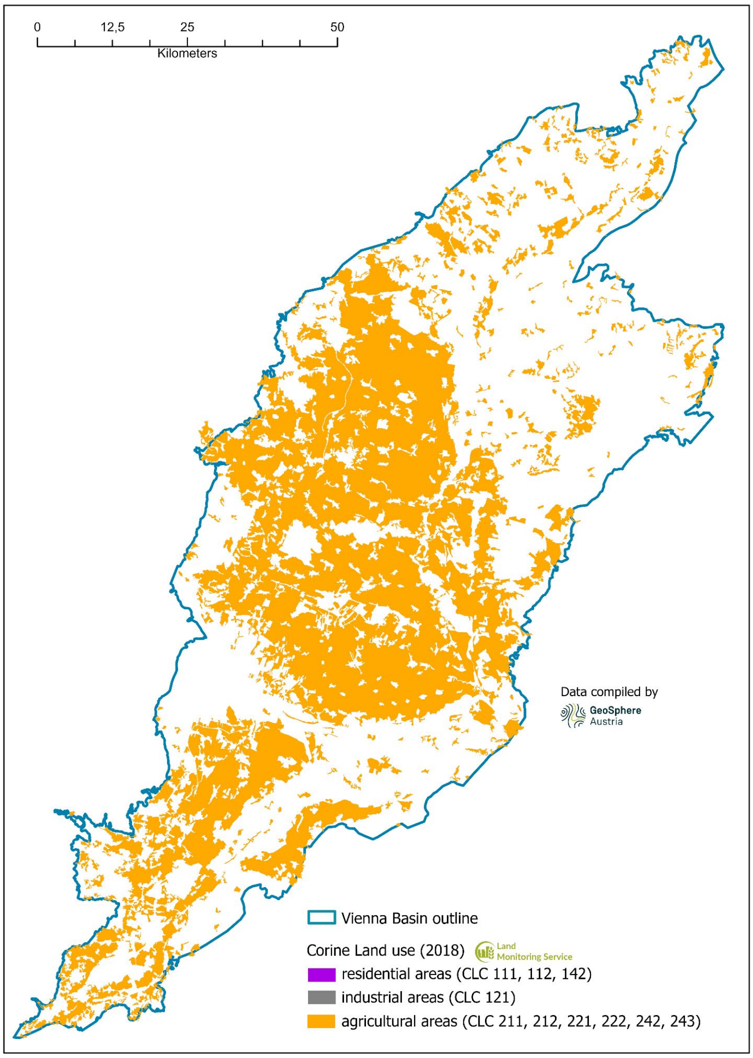

Figure 6: Land use – Agricultural areas in the Vienna Basin.

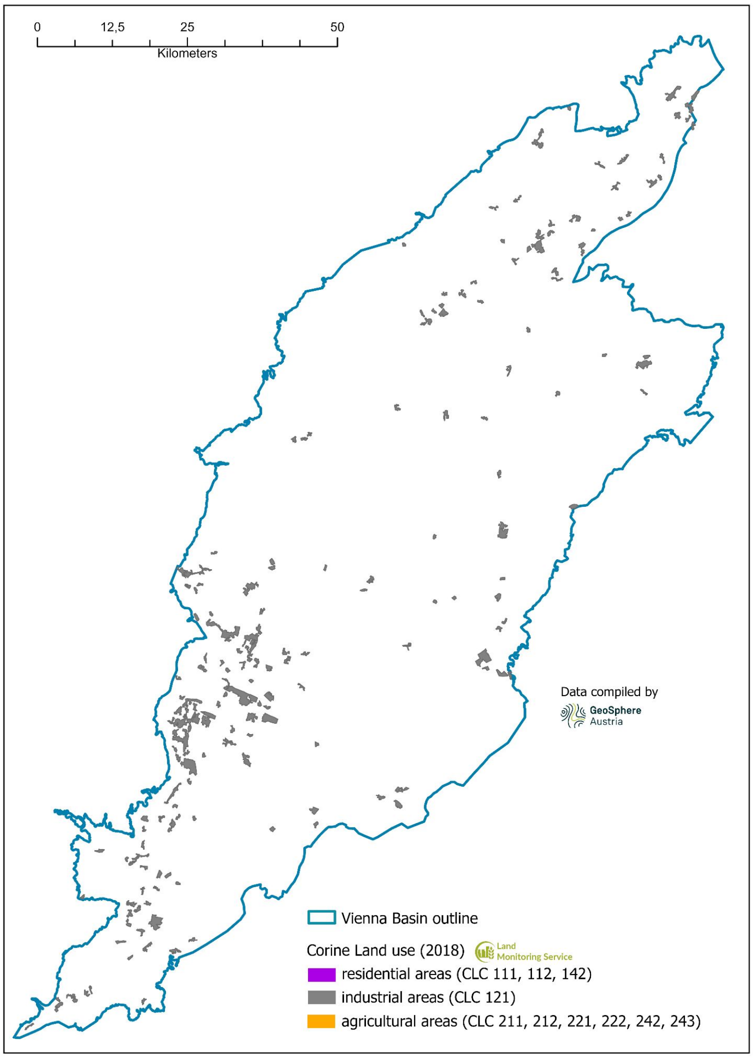

Figure 7: Land use – Industry in the Vienna Basin.

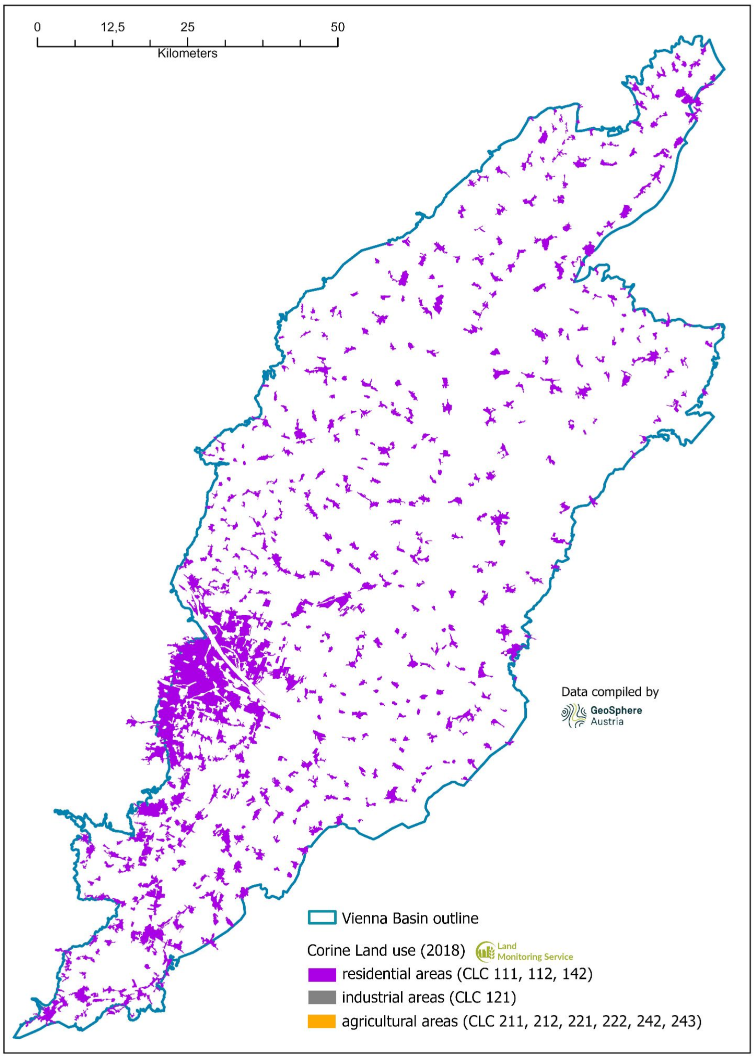

Figure 8: Land use – Residential areas in the Vienna Basin.

3. Overview of the Research Area

3.1. General Description

Mature Subsurface Data and Infrastructure

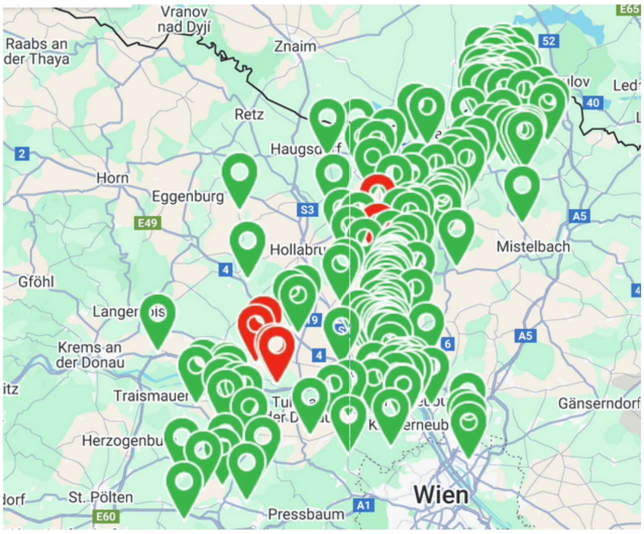

Figure 9: Oil and gas wells in the Vienna Basin/ Weinviertel (TRANSGEO Well Assessment Tool).

For over a century, the Vienna Basin has been one of Europe's most extensively explored sedimentary basins. Thousands of exploration and production wells have been drilled, and extensive datasets are available for seismic, stratigraphic, and petrophysical analysis. This wealth of subsurface information drastically reduces exploration risk – one of the largest cost components in geothermal development. Well logs, temperature profiles, production histories, and formation tests provide a detailed picture of reservoir conditions, enabling more accurate assessments of temperature gradients, permeability, and formation fluid properties.

Furthermore, many existing well sites, pads, access roads, and pipelines remain in place and can potentially be reused, thereby reducing development costs and easing permitting procedures. In some instances, electrical power supply and surface facilities are already available, which simplifies conversion projects.

Proven Geothermal Gradient and Suitable Reservoir Conditions

The Vienna Basin is characterised by a moderate to favourable geothermal gradient, with temperatures increasing by approximately 30–40°C per kilometre of depth. In deeper formations (2-3 km), reservoir temperatures of 80–120°C are common. These temperatures are sufficient for direct-use heating and, in some locations, for low-enthalpy power generation or hybrid systems.

Key reservoir formations such as the Badenian and Sarmatian sandstones and basin floor carbonates with fractured zones have demonstrated adequate permeability and porosity, proven during hydrocarbon production. Many of these formations are also water-bearing, which is essential for hydrothermal energy extraction.

Transition of the Oil and Gas Industry

The long history of hydrocarbon exploration has resulted in a large stock of several hundred depleted or marginal wells (as reported by their operators) that are reaching the end of their productive oil and gas life. Rather than being permanently abandoned, these wells could be re-engineered for geothermal use. This approach aligns with the growing focus on sustainable energy transition and circular use of industrial assets.

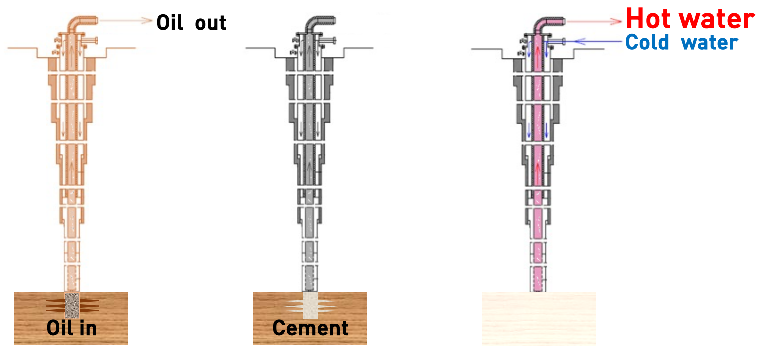

Figure 10: Converting an oil well into a geothermal well.
The hydrocarbon influx is isolated by cement to create a closed-loop, in which cold water is injected, heating up, and being produced.

Local operators like OMV have already recognised this opportunity. In collaboration with Wien Energie and academic partners, OMV has launched studies and pilot projects to assess deep geothermal potential for district heating in Vienna. These efforts show that both technical expertise and institutional interest are present in the region. Additionally, the technical feasibility of reusing depleted wells has been proven successfully.

Proximity to Heat Demand Centres

Unlike many remote geothermal sites, the Weinviertel is located close to major heat markets, notably Vienna and its surrounding municipalities, as well as regional centres like Mistelbach, Gänserndorf, and Zistersdorf.

This proximity is crucial, as heat transport infrastructure (heating pipelines) typically dominates project economics. A short distance between production wells and users enables efficient supply of geothermal energy to residential, commercial, or industrial heating networks and applications. In addition, the region already has well-developed energy and district heating infrastructure, enabling integration into existing systems.

However, in petrothermal systems repurposed from existing oil and gas wells, the available thermal output is modest, typically in the range of 35–75°C and 2–10 L/s. This corresponds to a thermal capacity often below 250 kW, which is not suitable for long-distance heat transport or integration into large district heating networks. Because heat losses increase rapidly with distance at such low temperature levels, the economic radius of viable heat use is generally limited to a few hundred metres around the well site.

For this reason, the most appropriate and realistic demand centres for petrothermal heat are small-to-medium consumers located immediately adjacent to the well, such as:

- Local agricultural facilities (greenhouses, crop drying, stable heating)
- Small industrial workshops or processing units (warehouses, food processing, material drying)
- Commercial buildings (logistics depots, office buildings, workshops)
- Municipal service buildings located near rural well sites (fire stations, public works depots)
- On-site use for the operating company (heating of surface facilities, control stations, equipment storage)

Because the repurposed wells are typically located in rural or semi-rural areas with scattered settlement patterns, the feasibility depends heavily on whether a suitable heat consumer already exists near the wellbore. Constructing new heat-use infrastructure solely to match the geothermal supply would rarely be economic for such small outputs.

Where no direct consumer exists close to the well, alternative approaches may be considered, such as:

- Developing a small, purpose-built heat application (micro-greenhouse, drying installation) directly on the well site.
- Using shallow buffer storage (e.g., insulated water tanks) for temporal load smoothing, though still limited by transmission distance.

- Integrating the heat into on-site processes (e.g., for maintenance buildings, sensor housings, or low-grade industrial utilities).

The technical and economic viability of petrothermal geothermal reuse is highly site-specific and relies on the presence or development of localised, low-temperature heat demand in the immediate vicinity of the well. Unlike large hydrothermal systems, which can support district heating networks, petrothermal wells are best treated as micro-scale, point-source heat producers, supplying dedicated consumers located very close to the production site.

Supportive Regulatory and Political Environment

While Austria, the Czech Republic, and Slovakia have expressed strong political interest in expanding renewable energy and improving energy security, the regulatory environment for repurposing existing oil and gas wells into geothermal wells remains underdeveloped and, in some areas, problematic. This affects both the subsurface legal regime and surface land-use planning.

Subsurface Regulatory Barriers: Mining Law Constraints

Oil, gas, and geothermal operations fall under mining law, which was not originally designed to support the transfer of depleted hydrocarbon wells into geothermal applications. Several unresolved legal issues significantly complicate project development:

- Liability Transfer Uncertainty: When repurposing an existing well, it is unclear who carries long-term responsibility for the integrity of the wellbore.
    - Oil and gas companies remain legally obliged to conduct proper Plug & Abandonment (P&A).
    - If the well is transferred for geothermal use, liability for legacy issues (e.g., casing corrosion, leakage, abandoned reservoir sections) is not clearly regulated.
    - As a result, many operators are reluctant to transfer wells, and new geothermal operators cannot reliably assess the legal and financial risks.
- Gap in Legal Definition of Geothermal Use: Mining laws in the region define hydrocarbon extraction clearly but give limited or no specific definition of geothermal heat extraction from repurposed wells.
    - This creates ambiguity in permitting requirements, reporting obligations, and safety standards.
    - “Petrothermal” or enhanced low-temperature geothermal applications are not explicitly covered.
- Permitting Complexity: A repurposed well requires new documentation, reservoir appraisal, and potentially additional drilling activities (e.g., cleaning, re-completion).
    - Current permitting pathways are not streamlined for such projects.
    - Reusing wells often triggers the same level of regulatory scrutiny as drilling a new geothermal well, negating much of the intended benefit.

These subsurface issues represent the most significant regulatory barrier and must be resolved through updated legislation, guidelines, or a dedicated geothermal well repurposing framework.

Surface Regulatory Barriers: Land-Use and Spatial Planning

Most former oil and gas wells in the Vienna Basin, Weinviertel, and adjacent Czech/Slovak regions are located on green land, agricultural land, or forest parcels, which creates additional challenges:

- Restrictions on Non-Agricultural Use: Even very small geothermal surface installations (e.g., pump units, heat exchangers, small technical buildings) can be classified as non-agricultural infrastructure, triggering prohibitions or complex rezoning requirements.
- Incompatibility with Current Spatial Planning: Regional and municipal zoning plans rarely foresee energy installations (even small, low-impact geothermal facilities) in agricultural or forest zones.

    - Temporary or low-footprint installations are not treated differently from large-scale energy infrastructure.
    - Obtaining exceptions is possible but typically slow and uncertain.
- Environmental Protection Areas: Some well sites fall within water protection areas or landscape conservation zones, which further restrict development.

These surface planning constraints can block otherwise technically and economically feasible geothermal reuse projects, regardless of subsurface conditions.

Lack of Integrated Regulatory Framework

At present, the legal frameworks governing:

- mining operations,
- environmental permitting,
- land-use planning, and
- energy generation

are not aligned in a way that supports small-scale petrothermal geothermal repurposing. No country in the Vienna Basin region has yet introduced a comprehensive regulatory pathway specifically tailored to geothermal conversion of depleted wells.

Policy Outlook - Unresolved but Recognised Issues

Despite the current barriers, the topic is increasingly recognised in energy transition strategies:

- Regional authorities express interest in geothermal development, particularly for heating.
- Repurposing depleted hydrocarbon wells is seen as a potential low-impact, low-emission opportunity.
- Several research initiatives (national and EU-funded) highlight the need for regulatory updates.

However, no concrete legislative reforms have yet been implemented, and project developers must still navigate a fragmented and often ambiguous regulatory landscape.

Potential for cross-border cooperation

Because the Vienna Basin extends into the Czech and Slovak territories, it provides a natural setting for transnational cooperation in geothermal research and development. The geological continuity across borders allows for joint data evaluation, shared research funding, and harmonisation of standards.

Cross-border collaboration could also enhance regional energy security and strengthen the EU’s broader energy diversification goals.

Alignment with sustainability and decommissioning goals

Converting existing hydrocarbon wells into geothermal producers or monitoring wells contributes to responsible decommissioning and CO_2 emission reduction. It reduces the environmental footprint associated with new drilling and avoids the costs and ecological risks of full abandonment.

In addition, the transition provides new employment opportunities for the existing oil and gas workforce — a socially and politically valuable benefit in a region with a long industrial tradition.

3.2. Transport Connectivity

The Weinviertel region and the Vienna Basin are among the best-connected areas in Central Europe. Their location at the crossroads of Austria, the Czech Republic, and Slovakia gives them direct access to major economic centres, well-developed transport corridors, and existing industrial infrastructure.

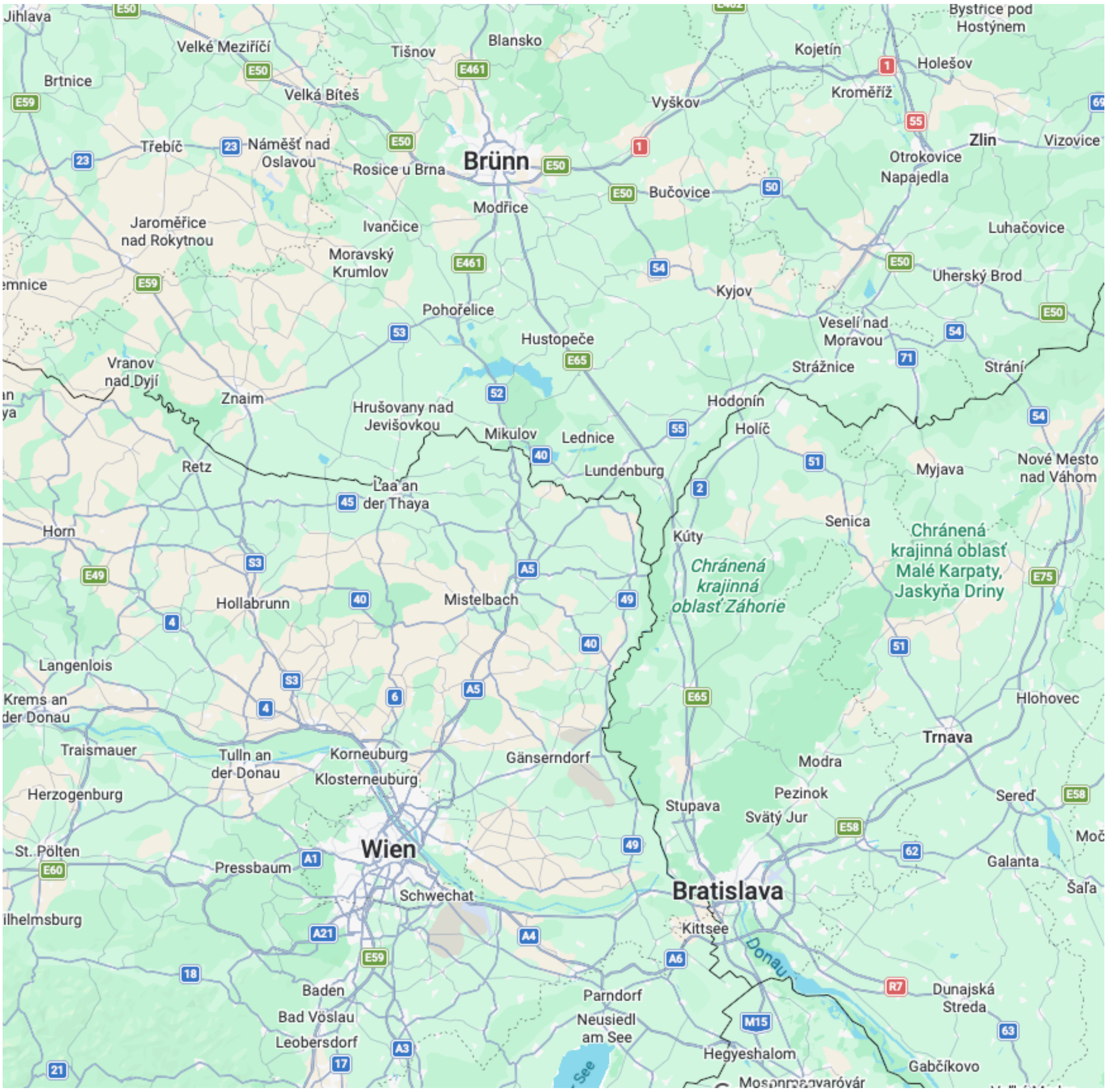

Figure 11: Map of the Weinviertel region and the Vienna Basin with main roads.

This connectivity is a key asset for geothermal development projects, allowing efficient movement of materials, personnel, and services between Austria and neighbouring countries.

Road Network

The region is traversed by an extensive and modern motorway and primary road system, providing excellent access for heavy transport, drilling rigs, and maintenance vehicles.

- The A5 Nordautobahn forms the main north-south axis through the Weinviertel, linking Vienna with Poysdorf and the Czech border near Mikulov. It connects seamlessly with the Czech D52/D2 motorway toward Brno. Distances:
    - Vienna – Mistelbach: ~45 km
    - Vienna – Zistersdorf: ~60 km
    - Vienna – Poysdorf: ~70 km
    - Vienna – Brno: ~130 km (approx. 1.5 hours by road)

- To the southeast, the A4 (Ostautobahn) and A6 (Nordostautobahn) provide rapid access to Bratislava, located only ~80 km from Vienna and ~90 km from Gänserndorf.
- The S1 and S2 expressways around Vienna connect these corridors and allow efficient transport from the Weinviertel to Vienna International Airport, industrial zones, and logistics centres.

Secondary Bundesstraßen (federal roads) and country roads offer dense regional coverage, ensuring site access even in rural wellfield areas. Most former oil and gas fields already have established service roads and load-bearing surfaces, which can be reused or upgraded for geothermal operations, minimising new construction.

Rail Network

The Vienna Basin lies along the historical north-south railway corridor connecting Vienna, Brno, and Prague, and the east-west corridor linking Vienna and Bratislava.

- The ÖBB North Railway (Nordbahn) passes directly through the Weinviertel (stations at Gänserndorf, Mistelbach, and Poysdorf) and continues into the Czech Republic via Břeclav to Brno.
- The Vienna-Bratislava railway line provides high-frequency passenger and freight service between the two capitals, continuing toward Trnava and Košice.
- Freight terminals in Vienna, Wolkersdorf, and Bratislava-Petržalka facilitate the transport of drilling equipment, tubulars, and heat-exchange modules.
- Some industrial sidings and branch lines in the Weinviertel (e.g., Zistersdorf) were originally built for oil field logistics and could potentially be reused for geothermal material handling.

Rail connectivity enhances sustainability by offering low-emission freight transport options, consistent with the environmental goals of renewable energy projects.

Air Transport

The region benefits from access to three international airports within a 150 km radius, all connected by motorway and rail links:

Airport	Distance from Mistelbach	Key Features
Vienna International Airport (VIE)	~60 km (~50 min by car)	Austria's main hub with global connections and extensive cargo facilities
Bratislava Airport (BTS)	~100 km (~1 h 15 min)	Secondary regional airport with cargo and charter capacity
Brno-Tuřany Airport (BRQ)	~120 km (~1 h 30 min)	Serves southern Moravia; potential logistics partner for Czech-side projects

Table 2: Airports in the Vienna Basin.

The availability of multiple airports enables flexible logistics and business travel, as well as air freight of high-value technical components or urgent spares.

Cross-Border Access and Regional Integration

The Vienna Basin straddles the borders of Austria, the Czech Republic, and Slovakia, forming one of Europe's most economically integrated tri-national regions.

Cross-border infrastructure includes:

- Motorway crossings:
  - Drasenhofen-Mikulov (A5/D52, Austria-Czech Republic)

  - Kittsee-Jarovce (A6/D4, Austria-Slovakia)
- Rail crossings:
  - Břeclav (Austria-Czech Republic, main freight corridor)
  - Marchegg (Austria-Slovakia)

All routes are part of the EU Trans-European Transport Network (TEN-T), ensuring high-capacity road and rail standards.

The proximity to Brno (a Czech innovation and manufacturing hub) and Bratislava (a financial and industrial centre) provides excellent opportunities for cross-border supply chains, research collaboration, and workforce exchange. These are key enablers for a sustainable geothermal industry.

Energy and Industrial Infrastructure

Beyond physical transport, the region is strongly integrated into Austria's and Central Europe's energy infrastructure:

- High-voltage transmission lines traverse the basin, allowing grid integration of geothermal power or operation of large-scale heat pumps.
- Several district heating networks (notably in Vienna, Wolkersdorf, Mistelbach, and Bratislava) provide potential offtake points for geothermal heat.
- Industrial clusters around Vienna, Bratislava-Petržalka, and Brno-South Moravia represent strong potential demand for process heat, an important market for medium-temperature geothermal projects.

Summary: Infrastructure Relevance for Geothermal Development

Factor	Description	Relevance for Geothermal Projects
Central European location	At the intersection of Austria, Czech Republic, and Slovakia	Facilitates multinational cooperation and investment
Motorway access (A5, A4, A6)	Direct connection to Vienna, Brno, and Bratislava	Simplifies transport of drilling and construction equipment
Rail connectivity	Integrated into north-south and east-west European corridors	Enables sustainable freight options
Airports (VIE, BTS, BRQ)	Three international airports within 90-120 minutes	Supports logistics, research, and business travel
Existing oil/gas infrastructure	Legacy well sites and service roads	Reduces development costs
Energy network integration	Grid and heating network coverage	Facilitates power and heat offtake

Table 3: Key infrastructure factors and their relevance for geothermal project development.

3.3. Development of Infrastructure

The Weinviertel and the Austrian sector of the Vienna Basin benefit from a well-developed and highly reliable technical infrastructure. Decades of oil and gas production, combined with intensive agricultural, municipal, and industrial activity, have resulted in a dense network of power lines, water systems, and wastewater treatment facilities. These assets create a favourable foundation for repurposing depleted hydrocarbon wells into geothermal production or injection wells.

This section summarises the current state of regional infrastructure and evaluates its implications, opportunities, and potential risks for geothermal conversion projects.

Electricity Infrastructure

The Weinviertel and Vienna Basin form part of Austria's northeastern electricity corridor, which connects Vienna with Lower Austria, Slovakia, and the Czech Republic. The transmission network operated by Austrian Power Grid (APG) includes multiple 110 kV and 220 kV high-voltage lines crossing the area, supported by substations at Mistelbach, Zistersdorf, Wolkersdorf, and Gänserndorf. These substations lie within short distances (typically 5 to 15 km) of many mature oil and gas fields, including Matzen, Auersthal, and Prottes.

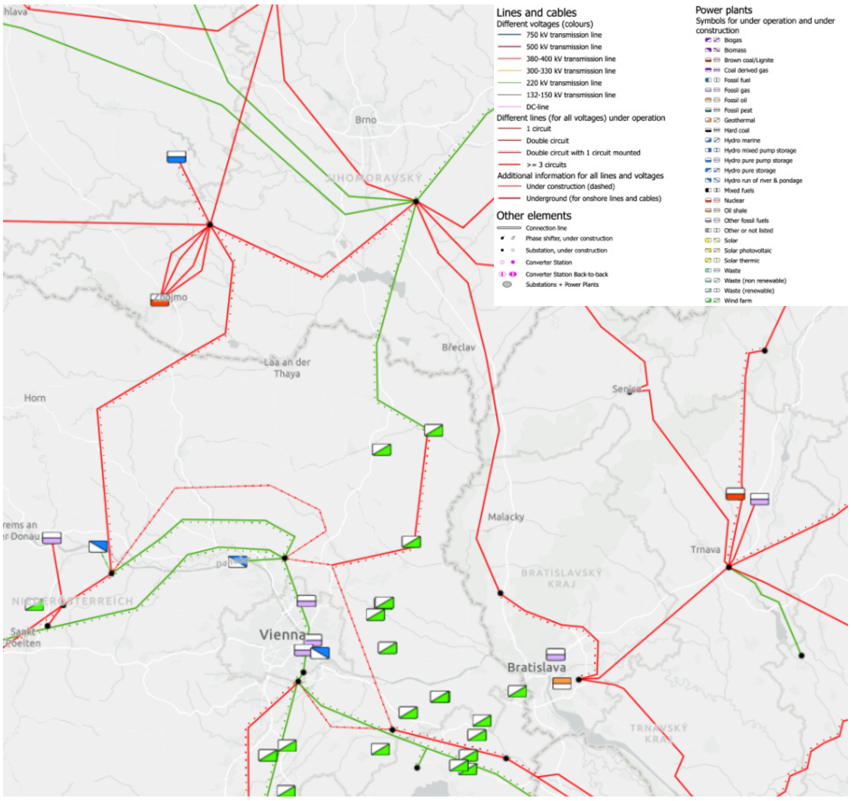

Figure 12: Vienna Basin ENTSO-E transmission system map.

Local distribution networks, managed mainly by EVN Netz GmbH, ensure reliable power delivery to municipal, industrial, and agricultural consumers. Power supply quality in the region is high, with minimal outages and sufficient reserve capacity to support continuous industrial operations.

From a development perspective, this mature network significantly reduces the need for new long-distance grid extensions. For geothermal applications, electricity can be fed into the grid near the production site, typically through 10–30 kV medium-voltage connections or directly to 110 kV substations for larger plants. In addition, stable electricity supply supports the continuous operation of geothermal pumping systems, heat exchangers, and control equipment.

Implications for Geothermal/Repurposed Wells

The strong existing electrical infrastructure provides a solid foundation for geothermal development:

- Many oil and gas fields already have power connections that can be reused or upgraded for geothermal operation, reducing capital costs.
- The proximity of substations and transmission corridors facilitates grid integration for small and medium-scale geothermal generation.
- The network supports the creation of hybrid energy systems, combining geothermal base-load output with nearby wind and solar resources (a common configuration in the Weinviertel).

In district heating applications, a stable electrical supply ensures the reliable operation of heat pumps and circulation systems, further enhancing the value of geothermal integration.

Considerations/Risks

While favourable, several points warrant attention:

- Grid capacity in certain areas may be constrained due to existing renewable inputs, especially from large wind farms north of Mistelbach. Early consultation with APG and EVN is essential to confirm connection feasibility.
- Voltage level and connection costs depend on project scale: medium-voltage access suits small plants, whereas large facilities require high-voltage interconnection with additional transformer equipment.
- Regulatory compliance with E-Control Austria's standards must be ensured, including environmental and land-use reviews for any new grid works.
- Reliability provisions, such as backup power systems, are recommended for critical installations.
- Cross-border coordination with Czech and Slovak grid operators may become relevant for transnational energy exchange or joint demonstration projects.

Water Supply Infrastructure

The region benefits from a robust and well-documented groundwater-based water supply system. The main aquifers lie within Neogene sediments of the Vienna Basin, yielding high-quality water with stable production rates. Municipal and regional water utilities (particularly EVN Wasser GmbH and local water cooperatives) operate extensive distribution networks linking towns such as Mistelbach, Zistersdorf, Wolkersdorf, and Poysdorf.

Interconnections between supply zones ensure redundancy and allow for flexible management of seasonal demand. Water infrastructure upgrades in recent decades have focused on leakage reduction, digital monitoring, and pressure stabilisation, ensuring consistent service even in rural communities.

Implications for Geothermal/Repurposed Wells

- Operational support: Drilling, hydraulic testing, and plant operation can utilise existing water networks, minimising the need for new abstraction permits.
- Data availability: Hydrogeological studies conducted for potable water management provide valuable baseline information on aquifer depth, permeability, and chemistry, supporting geothermal reservoir assessment.
- Integration potential: In some municipalities, co-located water and district heating systems could allow preheating or seasonal storage of domestic water using low-temperature geothermal energy.

Considerations / Risks

- Groundwater protection zones (Schutzzonen) around municipal wells require careful planning and authorisation for any subsurface activity.
- Well integrity in repurposed oil wells must be verified to prevent saline or mineralised fluid migration into freshwater aquifers.
- Limited freshwater availability during dry seasons may restrict water-intensive phases such as drilling or hydraulic stimulation.
- Monitoring obligations under Austrian water law demand continuous tracking of temperature and quality parameters for geothermal reinjection.

Wastewater and Fluid Disposal Infrastructure

Municipalities across the Weinviertel and Vienna Basin are served by modern, centralised wastewater collection and treatment systems. Most operate mechanical-biological treatment plants, managed through intermunicipal wastewater associations, discharging into the March (Morava) and Danube river systems in compliance with EU directives.

Industrial sites and former oil and gas facilities often maintain their own pre-treatment and sedimentation systems, which can be refurbished or repurposed for geothermal use.

Implications for Geothermal / Repurposed Wells

- Existing wastewater networks can handle non-hazardous process effluents from geothermal surface operations.
- Deep well reinjection remains the preferred disposal method for geothermal brine, leveraging geological formations already characterised through decades of hydrocarbon production.
- Opportunities exist to reuse or upgrade legacy wells as reinjection or monitoring wells, minimising drilling requirements.
- In some industrial areas, cascaded use of geothermal water (for example, supplying greenhouse heating or food processing before disposal) can enhance sustainability and profitability.

Considerations/Risks

- Thermal and chemical discharge limits are strict; direct surface disposal of geothermal water typically requires cooling and chemical treatment.
- Legacy well rehabilitation may be required to prevent leakage from aging cement or casing.
- Permitting is multi-tiered, involving the Wasserrechtsbehörde, Landesregierung, and Umweltbundesamt, which may extend timelines.
- Because the Vienna Basin is transboundary, cross-border environmental notification under the Espoo Convention may apply for large projects.

Summary and Strategic Outlook

The Weinviertel/Vienna Basin region offers one of Austria's strongest infrastructural environments for geothermal conversion of existing oil and gas wells. High-quality electricity, water, and wastewater networks provide a ready-made platform for low-risk project development, significantly reducing the need for new civil or utility works.

However, project developers must ensure:

- Early engagement with grid and water authorities,
- Comprehensive well integrity and hydrogeological assessments, and
- Alignment with environmental and cross-border regulations.

When managed effectively, these factors position the region as a prime candidate for pilot and commercial geothermal projects, leveraging its mature infrastructure to advance Austria's transition toward sustainable energy.

3.4. Spatial Planning

The Weinviertel, as part of the Vienna Basin, comprises four administrative districts and more than 100 municipalities. The districts of Gänserndorf and Mistelbach contain the highest concentration of oil and gas wells, accounting for the majority of the roughly 500 active, abandoned, or depleted wells in the region. Fifty-seven municipalities in the Weinviertel belong to the Association of Oil and Gas Communities (Gemeindeverband der NÖ Erdöl- & Erdgasgemeinden, VEG), reflecting the long-standing importance of hydrocarbon production in this area.

Figure 13: Municipalities of the Weinviertel region in the Vienna Basin.

For the potential reuse of depleted wells, local spatial planning documentation is a key parameter. Knowledge of the applicable zoning rules is essential for determining which structures may be built on-site and which uses are legally permitted. Spatial planning in Austria is regulated at the level of the federal states (Länder). This means that planning law in Lower Austria (which covers the Weinviertel and the Austrian part of the Vienna Basin) differs from planning law in other federal states, such as Upper Austria (Molasse Basin).

There is no uniform spatial planning map for the entire Weinviertel. Each municipality prepares and maintains its own zoning documentation, often in differing formats. In some cases, plans are only available in paper form at the municipal office; in others, limited digital versions exist. Because of these differences, a detailed assessment of geothermal reuse possibilities must be carried out individually for each well location.

Spatial planning in Lower Austria serves several functions, including observation, analysis, and visualisation of spatial and structural developments. This encompasses land use, settlement development, green spaces, raw material extraction, infrastructure, tourism, recreation, education, and demographic trends. Such assessments are prepared both for specific thematic areas and for broader regional scales, including the five main planning regions of the state.

The Weinviertel borders the Czech Republic, and the Vienna Basin extends seamlessly across this political boundary. On the Czech side, the same geological surfaces host numerous oil and gas wells, both active and abandoned, including in the municipality of Hrušky, where the pilot well Hrušky Z40 is located.

District of Gänserndorf

The district of Gänserndorf is one of the two most important oil and gas production areas of the Weinviertel. It is the easternmost district of Austria and shares a direct border with Slovakia. The district comprises 44 municipalities, many of which contain active or abandoned wells.

With an area of 1,271 km², Gänserndorf is the largest district in Lower Austria. Its landscape is predominantly flat and characterised by the Danube and March floodplains. The district capital, the town of Gänserndorf, has a rapidly growing population supported by its proximity to Vienna. The district as a whole has around 110,000 inhabitants.

Agriculture plays a major role in the region. Gänserndorf lies in the fertile Marchfeld, known for its arable farming. The area supports a mix of conventional and organic agriculture, with the share of organic farmland increasing over time.

A district-wide spatial planning document is not available. Zoning information can only be obtained individually from each municipality, for example from the town of Gänserndorf.

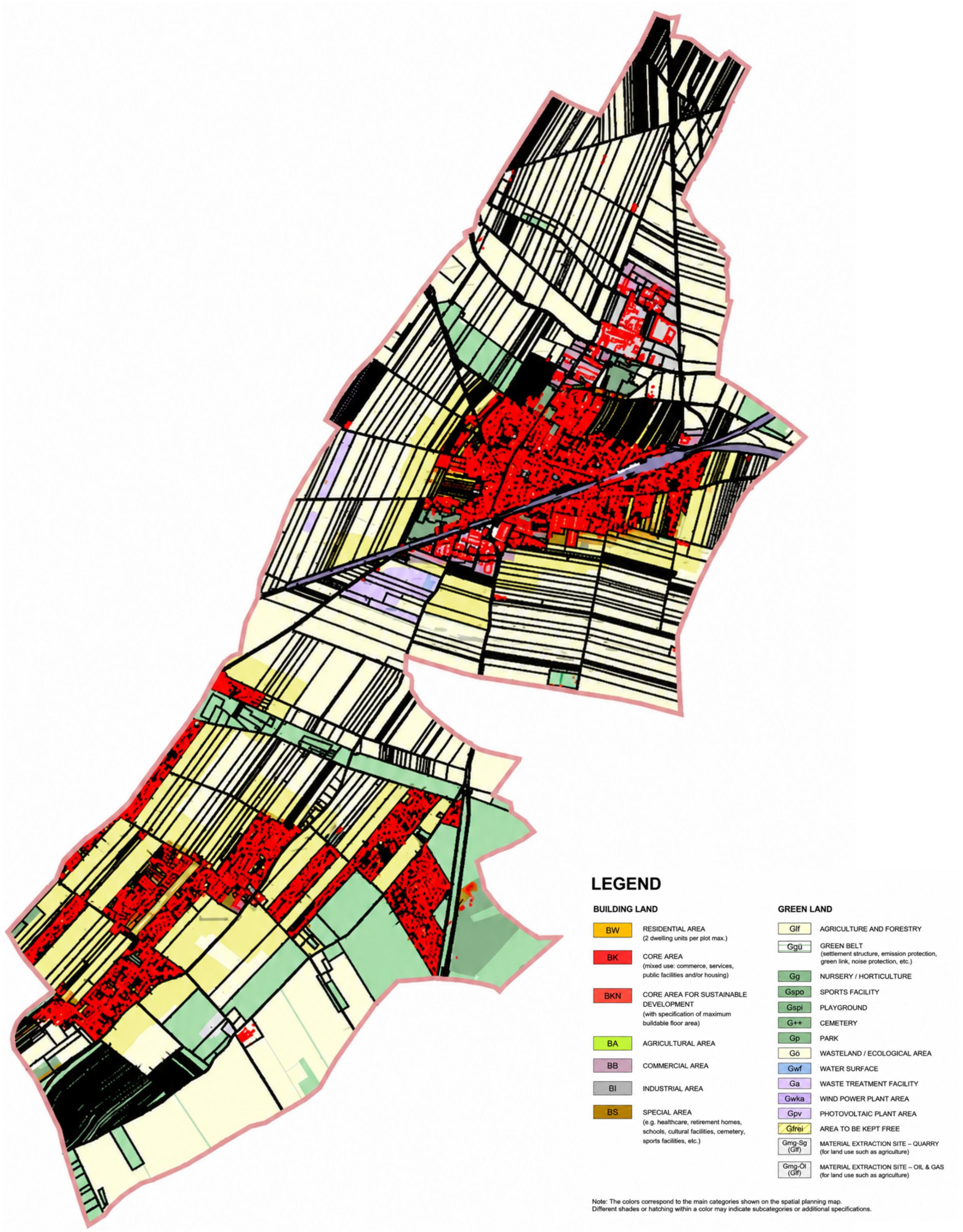

Figure 14: Spatial planning documentation of the municipality of Gänserndorf.
The zoning plan illustrates a predominantly rural, agricultural landscape characterised by numerous small, narrow field parcels arranged closely alongside one another.

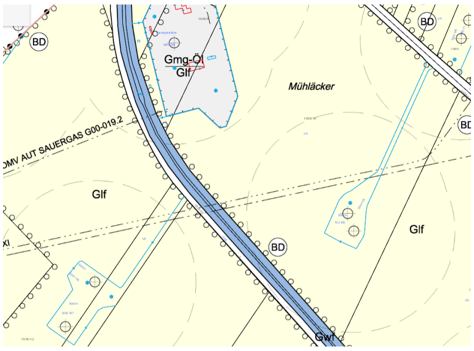

Figure 15: Details of oil and gas production sites (outlined in light blue) as shown in the spatial planning map.

District of Mistelbach

The district of Mistelbach is the second major oil and gas region in the Weinviertel. Located in the northernmost part of the Vienna Basin, it borders directly on the Czech Republic. Mistelbach consists of 36 municipalities.

The district covers 1,291.75 km², similar in size to Gänserndorf, but has a smaller population of approximately 77,000 inhabitants. Municipal spatial planning maps typically show a strongly rural and agricultural landscape, with extensive fields and limited settlement density.

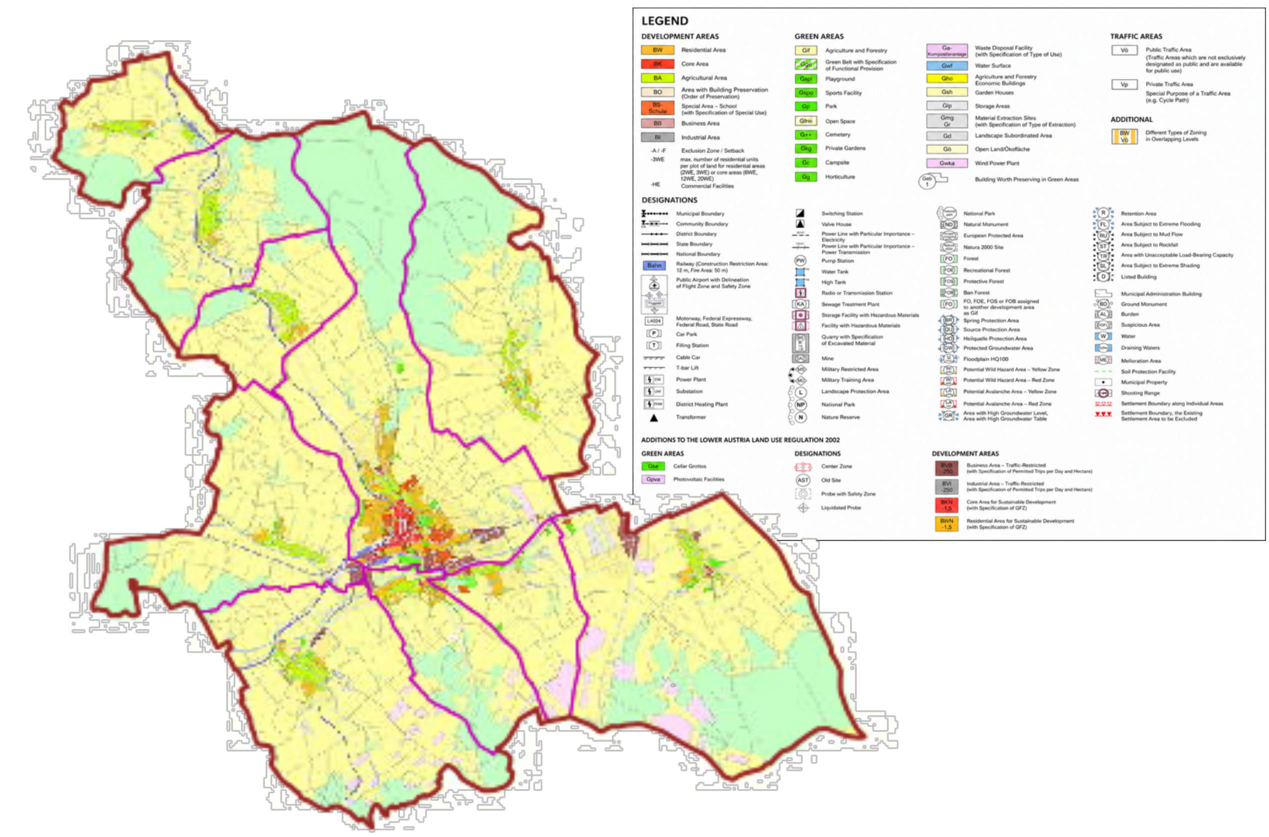

Figure 16: Spatial planning documentation of the municipality of Mistelbach, illustrating its rural and agricultural land-use structure.

Municipality of Hrušky

The municipality of Hrušky (German: Birnbaum) is located within the Czech portion of the Vienna Basin. It has around 760 inhabitants and lies approximately 100 km from Vienna. The area is characterised by narrow agricultural fields, small parcels, and vineyards. Oil and natural gas deposits extend both to the north and south of the village, and numerous active and inactive hydrocarbon wells remain in the area, including the pilot site Hrušky Z40.

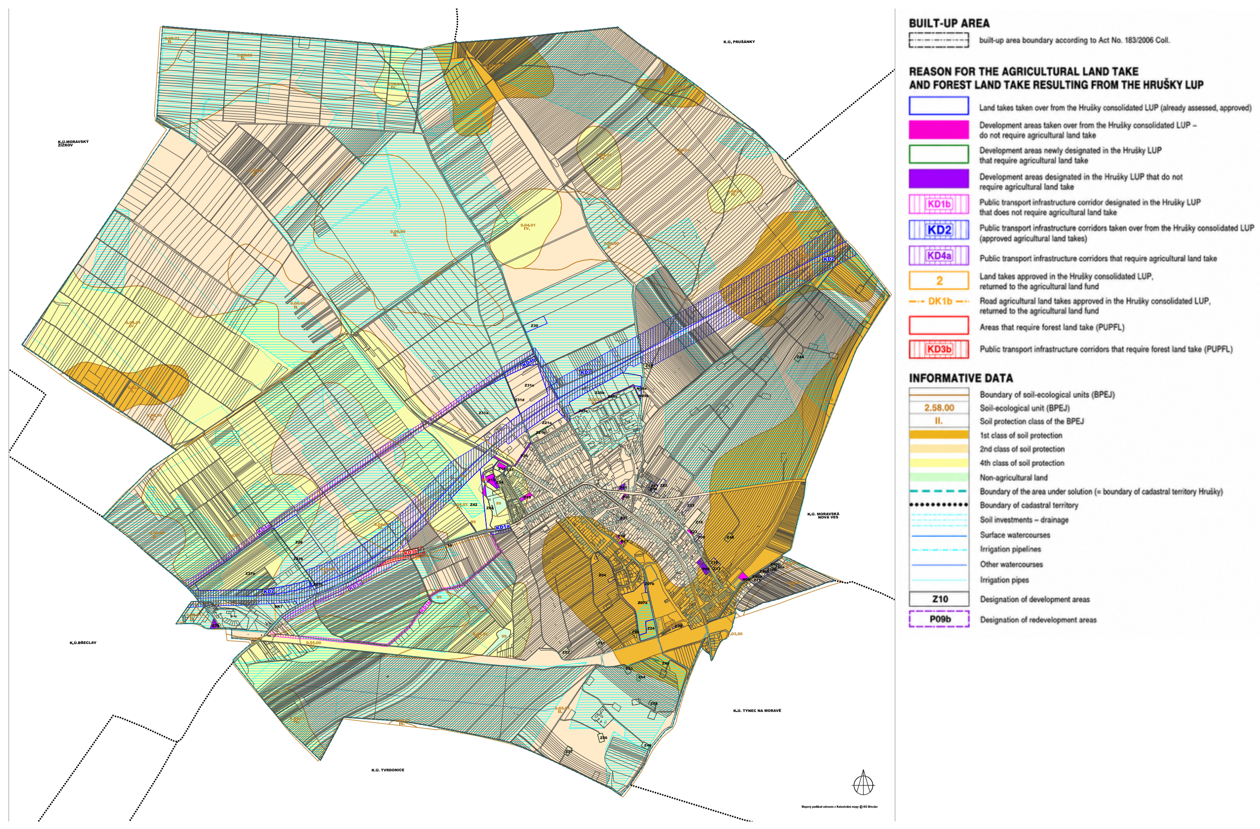

Figure 17: Spatial planning documentation of the municipality of Hrušky.

Summary

The spatial planning documentation of the examined districts and municipalities shows that the Weinviertel and adjacent Czech areas are predominantly rural and agricultural. Because spatial planning rules vary significantly between municipalities and are often available only locally, each well site requires an individual assessment of zoning constraints and land-use compatibility to determine whether geothermal repurposing is permissible or feasible.

4. Hrušky Pilot Site

4.1. Introduction

The municipality of Hrušky, located in the South Moravian Region of the Czech Republic, lies only about 15 kilometres northeast of the Reintal-Lanžhot border crossing and forms part of the northern Vienna Basin. This area shares the same tectonic and sedimentary evolution as the Austrian Weinviertel and western Slovakia. Since the early 20th century, both regions have been centres of oil and gas exploration and production, resulting in a dense network of wells and extensive subsurface datasets.

Figure 18: The municipality of Hrušky and the Hrušky Z-40 well location.

Many wells in the Hrušky field have reached the end of their productive life, making them potential candidates for geothermal and petrothermal repurposing. The pilot project at Hrušky Z40 demonstrated that converting a former oil well into a deep borehole heat exchanger is technically feasible and that the regional geological setting provides suitable temperatures for small-scale heat extraction.

The Austrian Weinviertel and the Czech part of the Vienna Basin share nearly identical geological, thermal, and structural characteristics as well as comparable regulatory and infrastructural environments. Therefore, Hrušky serves as a highly relevant analogue for geothermal well reuse projects on the Austrian side of the basin. Lessons from the Czech pilot, including subsurface conditions and DBHE performance expectations, can therefore be directly applied to prospective projects in the Weinviertel.

4.2. Geology

Hrušky is situated in the northern part of the Vienna Basin. The subsurface lithology consists of thick Miocene sediments, including Lower Miocene marine units, Middle Miocene Badenian carbonates, and Upper Miocene Sarmatian and Pannonian clastic sediments. These stratigraphic units extend uninterrupted across the Austrian–Czech border, creating a continuous geological framework shared with the Weinviertel. The structural style (normal faulting, tilted blocks, and local horst-graben geometries) is also consistent across both regions.

Hydrocarbon production in Hrušky has historically targeted Sarmatian and Pannonian sandstone reservoirs, which typically offer porosities of 15–25%. Productive horizons include several Badenian and Sarmatian sandstone layers, with significant reservoirs found between roughly 1,050 and 1,600 m depth. Beneath these, additional unit groups extend to depths of approximately 2,800 m. The reservoir rock mainly consists of fine-grained, moderately consolidated sandstones with thicknesses ranging from 7 to 30 metres. Structurally, the Hrušky deposits lie along the Lanžhot–Hrušky fault zone, forming an extended semi-vault geometry.

For geothermal purposes, detailed permeability is less critical because closed-loop petrothermal systems do not require natural formation flow. What matters instead is the stable geothermal gradient, which is approximately 25–32°C/km in the region. At the depths of existing wells, temperatures of 25-60°C can typically be achieved, which are suitable for low-temperature heat applications.

The Austrian Weinviertel exhibits the same stratigraphy, structural patterns, and thermal regime. Hydrocarbon reservoirs are similarly developed, and the geothermal gradient of ~25-30°C/km results in comparable temperature conditions for repurposing. Because both sides of the basin share this common geological setting, the results and operational experiences from the Hrušky pilot project offer a robust reference for geothermal well reuse in the Weinviertel.

4.3. Concession Area

The Hrušky hydrocarbon field is located within a long-established exploration and production concession area in the Czech sector of the Vienna Basin. Historically, Hrušky represented the largest hydrocarbon deposit in the region, with production beginning in the early 20th century and continuing for several decades. After most of its recoverable oil reserves were extracted, the field was repurposed and today serves primarily as a natural gas storage site, utilising existing reservoirs and well infrastructure. This transformation reflects the field's favourable geological characteristics and its continued strategic value for regional energy operations.

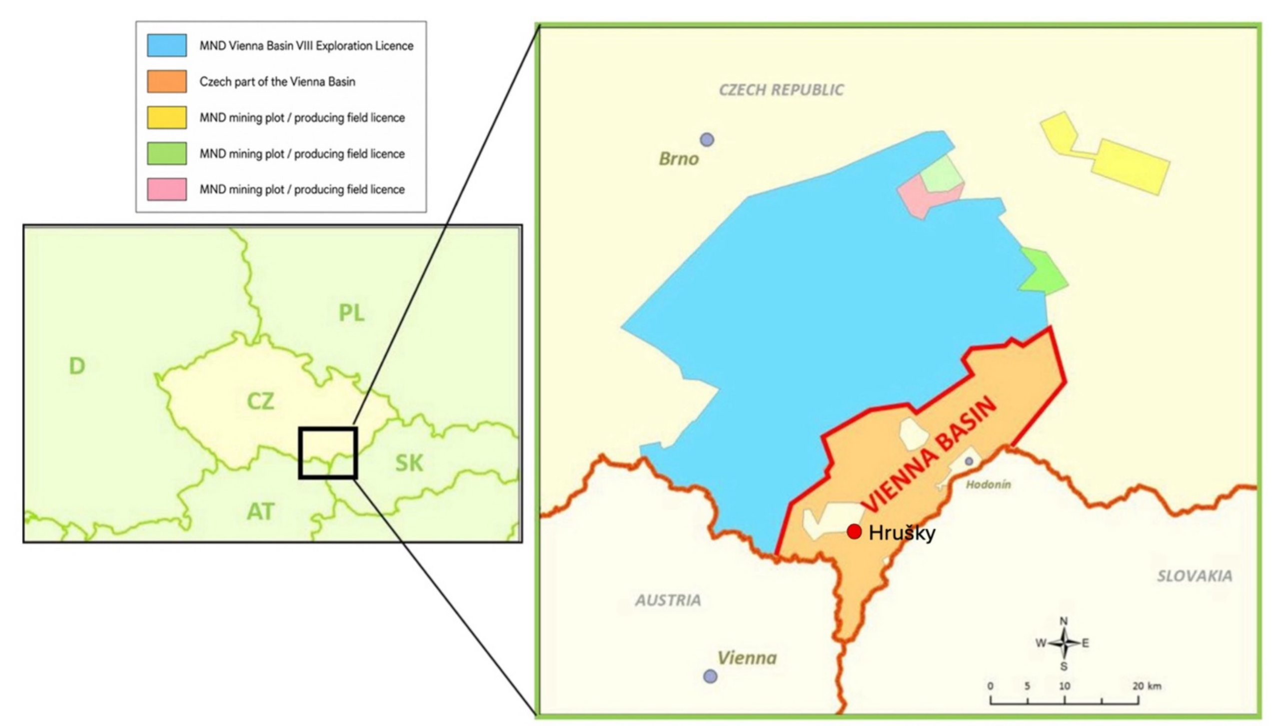

Figure 19: Vienna Basin exploration license in the Czech Republic.

The concession area defines the spatial extent of subsurface rights and governs the regulatory framework under Czech mining law, including the conditions for exploration, production, storage, abandonment, and potential future repurposing. Even though the wells in the Hrušky field have been depleted in terms of oil production, they remain subject to these legal obligations. Any shift from hydrocarbon extraction or storage to geothermal use requires an evaluation of subsurface rights, transfer procedures, and the division of long-term well integrity responsibilities between the original operator and a potential geothermal developer.

A comparable situation exists in the Austrian Weinviertel, where large concession areas granted for hydrocarbon exploration have resulted in extensive well networks and highly detailed geological datasets. Although regulatory frameworks differ between the Czech Republic and Austria, both regions share the advantage of well-documented subsurface conditions and decades of operational experience. This makes concession areas such as Hrušky highly valuable for assessing the feasibility of geothermal repurposing.

In the context of the TRANSGEO project, the Hrušky concession area provides an instructive example of how legacy hydrocarbon fields can be evaluated for geothermal conversion. The insights gained here support a broader cross-border understanding of administrative, legal, and operational challenges associated with well reuse in the Vienna Basin.

4.4. Well Construction

The wells drilled in the Hrušky field were designed and constructed according to standards applicable to oil and gas production in Central Europe during the mid- to late 20th century. Typical wells in the field reach depths between 1,000 and 1,800 metres, targeting multiple Miocene reservoir horizons. The well architecture generally consists of a conductor casing, surface casing, intermediate casing strings, and production casing, completed with cemented annuli to ensure zonal isolation.

The construction quality and long production history provide extensive information on borehole stability, casing conditions, and cement integrity. Many wells have undergone multiple workovers, recompletions, and testing phases, yielding valuable documentation for evaluating their suitability for geothermal repurposing. As part of standard Plug & Abandonment (P&A) planning, integrity assessments (such as cement bond logs, calliper logs, and pressure tests) are typically available or can be readily performed. These assessments form a critical input for determining whether the well can safely host a Deep Borehole Heat Exchanger (DBHE) or similar closed-loop geothermal system.

In a geothermal repurposing scenario, mainly the lower part of the wellbore is required to serve as the main heat-exchange interval. The upper sections may undergo partial modifications, including removal of production tubing, cleaning of the borehole, and installation of new wellhead equipment compatible with geothermal operation. The conversion process generally overlaps with activities required under the oil company's P&A obligations, which can substantially reduce net project costs. Where necessary, casing repairs, cement remediation, or installation of liners can ensure long-term mechanical integrity.

The Hrušky well construction practices are representative of those used across the Weinviertel hydrocarbon fields in Austria. Well designs, casing programs, and cementing methods are comparable, reflecting shared geological conditions and long-standing cooperation between regional operators. As a result, technical insights gained from the Hrušky pilot (such as cleaning requirements, DBHE installation procedures, and wellhead modifications) can be directly applied to similar well repurposing projects in the Austrian Vienna Basin.

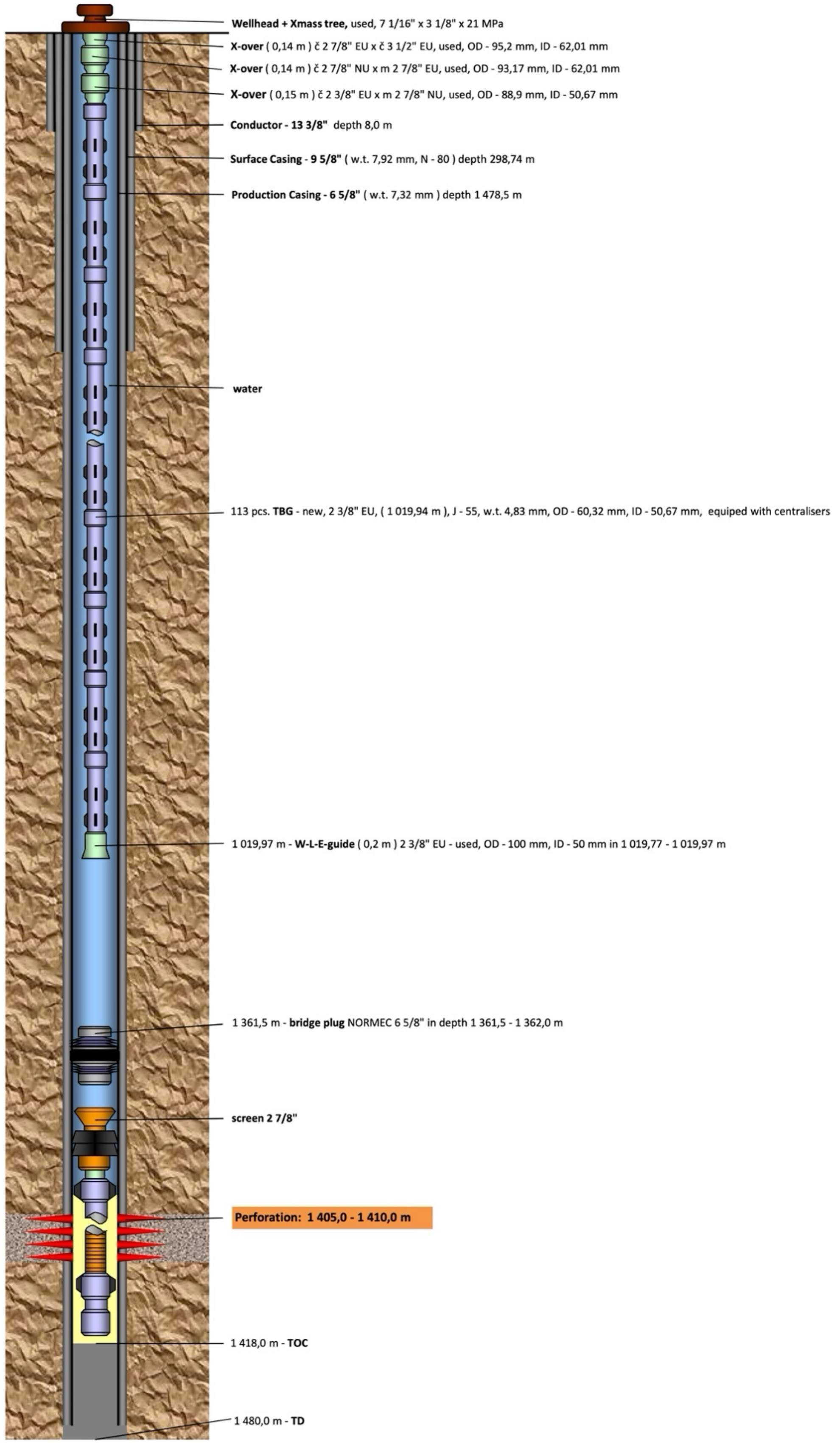

Figure 20: Well schematic Hrušky Z40.

5. Environmental Features of the Project from the Perspective of Environmental Impact

The conversion of a decommissioned hydrocarbon borehole into a geothermal (petrothermal) production well represents an environmentally favourable approach to subsurface energy utilisation. By reusing existing infrastructure rather than drilling new wells, this method significantly reduces surface disturbance, resource consumption, and potential environmental risks typically associated with new field development.

5.1. Reduced Surface and Subsurface Footprint

One of the primary environmental advantages lies in minimising land use and surface impact. The well site, access roads, and related infrastructure already exist from the previous hydrocarbon operation. Reutilising these facilities avoids additional land clearance, reduces the need for construction materials, and limits ecological disruption to the surrounding area. The existing site layout can be adapted for geothermal operations with minimal modifications, often confined to installing new wellhead equipment, piping, and a compact surface heat-exchange unit.

On the subsurface level, reusing a structurally verified borehole minimises the risk of unintended interactions with other formations. The borehole trajectory, casing design, and cementing conditions are already known from historic data, allowing precise planning for retrofitting and testing without the uncertainty of new drilling. Using an existing wellbore as a Deep Borehole Heat Exchanger also eliminates the risk of induced seismicity or uncontrolled fluid migration.

5.2. Resource Efficiency and Waste Minimisation

Reusing an existing well directly contributes to resource efficiency by reducing the need for new drilling materials, such as steel casing, drilling muds, and cement. Since no extensive drilling waste is generated, cuttings, mud disposal, and associated transport emissions are largely avoided. The limited construction phase leads to a smaller carbon footprint and a reduction in local nuisance factors such as dust, traffic, and noise emissions.

Additionally, by maintaining or rehabilitating the integrity of the existing well, the project extends the useful life of industrial assets, aligning with the principles of circular economy and sustainable resource management. Only minor volumes of waste, mainly from cleaning, decommissioning of obsolete hydrocarbon equipment, and installation of geothermal components, are expected, all of which can be managed under standard waste handling protocols.

5.3. Groundwater and Soil Protection

Environmental protection measures are focused primarily on groundwater and soil integrity. Before conversion, the existing borehole undergoes a comprehensive well integrity assessment to verify the condition of casings, cement bonds, and annuli. Any identified weaknesses are remediated through re-cementing, casing repairs, or liner installations to ensure complete hydraulic isolation between deep geothermal horizons and shallower freshwater aquifers.

During operation, the closed-loop or semi-closed geothermal system prevents any direct contact between geothermal fluids and surface or groundwater bodies. In cases where reinjection of produced fluids is necessary, reinjection zones are carefully selected to ensure compatibility with formation characteristics and to prevent any upward migration. Continuous temperature and pressure monitoring ensures early detection of anomalies that might indicate leakage or fluid movement outside the designed system.

5.4. Air Emissions and Noise

Since petrothermal geothermal systems are based on closed fluid circuits, air emissions are minimal. No combustion processes occur at the well site, and the geothermal fluid is typically non-volatile, eliminating emissions of hydrocarbons or greenhouse gases that are common in fossil fuel extraction. Any minor emissions originate from auxiliary systems such as emergency generators or circulation pumps, which can be mitigated through the use of low-emission equipment and renewable electricity.

Noise emissions during the conversion phase are temporary and localised, arising mainly from workover operations, pump installation, and surface construction. These impacts are short-term and can be managed through acoustic barriers, restricted working hours, and monitoring to comply with local environmental noise standards.

5.5. Biodiversity and Landscape Considerations

Because the site footprint remains unchanged and most equipment is installed on land already used for industry, biodiversity and landscape impacts are minimal. Reactivating a well within an existing oil or gas field avoids encroachment into new or sensitive habitats. Visual impacts are also low, as geothermal surface installations (heat exchangers, pumps, and control units) typically occupy less space and are lower in height than the original hydrocarbon facilities.

5.6. Climate and Sustainability Perspective

From a climate perspective, converting an existing borehole into a geothermal system contributes directly to decarbonisation by enabling the production of renewable, low-carbon heat or power. The lifecycle greenhouse gas emissions are a fraction of those from fossil fuel operations, even when considering construction and retrofit activities. The project also supports the transition of traditional energy regions, such as the Vienna Basin and Weinviertel, toward sustainable energy production, thus leveraging local geological expertise while reducing environmental legacy issues associated with ageing hydrocarbon infrastructure.

5.7. Summary of Environmental Impact

Overall, the environmental profile of converting an existing borehole for geothermal use is characterised by:

- Substantial reduction in land disturbance and material use
- Low emissions and waste generation during conversion and operation
- Effective protection of groundwater and soil through tested well integrity
- Minimal impact on biodiversity and local communities
- Positive contribution to regional climate and sustainability goals

In conclusion, the repurposing of an existing hydrocarbon borehole into a geothermal well represents a low-impact, high-sustainability pathway for regional energy transformation, combining efficient resource use with measurable environmental benefits.

6. Techno-Economic Analysis of the Feasibility of Investing in a Geothermal Field at the Potential Location with the Aim of Producing Thermal Energy

6.1. Introduction to Techno-Economic Analysis

This techno-economic analysis evaluates the feasibility of repurposing an existing depleted hydrocarbon well for petrothermal energy production in the Weinviertel/Vienna Basin region. Unlike traditional hydrothermal systems, petrothermal applications exploit conductive heat transfer within low-permeability formations, using the existing wellbore as a closed-loop heat exchanger rather than relying on natural fluid flow.

The primary economic rationale for such projects lies in the reduction of drilling and abandonment costs, the generation of low-carbon heat, and the reuse of existing infrastructure that would otherwise require full decommissioning.

Key factors for assessing investment feasibility include:

- Energy Market Context: The regional market for low-temperature renewable heat is growing, driven by demand from agriculture, light industry, and municipal buildings. Conventional heat supply based on gas remains volatile, with prices between €40–70/MWh_{th} in Austria and neighbouring regions.
- Price Trends and Competition: Rising carbon prices and stricter environmental regulations increase the competitiveness of geothermal heat, even at modest temperature levels. Petrothermal systems are best suited for decentralised applications where small, continuous heat loads (50–250 kW_{th}) can be utilised locally.
- Strategic and Environmental Relevance: The reuse of a decommissioned well offsets part of the oil company's plug & abandonment costs, while creating a renewable energy asset with minimal new surface disturbance. The resulting system contributes to CO_2 reduction, circular economy principles, and responsible end-of-life management of oil & gas infrastructure.

6.2. Plan of Engineering Works for the Revitalisation of an Existing Borehole

Because the existing well already penetrates the required depth, the primary engineering activities involve re-entering, cleaning, verifying, and partially modifying the well to accommodate a closed-loop heat exchanger or coaxial tubing system.

A significant portion of the well preparation and safety sealing work coincides with the mandatory plug & abandonment (P&A) obligations of the former operator, effectively reducing project CAPEX.

Typical Work Breakdown and Indicative Cost Ranges

Work Item	Description	Indicative Cost (€)
Geological and Thermal Re-evaluation	Review of temperature gradient, borehole geometry, and expected thermal yield	20,000-40,000
P&A Coordination and Cost Sharing	Shared civil and safety works with oil/gas operator	(Included in P&A)
Well Cleaning and Inspection	Removal of tubing, debris, borehole imaging	30,000-60,000
Integrity Testing	Cement bond and pressure tests	20,000-40,000
Installation of Closed-Loop System	Coaxial or U-tube system, sealing packers, sensors	100,000-200,000
Surface Heat Exchanger and Circulation System	Plate heat exchanger, circulation pump, control cabinet	50,000-80,000
Electrical Connection and Control	Wiring, instrumentation, SCADA	10,000-20,000
Environmental & Safety Measures	Monitoring, minimal site reinstatement	10,000-15,000
Total (indicative)		**€250,000 - €450,000**

Table 4: Typical work breakdown and indicative cost ranges.

Compared to new geothermal drilling, this represents a 90% cost reduction and turns a decommissioning liability into a productive asset.

6.3. Defining Assumptions for Economic and Financial Analysis

Parameter	Assumption
Project Review Period	20 years
Residual Value	5% of CAPEX after review period
Discount Rate (Real)	6-8%
Inflation Rate	2% per annum
Temperature at Wellhead	25-60°C
Flow Rate (Closed Loop Equivalent)	2-10 L/s
Thermal Capacity (Continuous)	50-250 kW_{th}
Annual Operating Hours	6,000-7,000
Annual Thermal Energy Output	300-1,500 MWh_{th}
Heat Selling Price	€40-60/MWh_{th}
Exploitation Fees / Royalties	None
Employment Impact	<1 FTE (monitoring and remote supervision)
CO_2 Emission Reduction	~0.2-0.3 t CO_2 avoided per MWh_{th} (compared to natural gas)

Table 5: Defining assumptions for economic and financial analysis.

6.4. Assessment of Basic Investment Amount

For a single-well Deep Borehole Heat Exchanger, total investment (CAPEX) is estimated at €250,000-€450,000, depending on borehole condition, retrofitting complexity, and surface connection distance. If part of the well preparation is conducted under the oil company's P&A budget, the net incremental cost for the geothermal conversion could drop to €150,000–€250,000. With an annual energy output of roughly 600–1,000 MWh_{th}, this corresponds to specific investment costs of €250–400 per installed kW_{th} or €15-25/MWh_{th} over the lifecycle, which is competitive for renewable heat at a small scale.

6.5. Defining Benefits and Financial Effects of the Project

Determination of Price and Revenue Calculation

Revenues depend on the geothermal heat output, sale price, and operational period: $R = Q \times P$

Where:

- R = annual revenue (€)
- Q = annual energy sold (MWh_{th})
- P = sale price (€/MWh_{th})

Assuming a sale price of €50/MWh_{th} and 800 MWh_{th} of annual production, the annual revenue would be approximately €40,000.

Operating Expenses (OPEX)

OPEX for a petrothermal unit is minimal and largely electricity for the circulation pump (1–5 kW) and periodic inspection.

Cost Category	Description	Typical Annual Cost (€)
Electricity for Pump Operation	3,000–5,000 hours/year at €0.20–0.25/kWh	1,000–2,500
Supervision and Maintenance	Remote monitoring, annual inspection	2,000–4,000
Insurance and Overheads	Minor administrative costs	1,000–2,000
Total OPEX		**€4,000–8,000 / year**

Table 6: Operating Expenses for a petrothermal unit.

Economic Indicators (Representative Case)

Indicator	Result (approximate)
Net Present Value (NPV, 20 years, 7% discount)	€100,000–180,000
Internal Rate of Return (IRR)	8–11%
Discounted Payback Period	8–10 years

Table 7: Economic Indicators for the representative case.

Conclusion of Economic Evaluation

Although revenues are modest, the project is economically viable when combined with avoided decommissioning costs and environmental benefits. It provides a stable, long-term renewable heat source for local use with negligible operational costs and risks.

6.6. Sensitivity Analysis

Parameter	Variation	Impact on NPV	Comment
Heat Selling Price	±20%	±25-30%	Strongest sensitivity
CAPEX (Net of P&A Contribution)	±20%	±20%	High influence
Operating Hours	±15%	±10-15%	Dependent on demand
Discount Rate	6-10%	−10% NPV at higher rate	Financial exposure
Electricity Price (for pump)	±50%	<5%	Negligible impact

Table 8: Parameters for sensitivity analysis and impact on NPV.

Overall, the economics remain stable within reasonable variation ranges, with price and CAPEX being the most critical parameters.

6.7. Defining Project Risks

Risk Category	Description	Mitigation Measures
Technical / Technological	Wellbore degradation, limited thermal yield	Detailed integrity tests, use of insulated coaxial tubing, pilot testing
Economic / Financial	Low heat demand, pricing below threshold	Secure local heat offtake agreements, municipal partnerships
Environmental	Potential minor leakage, disturbance during re-entry	Use of certified sealants, monitoring sensors, low-impact rework procedures
Institutional / Regulatory	Ambiguity in geothermal licensing for P&A reuse	Early engagement with authorities, alignment with closure obligations
Social / Acceptance	Perceived link to former oil activity	Emphasise renewable conversion, local awareness campaigns

Table 9: Risk categories and mitigation measures.

The overall project risk is low, as most environmental and structural risks are already mitigated during the P&A process, and the operation phase has negligible emissions or fluid handling.

6.8. Summary

Reusing an existing hydrocarbon borehole for petrothermal energy generation represents a cost-effective, environmentally responsible, and technically straightforward option for small-scale renewable heat production.

By combining mandatory well closure activities with geothermal repurposing, total investment is minimised, OPEX remains very low, and the system contributes meaningfully to regional decarbonisation without major infrastructure demands or social impact.

7. Conclusion

The feasibility study demonstrates that repurposing a depleted oil or gas well in the Weinviertel/Vienna Basin as a Deep Borehole Heat Exchanger is technically achievable, environmentally low-impact, and potentially economically viable, provided that suitable local heat demand exists near the wellbore. Thermal conditions in the basin are modest but sufficient to support small-scale petrothermal systems designed for continuous, low-temperature heat supply.

From a technical perspective, the reuse of existing well infrastructure significantly reduces project complexity and cost compared to drilling a new geothermal well. Much of the necessary well preparation aligns with work already required under Plug & Abandonment obligations, which can reduce the net investment for geothermal conversion. Operating costs are very low, dominated by minimal pump electricity and periodic supervision, and system availability is high.

Economically, the system can deliver stable and predictable heat output at competitive prices, especially when replacing fossil-fuel-based heating in nearby agricultural, commercial, or municipal facilities. Financial viability is strongest when a reliable, year-round heat consumer is located within a few hundred metres of the well. Sensitivity analyses show that the project is most responsive to heat price, CAPEX, and local demand conditions, while relatively insensitive to electricity prices or operational expenditures.

However, the assessment also identifies significant regulatory and land-use challenges. Current mining laws in Austria and neighbouring countries do not provide a clear framework for transferring long-term well liability from hydrocarbon operators to geothermal users. Surface planning regulations make it difficult to install even small technical structures in agricultural or forest zones, which is where most legacy well sites are located. These unresolved issues currently represent the main barrier to the broader deployment of DBHE systems in the region.

Overall, repurposing depleted wells for petrothermal energy generation offers a promising but currently under-supported opportunity. With suitable regulatory clarification and land-use planning adjustments, such systems could significantly contribute to local decarbonisation, minimise abandonment liabilities, and provide a sustainable, low-impact energy source for rural communities in the Weinviertel and the broader Vienna Basin.

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