# C. Description of the pilot area

## 1. Infrastructural and socio-economic settings

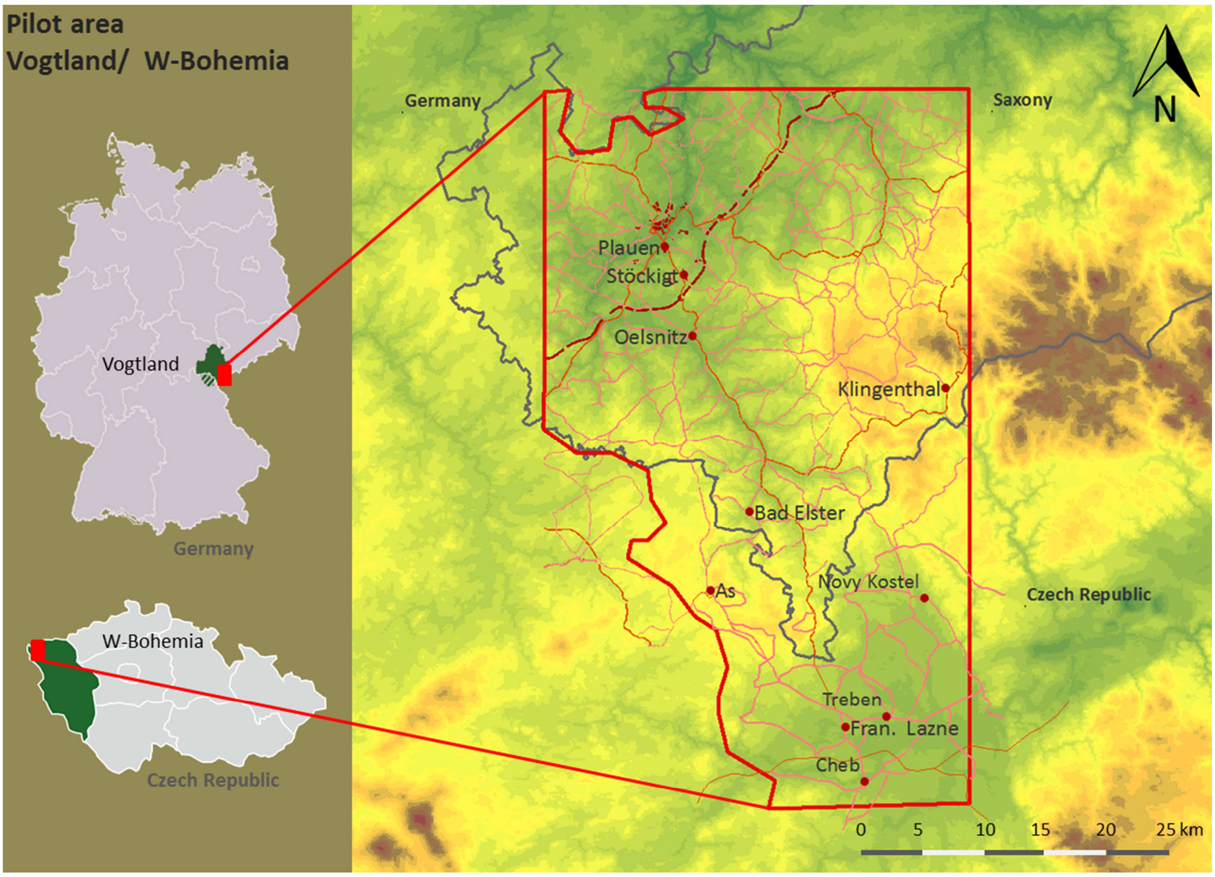



**Figure 1: The Pilot area – map overview.**

The pilot area is located in the SW Saxon part of the Vogtland region and extends to the most western part of Bohemia (Figure 1). It covers an area of 1,900 km$^2$ (540 km$^2$ in W-Bohemia and 1,360 km$^2$ in Vogtland). The NW part of the pilot area consists of a hilly landscape with woody hilltops and steep and wide river valleys. In the south and southeast, the Vogtland rises to mid-height mountain range, where coniferous forests form the dominant part of the vegetation. The highest mountain reaches 974 m. This landscape consists of a rocky subsurface with thin soils and mainly surface-near drainage systems.

The Vogtland region is populated by 165 inhabitants per square kilometre (Statistisches Landesamt Sachsen, 2014), who live either in small towns or in villages. The district city in the region is Plauen with approx. 65,000 inhabitants. The pilot area is a historical industrial region. The infrastructure is well developed with a dense net of streets and railways and a highway connecting the region to other parts of Saxony, Thuringia and Bavaria and Czech Republic.

On the Czech side, four cities over 5,000 inhabitants are located in the region – Cheb (32,355 inh.), Aš (13,190 inh.), Kraslice (6,885 inh.) and Františkovy Lázně (5, 536 inh.). Totally, 23 towns and villages are located in the Czech part of pilot area. Over 72,000 of inhabitants live in the region (Český statistický úřad, 2016).

Significant differences in population density, transport infrastructure and land use are obvious in the SE and NW parts of region. The NW corner of the pilot area is mostly covered by woods, less roads and populated places are present here. On the other hand, the area near Cheb and Františkovy Lázně has dense network of roads and railways. The main industrial sectors in the region are engineering and textile industry, wood industry, ceramic industry and brown coal mining industry In the past years the business park in Cheb grew up due to the presence of highway D6 with good connection to Germany.

# 2. Regional geological and hydrogeological characteristics

## 2.1. Geology

The pilot area is located in Saxothuringian zone of the Bohemian Massif. The northern part of the pilot area comprises of the Vogtland syncline. The southern part belongs to the Fichtelgebirge-Erzgebirge anticline composed of crystalline complexes. These units are separated by the SW-NE striking Central Saxonian lineament. The metamorphic grade of the Variscian rocks in the pilot area increases generally from north to south. In the south, the Fichtelgebirge (Smrčiny) and Erzgebirge (Krušné hory) crystalline complexes are covered by the Cenozoic Cheb basin.

The oldest high grade metamorphic rocks are of Cambrian age. Less metamorphosed phyllites and slates comprise the Ordovician Series. Cherts, chert shales and alum shales were depositied in the Silurian. The north western part of the pilot area is composed of Devonian rocks. The Lower and Middle Devonian rocks are dominated by shales, the Upper Devonian by volcanites. The Mehlteuer syncline in the NW, a part of the Vogtland syncline, consists of Lower Carboniferous greywackes and shales. The Paleozoic development in the Vogtland syncline ends with the intrusion of the Permian-Carboniferous plutonic rocks. These are the Fichtelgebirge granite and the Bergen and Kirchberg granites (Mlčoch et al., 1997). Sequences of the Cheb – Dyleň crystalline, which is also assigned to the Saxothuringian zone, crop out south of the Fichtelgebirge pluton. Its southern part consists of micaschists with andalusite, eventually sillimanite.

The post-variscian platform evolution of pilot area is represented by Cheb basin. The first episode of the Cenozoic Cheb Basin evolution is related to the structural domain of the Eger (Ohře) Graben (Špičáková et al. 2000). The specific role of the Cheb Basin in the geological fabric of the NW part of the Bohemian Massif is a result of its location at the intersection of the Eger Graben structural domain, characterized by dominance of NE-striking graben systems, and the NW-striking Cheb-Domažlice Graben, a major feature in the topography of Western Bohemia. The eastern margin of the basin is defined by the Eastern Border Fault Zone, a northern termination of the Mariánské Lázně Fault Zone, which facilitated basin subsidence during later evolution. The western margin of the basin forms a transition to the zone of erosional relicts of Neogene sediments and volcanic rocks of the Fichtelgebirge Mts. in Bavaria. Locally the Cheb basin is covered by Quarternary sediments. Total thickness of Cenozoic sediment infill of the Cheb basin is 300 m.

## 2.2. Hydrogeology

Three different hydrogeological setups can be distinguished in the pilot area:

Magmatic and metamorphic crystalline rocks in the Vogtland and Fichtelgebirge are dominated by fracture porosity. The main fracture directions are NE-SW, E-W and NNE-SSW. The fractures are unevenly distributed. Discontinuous aquifers with variable thickness can be unconfined, partially (semi)-confined and confined. The water level approximately copies terrain morphology. Water circulation in deeper zones is regionally associated with faults and locally with fractures. The near-surface groundwater in weathered rocks is important for the local supply with drinking water.

The major groundwater reservoir in pilot area is located in the Cheb basin. The Cheb basin has a typical structure of alternating aquifers and aquitards. According to Krásný et al. (2012) it comprises 3 major hydrogeological units. The first is the Basal Collector (Lower Clay and Sand Fm.). The second is the Middle

Aquitard (Cypris Fm., sporadically Main Coal Seam Fm., Vonšov Member of upper Vildštejn Fm. and Lower Clay and Sand Fm.). The third is Upper Collector Complex Aquifer (Nová Ves Member of Vildštejn Fm.). The upper part of Vildštejn Formation and fluvial sands and gravels in the area of the confluence of the Ohře and Odrava rivers form the uniform aquifer which is characterized by high transmissivities. The infiltration area of the basin spreads NW and W to Fichtelgebirge. Water is transported eastward in a Basal Collector Complex and in the crystalline basin footwall. Then the water is partially drained in Slatinný stream valley (Františkovy Lázně, WNW-ESE structure) and in the area of Soos (NW-SE structure). The main drainage is located in Ohře river valley in the vicinity of Kynšperk nad Ohří.

Deep water circulation in the area of interest is expressed by presence of carbonated mineral water springs spatially associated with tectonic discontinuities in Cheb basin. The highest density of natural mineral water springs was reported in Františkovy Lázně and Soos. Other springs of natural mineral and radioactive water occur in and outside of the Cheb basin.

# 3. Market situation and existing shallow geothermal use

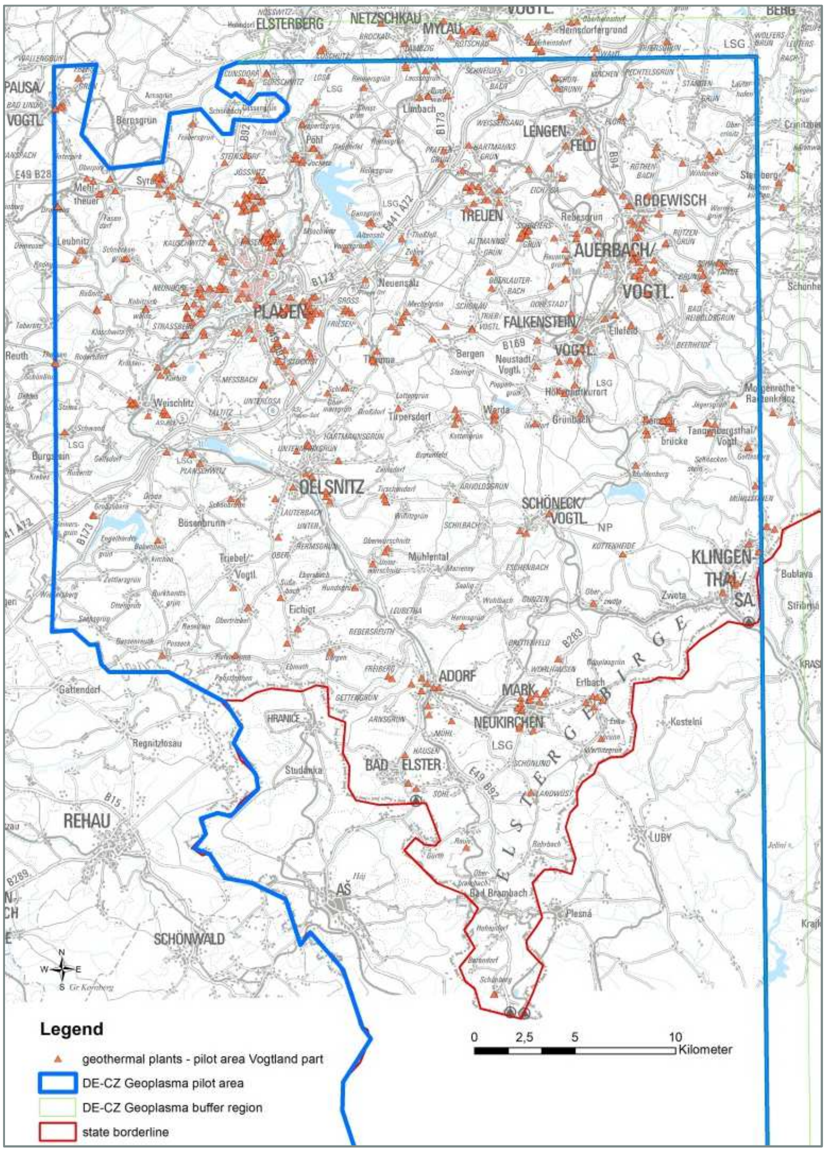
In the Vogtland, most of the geothermal plants are concentrated around the cities Plauen and Auerbach (Figure 1). The main installations are for detached and family houses with a heating capacity approx.10 kW. There are 20 geothermal plants with a heating capacity higher than 30 kW for public and business buildings and one swimming pool. The largest plant with 180 kW is installed at an administrative building. In sum, 579 geothermal uses are registered with a total heating capacity of approx. 7.2 MW. As shown in the Tab. 1 the geothermal closed loop systems dominate. Five geothermal uses are open loop systems (<1%), which is due to the geological situation. Geothermal cooling is not registered for Vogtland area. **Fehler! Verweisquelle konnte nicht gefunden werden.** illustrates the annual development of new geothermal installations and shows the rapidly increasing geothermal uses between the years 2004 and 2008. Since 2008 there was a decrease until 2010, due to the financial and building crisis. Since 2011 there has been a constant annual growth of approx. 19 new installations.

**Tab. 1. An overview of geothermal uses at pilot area part Vogtland (Source: LfULG, Dec. 2016)**

| | pilot area closed loop systems | pilot area open loop systems | sum |
|---|---|---|---|
| **geothermal uses** | 574 | 5 | **579** |
| **installed heating capacity [kW]** | 7,214 | 55 | **7,269** |

The evolution of the heat pump market in the Czech Republic is monitored by Ministry of trade with the cooperation of Czech Heat Pump Association (**Fehler! Verweisquelle konnte nicht gefunden werden.Fehler! Verweisquelle konnte nicht gefunden werden.**). Collected data are based on form survey of companies covering >80% of heat pumps sales in the Czech Republic. The rest share (<20 %) of market is determined by expertise estimation of the Czech Heat Pump Association.

Because the statistics does not include territorial aspect, it is not possible to determine the number of heat pump installations in the pilot areas within the Czech Republic.



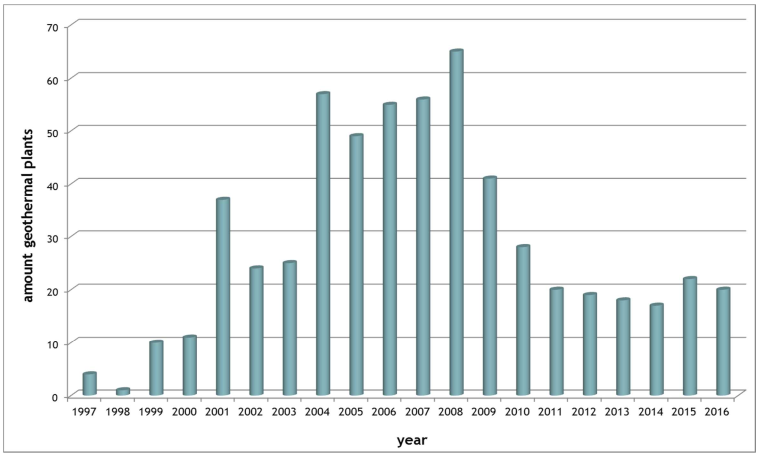




**Figure 1. Geothermal uses at pilot area part Vogtland and the development of annual installations of geothermal plants.**

**Tab. 2. An overview of geothermal uses in the Czech Republic.**

| | Air/Air | Air/water (recuperation) | GHP (closed loop) | GHP (open loop) | Total |
|---|---|---|---|---|---|
| Year | Number of sold heat pumps in CZE | | | | |
| **2010** | 4, 199 | - | 1, 707 | 53 | **5 ,959** |
| **2011** | 4, 908 | - | 1, 951 | 50 | **6, 909** |
| **2012** | 5, 325 | 21 | 1, 825 | 44 | **7, 215** |
| **2013** | 5, 747 | 15 | 1, 694 | 49 | **7, 505** |
| **2014** | 6, 247 | 35 | 1, 532 | 46 | **7, 860** |
| **2015** | 7, 193 | 11 | 1, 479 | 107 | **8 ,790** |

# 4. Main challenges and needs for shallow geothermal use

The Eger graben is located in the south of the pilot area. This graben is associated with a lithospheric uplift which causes a geothermal gradient of >5.5 K/100 m. Towards the north of the pilot area, the geothermal gradient is decreasing to a value of 3 K/100 m. This means, that the geothermal potential for the same kind of rock in the north of the pilot area is only half of its potential to the south. The tectonic and volcanic activity in the Eger graben is related to the ascent of juvenile water which is advected along fracture and fault systems. This juvenile water is used in spas and would increase the geothermal potential of geothermal plants located near-by. However, since the juvenile water is protected in curative water protection zones, the use of this geothermal potential contains also a land-use conflict risk.

Czech Geological Survey (CGS) collects many geoscientific data, but they are primarily used for activities and projects not concerning the shallow geothermal energy. This is the reason that the data suitable for evaluation of geothermal potential is often inconsistent. The additional fostering of geothermal usage is a main challenge in this region, because of the good geothermal rock conditions and the stand-alone house heating situation of rural areas.

# 5. Project objectives

The geothermal potential will be estimated based on a 3D model and be calibrated by project related field measurements. Furthermore, the project aims to develop a map of land-use conflict and risk factors for the use of shallow geothermal energy in the pilot area. The project results shall be presented on a multi-lingual web-portal, presenting the geothermal resources and risk factor for the public sector. An international expert web-platform shall disseminate levelled standards and approaches for the assessment, planning and management of shallow geothermal. Working on these products, joint planning and management standards including also long-term monitoring will be tested in the pilot area with strong involvement of the local stakeholders, which are responsible for the transposition of the project results into energy planning strategies. This demands new methodical workflows which have to be set up between the GeoPLASMA-CE project partners as well as internally in the CGS. We have to identify the gaps in data availability and plan, perform new measurements of the most demanded parameters.

The final aim of this project is to achieve standards for the collection, modelling and presentation of data and technical approaches, which are important for the planning of shallow geothermal plants which can be used by the stakeholders. We have to identify the gaps in data availability and plan, perform new measurements of the most demanded parameters.