C. Description of the pilot area

1. Infrastructural and socio-economic settings

The pilot area Vienna is located within the capital of Austria in Central Europe. The city of Vienna is situated at the easternmost extension of the Alps in the Vienna Basin, which constitutes the western part of the Pannonian Basin. Elevations in the pilot area only range between 145 m and 200 m above sea level.

The spatial extension of the pilot area covers parts of the city of Vienna and several municipalities in Lower Austria. The total extent of the pilot area is 220 km². The major part comprises the districts 21 (Floridsdorf) and 22 (Donaustadt) and only a small part encompasses municipalities in Lower Austria adjacent to these districts (Gerasdorf bei Wien, Groß-Enzersdorf, Oberhausen, Wittau, Probstdorf, Mühlleiten, Schönau an der Donau).

The outline of the pilot area was derived from the boundary of the ground water body Marchfeld and the urban catchment area of the city of Vienna. The river Danube constitutes the southwestern border of the pilot area. Figure 1 shows the outline of the pilot area.

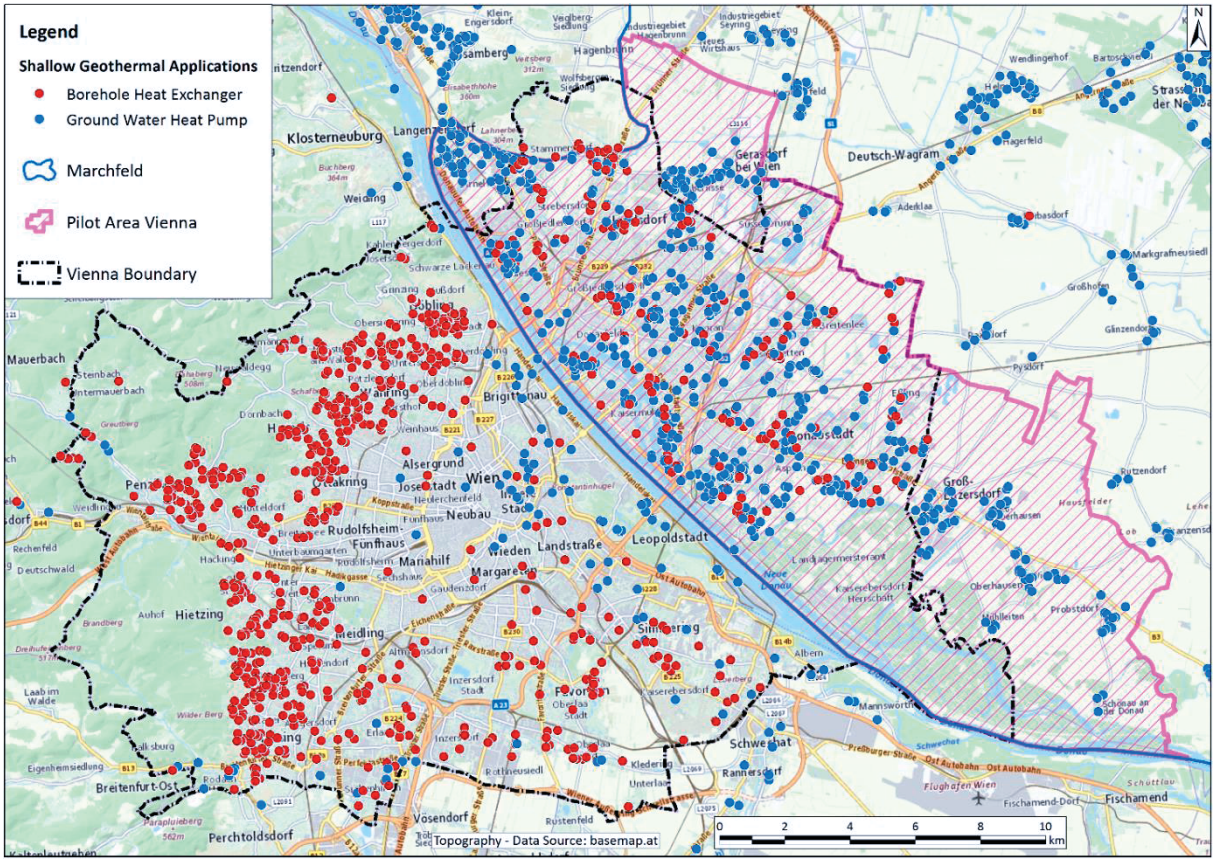

Figure 1 Outline of pilot area Vienna and existing shallow geothermal applications.

The Austrian organization “Statistik Austria” provides information about the population in the pilot area, the latest statistics for Vienna are available for 2015, whereas the numbers for Lower Austria are from 2001. A total of 339,356 people are registered in the pilot area, whereof 95 % live in Vienna. The difference between the two states might not be as high as the numbers show, since they neglect a population growth in Lower Austria of 10 years. The population density is also higher in the two districts of Vienna, 2,214

inhabitants per square kilometre and 193 inhabitants per square kilometre in the municipalities of Lower Austria.

The city of Vienna is growing, especially in the territory covered by the pilot area in the North – East part of the city, on the left bank of the river Danube. Four target areas of urban development are located in this region. The project "Seestadt Aspern" will provide housing for 20,000 people until 2028 and is therefore amongst the biggest European urban development projects. Densely built-up areas already cover around 2/3 of the pilot area. According to the CORINE database 2012 the remaining part comprises farming land, the so called Marchfeld, mostly in the municipalities in Lower Austria. Broad-leaved forest dominates the southern part Lobau in district 22.

2. Regional geological and hydrogeological characteristics

The Vienna Basin, which contains the pilot area Vienna, is one of the world's most studied pull-apart basins. It was formed in the Miocene, however the Vienna Basin fault system remains seismically active until today (Salcher et al., 2012). Alpine and Carpathian nappes constitute the basement formations. A transgressional phase succeeded the creation of the pull-apart structure and clastic sediments, primarily fine grained silts and sands, filled the basin. These Neogene sedimentary layers reach a total thickness up to 5,000 m. Deposition of sediments continued up to Upper Pannonian. Seismic activities resumed during the Quaternary and the former homogenous sedimentary unit was disrupted into horst and graben structures. The simultaneous subsidence of the graben sections and the deposition of sediments resulted in greater thicknesses of Quaternary sediments in the grabens than on the horsts. The distribution of sediments is shown in Figure 2.

The groundwater body Marchfeld (GK100020) consists of Quaternary sediments deposited from the rivers Danube and March, whereas 90 % of the sediments originated from the Danube and only 10 % from the March. The river Danube, the hill Bisamberg and the area Weinviertel border the groundwater body Marchfeld, to the South, West and North, respectively. Around 85 % of the groundwater body are located in Lower Austria, the remaining area is part of the City of Vienna, according to the data sheet of the groundwater body Marchfeld provided by the Federal Ministry of Agriculture, Forestry, Environment and Water Management. The total area of this porous aquifer, which consist mainly of gravel and sand, covers 942 km². The mean hydraulic conductivity of the aquifer is $5 \cdot 10^{-3}$ m.s^{-1} and its mean gross thickness is 25 m. The gross aquifer thickness varies between 3 and 80 m. Groundwater inflow, infiltration of surface water bodies and precipitation as well as artificial recharge comprise the processes of total groundwater recharge. The mean annual groundwater temperature is 12.8 °C. There are 72 observation wells located within the Marchfeld groundwater body (status as of 2015).

A study, conducted in the framework of the Ordinance of the Quality of Water Bodies, about the ages of groundwater within the aquifer, revealed dwell times between less than 5 and more than 50 years. The groundwater residence time within the pilot area Vienna vary up to 50 years and are mostly up to 25 years (Humer et al., 2015).

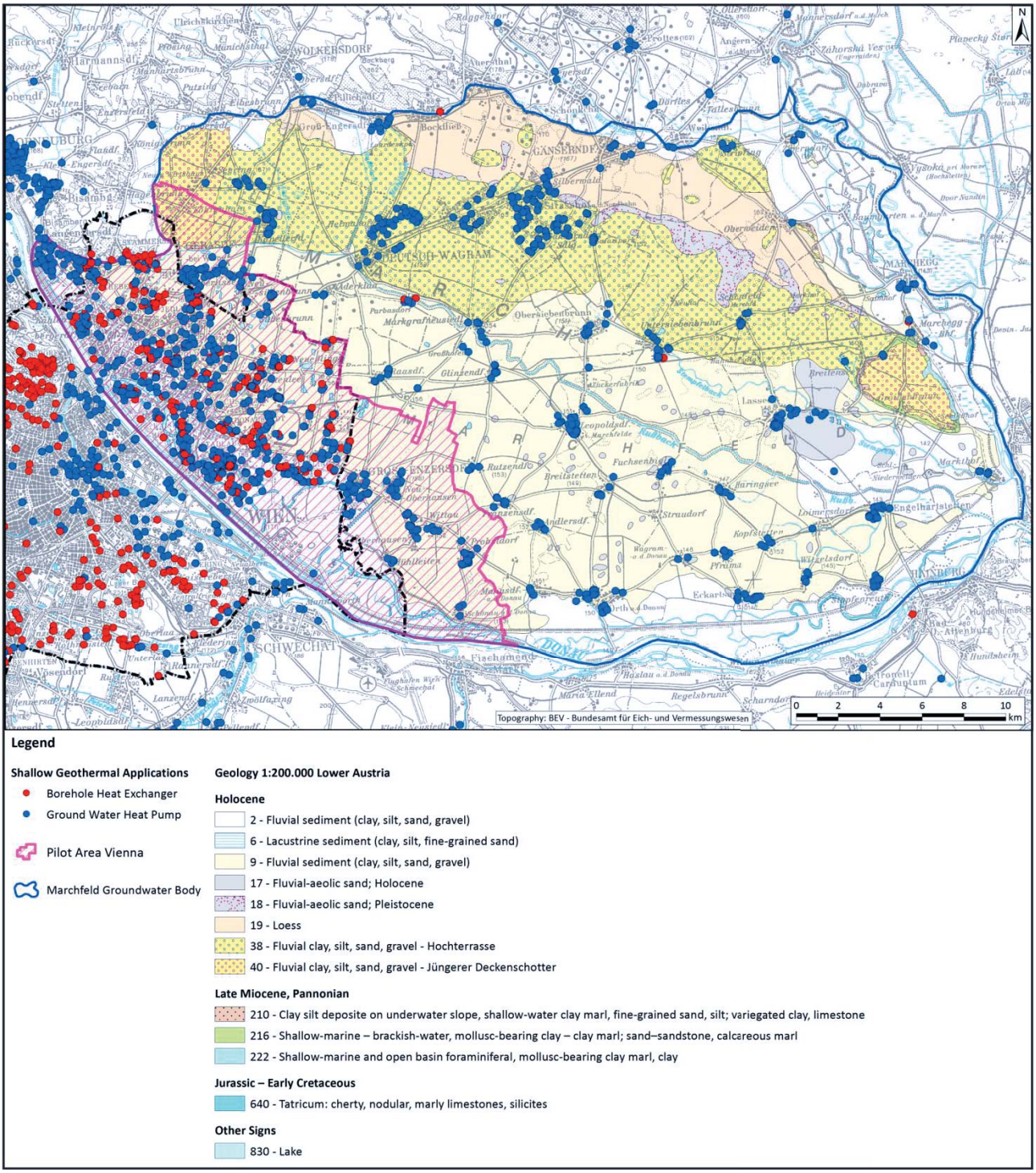

Figure 2 Geological map of groundwater body Marchfeld and outline of pilot area Vienna.

3. Market situation and existing shallow geothermal use

The numbers of geothermal heat pumps in Austria decrease since 2006, whereas the numbers of aerothermal heat pumps still increase. Aerothermal heat pumps are more popular, due to their low acquisition cost, and therefore displace the more efficient geothermal heat pumps steadily, as shown in Figure 3.

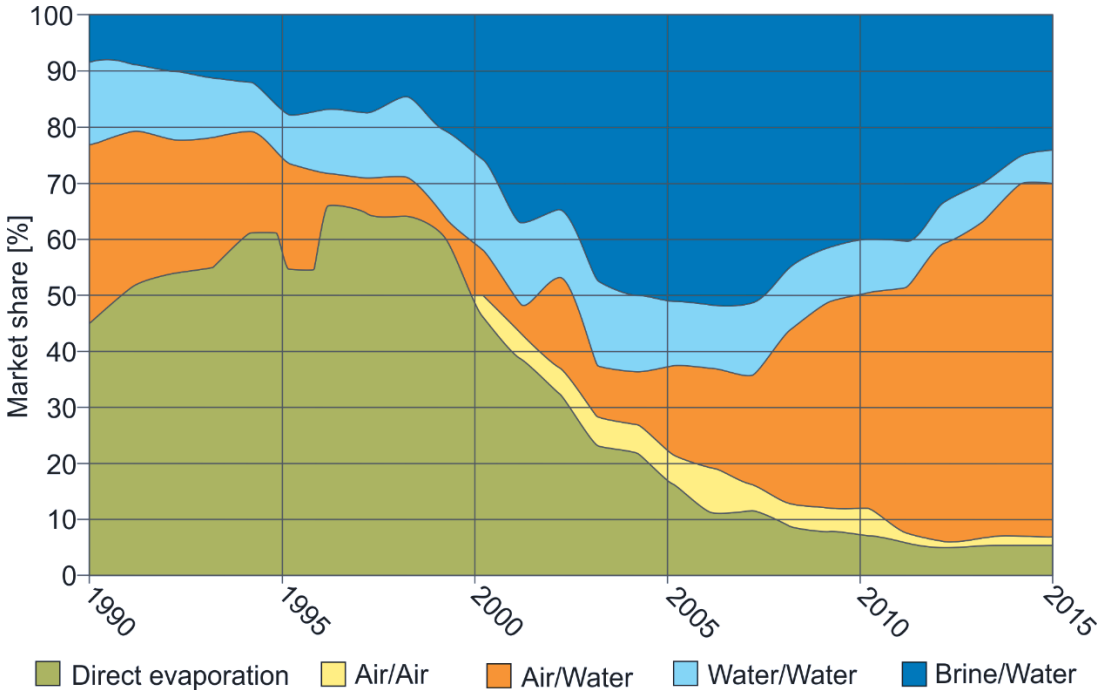

Figure 3 Development of the heat-pump market in Austria, regarding to annual sales and different heat sources. Taken from Biermayr et al. (2015), revised.

In Austria 5,885 geothermal heat pumps were sold in 2014. The number remained almost the same for 2015, with 5,897 units sold, according to statistics, created by the Austrian Ministry for Transport, Innovation and Technology.

The existing installations in the pilot area are shown in Figure 1 and Figure 2. A total of 217 borehole heat exchangers (closed loop systems) and 713 groundwater heat pumps (open loop systems) are registered within the pilot area. The numbers of existing installations for Vienna are from May 2016 and for Lower Austria from February 2017. Borehole heat exchangers are no longer registered within both states. Therefore the information about these systems might already be inaccurate. Nevertheless more than twice as many applications of open loop systems than of closed loop systems exist in the pilot area.

4. Main challenges and needs for shallow geothermal use

The market of shallow geothermal energy faces strong pressure in the City of Vienna, especially regarding the geothermal use of groundwater. Due to the increasing numbers of applications, conflicts of use will arise and cause thermal overload of the shallow groundwater bodies.

The Austrian Water Act (WRG 1959) focuses on the material use of groundwater, especially the drinking water supply. All possible energetic uses of the groundwater are only covered rudimentarily. The natural thermic condition, for example, without a change of quantity (extraction of and injection into the groundwater body), is not defined explicitly as a good groundwater condition. Hence the Water Act cannot meet the requirements concerning geothermal groundwater applications and certificates are still allocated in accordance with the principle “First-come, first-serve”. This procedure, however, neglects optimising the energetic use of the groundwater body.

The maps in Figure 1 and Figure 2 show, that the most applications of open loop systems are located within the groundwater body Marchfeld. This area is therefore well qualified to develop and test tools for

overcoming the challenges of user conflicts. The number of closed loop systems is more than two times lower in the districts 21. and 22. Furthermore the overall situation of user conflicts of closed loop systems, e.g. borehole heat exchangers, is different. Since water is neither extracted from nor injected into the aquifer, hydraulic and thermal impacts are not to be expected from these applications especially from single homes, which is currently the dominant use of borehole heat exchangers. Hence reactions to the challenges of open loop systems in the pilot area Vienna are much more urgent, than investigations on closed loop systems.

5. Project objectives

The aim of GeoPLASMA-CE in the pilot area Vienna is to provide management tools to meet the challenges of user conflicts for geothermal use of the groundwater (open loop systems). A guideline will be developed to overcome the individual treatment of single applications and to foster an integrative management of shallow geothermal applications within the groundwater body Marchfeld.

The following steps will be achieved within the project duration (2017 – 2019):

- Collection of geoscientific data (groundwater thickness, groundwater temperature…)
- Generation of groundwater model
- Creation of geothermal potential maps
- Compilation of guideline including planning tools

Geoscientific data as well as planning tools will comprise the guideline. The planning tools will include official regulations and support, which will be elaborated in accordance with municipal authorities of Vienna. An existing groundwater model of the aquifer Marchfeld will be updated and serve as input for a geothermal potential map. Since the groundwater temperature is another crucial factor, a groundwater temperature map for two seasons will be elaborated additionally. All geoscientific data will be used to establish a geothermal potential map for open loop systems.

The outputs of the project area, such as a guideline and maps, will be made available to the interested public via the GeoPLASMA-CE web portal. Everyone, who is linked in any way to shallow geothermal energy in Vienna, will have the possibility to receive wanted information using this web portal.

References

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